Assistive Learning, Awareness, And Emergency Response System For Children With Autism, Parents, And Caregivers

Solomon Amenyo, Thomas Henaku, Augustus Buckman, Alice Amoako

Abstract: The current study aimed to develop Assistive Learning, Awareness, and Emergency Response System (ALAERS) for Children with Autism, Parents, and Caregivers. Action research and participatory design methodologies were implemented with children with Autism Spectrum Disorder (ASD) along with the participation of their parents, teachers, caregivers, and field experts. The participatory design process involved three workshops with specialized units working with Autistic children, through which sensory exploration and idea generation for the design of the system and its elements were facilitated. Knowledge elicitation workshops with practitioners informed the design of the learning activities and the implementation of the user model. The system was perceived as entertaining, reader-friendly, memorable and engaging. The interactive nature of the assistive learning module was particularly helpful in raising satisfaction as they provided children with the opportunity to make their own learning decisions.

Index Terms: Assistive, Autism, Learning, Awareness, Children, Emergency, Disorder

1 Introduction

Autism is defined by severe and pervasive impairments in many necessary areas of development; it is characterized by a triad of impairment which includes social interaction, communication, and imagination [1]. It is also a lifelong disability. Some studies of people with autism have shown abnormalities in various regions of the brain, together with the cerebellum, amygdala, and hippocampus. Whereas these findings are significant, they need additional study [2]. In Ghana, children with autism are estimated to be 1% of the population of the country and can be found in all the 16 regions. Basically, the use of technology or digital means in the field of autism is very low in Ghana. Various autism centers and other supporting centers in Ghana that care for children with autism use manual ways of teaching them. Usually, they adopt the method of using pictures and sign languages to assist the children on how to communicate, interact, and express themselves.

In general, caring for children with autism and other intellectual disabilities in Ghana over the years has been done through manual means. Various governmental agencies and organizations that take responsibilities for these children have not identified any digital measures that can help improve the lives of the children.

2 The Problem

The environment of children living with autism in Ghana and other African countries have been very critical in terms of getting appropriate care and support for them, their caregivers and guardians. About 50% of the children with autism cannot express themselves verbally and up to 80% are intellectually challenged [3]. Hence, they must use images (Picture Exchange Communication System – PECS) and other forms of sign languages to express themselves. Stigmatization against children living with autism is high because society does not have much knowledge about autism as well as the need to accept these children. According to Salamon [4], social stigma might play a huge role in the depression, anxiety and different psychological state woes suffered by many children living with autism. In Ghana, there is no helpline system that aids parents and guardians of these children with autism in cases of emergency. This research aims at integrating the existing manual use of images and artworks into a technological solution to make it easier for parents and caregivers to teach children living with autism.

- *Solomon Amenyo, Ghana Communication Technology University, Faculty of Computing and Information Systems, Ghana, PH-+233246235444. E-mail: B020112028@live.gtuc.edu.gh*
- *Thomas Henaku, Ghana Communication Technology University, Faculty of Computing and Information Systems, Ghana, PH-+233208551888. E-mail: thenaku@gtuc.edu.gh*
- *Augustus Buckman, Ghana Communication Technology University, Faculty of Computing and Information Systems, Ghana, PH-+233274043050. E-mail: B020112032@live.gtuc.edu.gh*
- *Alice Amoako, Ghana Communication Technology University, Faculty of Computing and Information Systems, Ghana, PH-+233543426588. E-mail: B020112001@live.gtuc.edu.gh*

2.1 Related Research

2.1.1 Autism and Inclusion in Ghana

The notion that comes from inclusion is that each child ought to be an equally appreciated member of the school setting [5]. The term “inclusion” means teaching students with special needs together with their typically-developing mates. It is advantageous for students with special needs to study in inclusive classrooms, as it benefits both the included students and their naturally developing peers, who profit from being exposed to a variety of students [5].

The study of Eldar et al. [5] used a qualitative case-study approach to determine the outcomes of effective inclusion of students with Autism Spectrum Disorder. Their discoveries indicated that students with Autism Spectrum Disorder who are educated in inclusive classrooms have improved social skills, show increased engagement and assimilation, offer and get higher levels of social assistance, have a bigger social network and more concrete educational ambitions [5]. Advanced levels of success were related to social skills [5]. With respects to behaviour, students with Autism Spectrum Disorder demonstrated the ability for self-help, independence, meeting demands, smoother evolutions to change, and better coping mechanisms regarding self-restraint and determination [5]. Furthermore, recurring behaviours were reduced or missing [5]. There was little success in the cognitive field. For instance, a few reports showed an advancement in learning and academic skills in all subjects [5]. In a few cases, students with Autism Spectrum Disorder attained the class average or

stayed above this average [5]. In contrast, the study argued unproductive cases of inclusion. These participants indicated that the complications arose from not coming to an agreement regarding applicable classroom practices and the absence of teamwork among members participating in the formation of an inclusive classroom [5]. This research demonstrates the importance of suitable collaboration and its effect on forming a successful inclusive classroom.

2.1.2 Designing User Interface for Children

This section reviewed the characteristics and user interface design needs of children. According to Markopoulos and Bekker [6] Children, like adults, frequently use technology to accomplish their tasks. They believe a suitable user interface design is necessary to fulfill the computer needs of children. Moreover, based on the principle of user-centered design, there is no appropriate design for all groups of users. Furthermore, designers must develop software based on the target user's cognitive proficiency and taking into consideration children as a special group of users [7]. According to Hutchinson and Bederson [8], the major setback of children is that all children's software is developed by adults and most of them are not acquainted with children's abilities and their preferences. Hence, the applications may not be usable for children and they might even create some learning difficulties for them. Grammenos et al. [9] performed research on designing user interfaces for children by concentrating on the interaction design process to design dairy software for kids between 4-8 years old. Their findings endorsed the following assertions by previous researchers: (a) we have to use extremely visual menus and icons for children to appreciate the software since young children cannot read. (b) "Initiate a user-friendly education system which can be modified to children's preferences and cultural upbringing" [10]. (c) Produce interactive user interface via animation, sound and message boxes [11]. (d) Create an environment that has various standards and can regulate their input to thwart errors. (e) Design software in a manner that does not require combination keys of mouse and keyboard.

2.1.3 The Picture Exchange Communication System (PECS)

PECS was created within the Delaware Autistic Program in the USA centered on observations that 80% of the preschool children admitted had no practical communication skills [12]. The PECS includes the use of pictures in a diverse way from another picture or photograph patterns. PECS starts with demanding and not labeling, involves communication with others from the beginning and inspires the child to commence communication rather than answer to a prompt. The goal of PECS is for children to obtain key communication skills, mainly initiating communication, in a social exchange [13]. It imparts those who may not have any practical communication skills on how to give a picture of a preferred object to another person in substitute for that object. A serious part of the initial teaching is not to pre-empt by inquiring, 'What do you want?' or 'Do you want a drink?' but waiting for the child to hand over the picture card first, so the child instigates the communication [14].

3 METHODOLOGY

We derived our design methodology from a combination of Action Research (AR – from Education) and Participatory Design (PD – from Human Computer Interaction). We emphasized the need to move the locus of design and development closer to the user's community of practice, viewing design as a dynamic, incremental process that both changes and are changed by the context of practice. To improve practice, close collaboration between researchers and practitioners is vital: an iterative, practice-driven approach increases the chances that systems and practices that emerge have a real chance of taking root within the culture of schools. Our methodological guidelines were based on three design workshops, formative evaluation and research studies with Autism Spectrum Disorder children (aged between 4 – 14 years), and with young Autism Spectrum Disorder adults. We conducted three design workshops (Autistic children N = 55; Caregivers N = 33), two formative evaluation studies (Autistic children N = 15), three research studies (Autistic children N = 15), two knowledge elicitation workshops and several consultations with expert practitioners N = 5). The purpose of the design workshops was to inform the design of the look-and-feel of the interface including the functionality and interactive properties of objects and other aesthetic decisions. The purpose of the formative evaluation studies was to evaluate the design decision and the robustness of the individual components of the system. Research studies serve to further inform the design of the system – typically the architecture and functionality of the underlying components such as the user model of the child. In addition to the workshops with children and young adults, we also conducted two knowledge elicitation workshops and several consultations with expert practitioners (total N=5). The workshops and studies were conducted by the authors and different sub-teams involving caregivers, parents, experts and Autistic children in different schools in Accra, Ghana. Participatory Design (PD) has been adopted by HCI to achieve end-user involvement in the design of interactive artifacts [15]. PD presents an ethical argument for giving users a voice in technology design. Children, users with ASD, their Caregivers and Teachers are often marginalized in the design process. PD promotes mutually respectful relationships with stakeholders. This leads to an immersion of the designer in the users' world and allows for a more empathetic and mindful interpretation of their contributions. Our PD process involved three workshops with specialized units working with ASD children, through which sensory exploration and idea generation for the design of the system and its elements were facilitated [16].

3.1 Functional Requirements of the system

Requirements are defined in terms of precise actions or tasks which involve a set of inputs for required outputs or results.

- The Mobile User Module:
    - Emergency SMS Interface: The system's user can send a text message (SMS will have the sender's spatial data appended to the message, either through a coarse – network-based or fine – GPS) to Health Professionals, Special-Needs Educators, etc., in terms emergency.
    - Awareness Interface: System users can read more information about autism, causes, treatments, and therapies. There are more information that helps users understand autism and some of its red flags.

- Learning Platform for Children living with Autism: Children living with autism can use the system as a medium to study (read alphabet and numbers accompanied by audio-visuals, express their emotions/feelings and also learn about animals, vegetables, fruits, furniture, electronics, etc.)

- The Emergency SMS Receiver Module: This model will be used to receive emergency messages from users and use the Google Map feature to navigate to the sender's location.

These modules define the critical functionalities of the Autism Assistive and Awareness system. They form the key elements of the system software architecture.

3.2 Use Case Diagram

Fig. 1 shows the interaction between the user and the use cases. The user in this context can be a child with autism, a parent, or a caregiver.

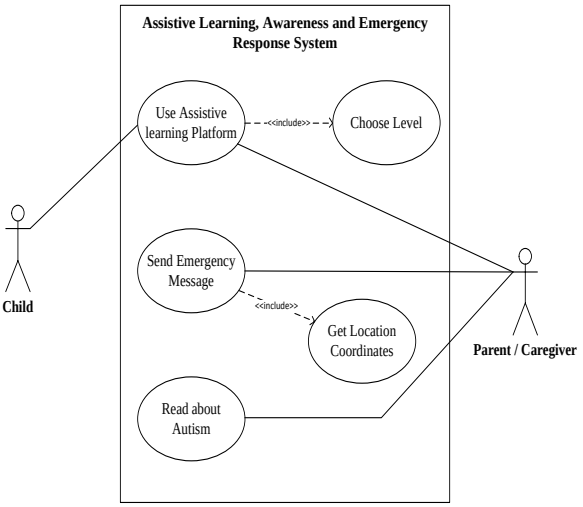


Fig. 1. Use case Diagram

3.3 Flowchart for Assistive Learning Module

Fig. 2 depicts the logical workflow of user interactivity with the assistive learning section of the system. Operationally, a user opens the assistive learning segment of the application which is labeled Kids World. At this phase, a level is selected to show the learning stage of the child. A child can undertake learning activity independently or with the help of a parent or a caregiver. The level can be switched or changed as the child undertakes the learning activity as shown in the diagram below.

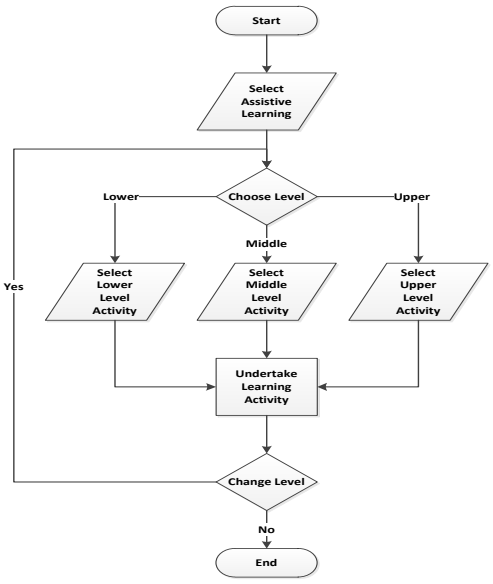


Fig. 2. Flowchart for Assistive Learning Module

3.4 Sequence Diagram for Emergency Response Module

The Sequence diagram as shown in Fig. 3 illustrates the sequence of rational phases for user interaction with the emergency response system. The user in the diagram is represented by an actor (a parent or a caregiver).

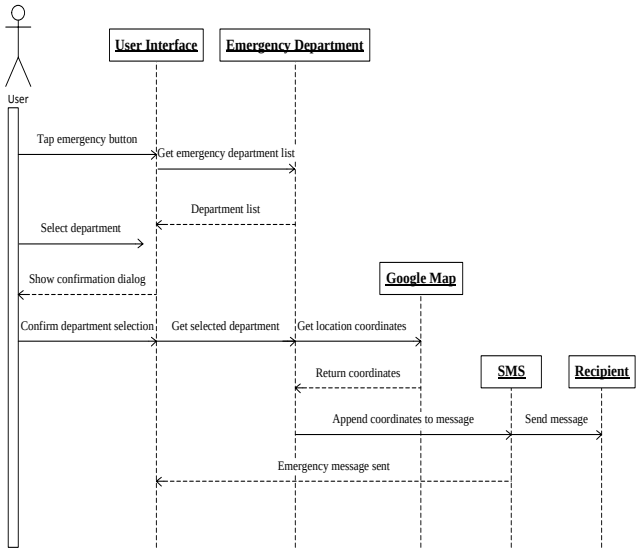


Fig. 3. Sequence Diagram for Emergency Response System

4 System Development and Testing

This segment defines the process of building and testing the system to confirm the functionalities of the modules and to authenticate the general system's functional requirements. The system comprises a mobile application that operates on an android system, an emergency SMS receiver that runs on a smartphone with a map feature.

4.1 Development Tools

The following tools were used for implementing the system:

- Android Studio IDE: This tool aided in the development of the mobile application. It provided the necessary framework and plugins for the mobile application.

- Java (Standard Edition): This object-oriented (OO) programming language allows for easy relation of programming constructs to objects from the real world. This language was chosen for the following reasons: (i) Relevant libraries needed to enhance the functional requirements of the mobile application are in the java programming language. (ii) Its platform independence. (iii) The programming language we are most conversant with.
- Google Android Software Development Kit (SDK) and Android Development Tools (ADT) Plugin for Eclipse: These are the development tools needed for the development of android applications, the SDK provides the programming tools and virtual devices needed for testing and the ADT plugin is required for creating an Android Development environment within the Eclipse IDE.
- HTML: This was used for structuring and styling the appearance of strings in the mobile application.
- XML: Extensible markup language is a language used to style the Graphical User Interface (GUI) of the mobile application.
- Google Maps API: The emergency SMS functionality made use of the Google Map API to extract the user's location coordinates.
- Microsoft Visio: This is technical diagramming software that helped create the flowchart, the use case diagram, and the sequence diagram.

4.2 System Interfaces

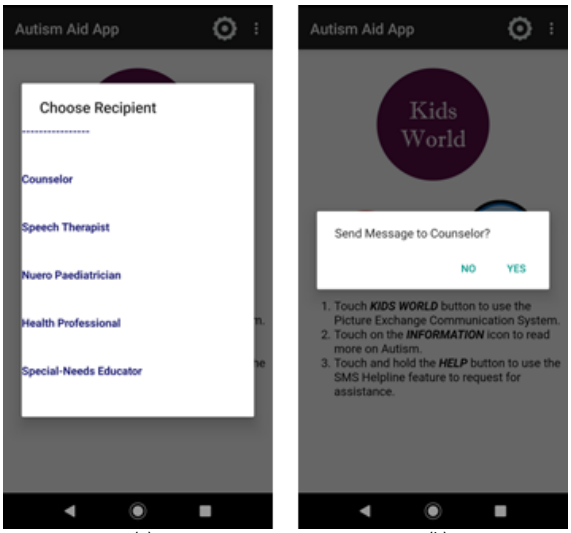
4.2.1 Mobile Application Home Page

The mobile application interface, shown in Fig. 4, runs on Infinix Note 5 Stylus mobile phone. When the application is launched, 3 buttons are displayed. Each button gives access to a major functionality of the system.

Fig. 4. Mobile Application Home Screen

4.2.2 Emergency Response Team Selection

The screens below in Fig. 5 (a) and (b) shows the emergency response teams (recipient of the emergency message) available for selection and the final confirmation screen that triggers an SMS to be sent.

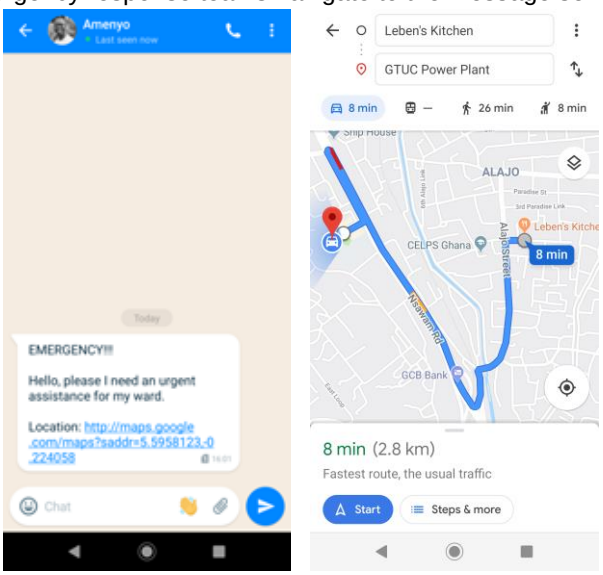


(a) (b)

Fig. 5. Emergency Response Team Selection Screen

4.2.3 Emergency Message Recipient Screen

Fig. 6 (a) shows the message sample that the emergency response teams receive. Google Map coordinates are appended to the text message for easy navigation to the sender, if necessary. Fig. 6 (b) is a sample of how the emergency response teams navigate to the message sender.



(a) (b)

Fig. 6. Emergency Message Recipient Screen

4.2.4 Awareness Screen

The screen below shows detailed information on autism, causes, treatments and therapies, red flags, etc.

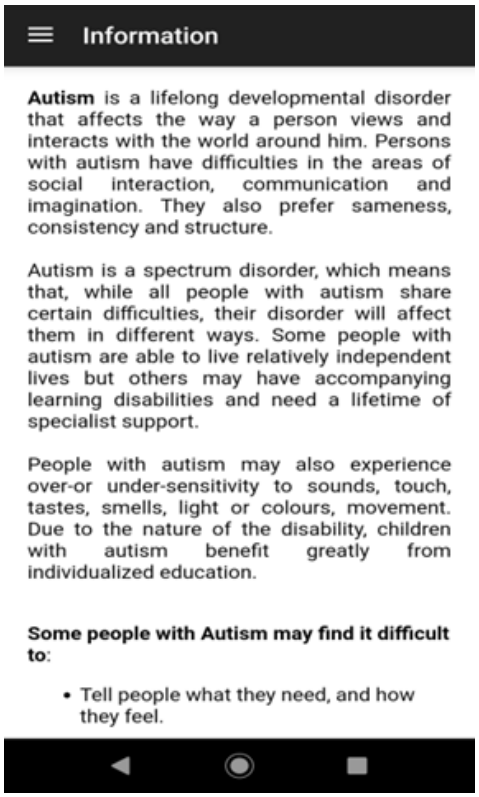


Fig. 6. Awareness Screen

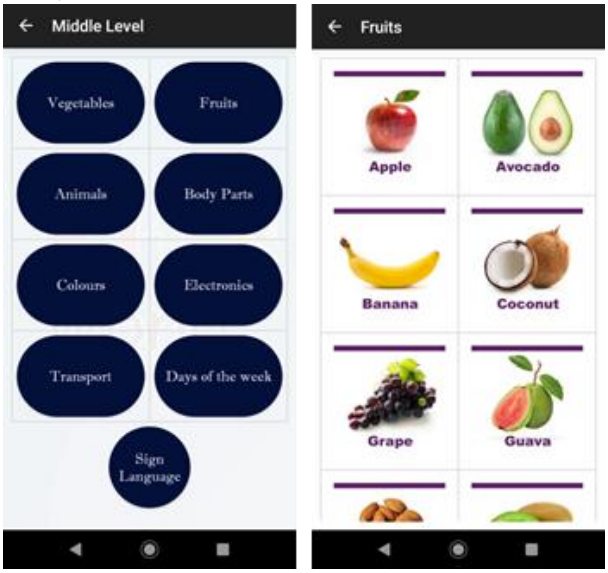
4.2.5 Assistive Learning Screen

This screen has levels that can be selected by children with autism when they want to learn. Levels depict different categories of grouped items.

Fig. 7. Assistive Learning Screen

4.2.6 Middle Level Screen

Fig. 8 (a) is an example of how items are grouped in a level. A child with autism can select a category to learn as shown in Fig. 8 (b). There is a voice that reads out an item when tapped by a child.



(a) (b)

Fig. 8. Middle Level Screens

4.3 Testing

SMS messages were sent from the Emergency Response System to the Emergency Aid Receiver to see how the user's spatial data is appended to the message. Google Map was used to navigate the coordinates sent to the receiver to check efficiency and compatibility. Children with autism from the Autism Awareness, Care and Training Center (AACT) and Hopesetters Autism Center from Accra and Tema respectively used the Assistive Learning Platform which has a lot of images accompanied by audio files. This was done to check how efficient these children will use the system seamlessly to confirm the heuristic interface design rules that were used.

5 Conclusion and Recommendation

Looking at the current trends in mobile phone usage in relation to education, it has necessitated the development of mobile applications to offer a user-friendly, thorough and organized system of services that will improve the lives of children with autism and their families through good communication. This system seeks to enable parents and caregivers, get assistance for children with autism in times of emergency. The Internet, modernization and the progress of technology are all urging to make life easier in the form of automated processes. USSD is a technology that has ample prospects; its design and build are seamless for several service options, from mobile payments, interactive chat through to emergency response services. The USSD technology can replace the SMS service used for the Emergency Response system as it is faster than other messaging options.

6 References

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