

Implementation of Augmentative & Alternative Communication Methods in Mobile Applications for Therapy of Autism Spectrum Disorder Patients

Evans Fuad
Informatics Engineering
Universitas Muhammadiyah Riau
Pekanbaru, Indonesia
evansfuad@umri.ac.id

Rahmad Gunawan
Informatics Engineering
Universitas Muhammadiyah Riau
Pekanbaru, Indonesia
rahmadgunawan@umri.ac.id

Fitri Indra Yani
Informatics Engineering
Universitas Muhammadiyah Riau
Pekanbaru, Indonesia
fitriindrayani@umri.ac.id

Abstract—Autism Spectrum Disorder (ASD) is an overall developmental disorder that causes delays in social skills, communication, and behavior in children, so it is very influential in academic and non-academic results. In this case some parents of children with ASD get difficulty to communicate and understand the wishes of their children, so parents cannot provide learning and therapy to their children outside the time of therapy. Most parents use instructional and therapeutic media aids that still use books and other aids, which are less effective in terms of cost, as well as learning to use books or pictures that are always in a state of silence (not moving, not active, and not changing the situation), and lack Multimedia applications that provide a variety of functions (communication, learning and therapy) in one application. Android-based mobile application as a tool for communication, learning and therapy was built so that children with ASD can express their desires and emotions easily, facilitate the learning process, and assist them in the therapy process. Based on the results of testing an android-based mobile application as a tool for communication, learning and therapy for ASD patients, 25 respondents consisting of parents, therapists, and teachers, showed that the application validity reached 82%, in this case the validity level of the application was in good criteria. Research shows that Augmentative and Alternative Communication can improve the quality of life of children diagnosed with ASD and non-verbal, by supporting and improving their communication.

Keywords—Autism Spectrum Disorder, Augmentative and Alternative Communication, Communication, Learning, Therapy

I. INTRODUCTION

Autism Spectrum Disorder (ASD) is an overall developmental disorder which results in obstacles in the field of social interaction, disruption in the field of communication (verbal-non verbal), disruption in the field of behavior, disruption in the field of feelings and emotions, and interference in the field of perception-sensory, as well as repeated interests [1].

The Ministry of Health of the Republic of Indonesia in 2015 noted that one in 250 children in Indonesia had autism disorders and there were approximately 12,800 children with autism in Indonesia [2]. Augmentative and alternative communication (AAC) is a medium and means used by children who experience obstacles in communication, so they can communicate well and smoothly with those around them. This method is instructions in the form of pictures and

symbols, which make it easier for autism sufferers and parents to communicate, and make it easier to carry out daily activities [3].

By utilizing digital media technology, the authors designed a mobile product in the form of communication aids for patients with ASD that are designed using the AAC method, and can be used by educators and parents, as one way to support and optimize therapeutic methods for children with Autism Spectrum Disorder for the sake of the realization of independence.

II. AUTISM

The term autism was created by Bleuler Freud in 1911. The word "Autism" comes from the Greek word "autos" which means "self." This term describes the condition in which a person is removed from social interaction, which means "isolated self." Children with autism find it difficult to act, that way other people consider it "abnormal" [1].

Autism disorder or Autism Spectrum Disorder (ASD) is a disorder of the development of complex and highly varied brain functions (spectrum). Usually these developmental disorders include the fields of communication, interaction, behavior, emotions and sensory [4]. Language skills in children with autism are strongly influenced by parental support for children with autism (OR = 31.5) [8].

In 1943, Dr. Leo Kanner, an American psychiatrist, argued that autism is as a schizophrenic childhood. Autism or Infantile Autism (Early Infantile Autism) is a term of autism that is used to indicate a symptom that is unique and prominent in children, often called Kanner's Syndrome. Prominent features of Kanner's syndrome include facial expressions that are blank as if daydreaming, losing their minds and it is very difficult for others to attract their attention or invite them to communicate [1].

As determined in DSM-IV-TR (American Psychiatric Association, 2000) that Autism disorders involve limitations in social relationships, verbal and non-verbal communication and various interests and behaviors. In the social domain, symptoms include impaired use of verbal behavior (e.g. eye contact, facial expressions, body movements) to regulate social interactions, failure to develop age-appropriate peer relationships. In the domains of behavior and interests, there are often unusual behaviors, inflexible adherence to non-functional routines, stereotyped body movements such as flapping hands, wiggling before the eyes, when walking and preoccupation with sensory parts or modalities of objects [1].

TABLE I. AUTISM SYMPTOMS

No	Disruption Type	Autism Symptoms
1	Disorders in the field of verbal and non verbal communication	Babbling in a language that nobody can understand
		When they start saying something, they do not understand the meaning
		Talking not used for communication
		He imitates a lot (echolalia) and some children are really good at imitating songs, tones and words
		20% of these children cannot communicate verbally until adulthood
2	Disorders in the field of social interaction	Bila menginginkan sesuatu ia menarik tangan terdekat dan mengharapkan tangan tersebut melakukan sesuatu untuknya.
		Refuse or avoid from making eye contact and do not respond when called
		Often refuses to be hugged
		No effort to interact with others, and prefer to play alone
3	Disorders in the field of feelings and emotions	Going away when approached
		In children with autism, excessive behavior can be seen such as motor hyperactivity, cannot be silent, repeating certain movements, such as sitting silently and blankly, doing monotonous and repetitive games, sitting silently fascinated by something, for example shadow and rotating objects.
4	Disorders in the field of feelings and emotions	Sometimes there is attachment to certain objects, such as a piece of rope, a card, paper, a picture, a rubber band or whatever it keeps holding and carrying everywhere.
		Unable to feel what other people feel, for example he does not feel sorry when seeing a child crying. He even comes and beats the crying child because he feels disturbed.
		Sometimes laughs alone, cries or mad without clear reason
5	Sensory perception disorder	They frequently rage uncontrollable, especially if they do not get what they want. They can be aggressive and destructive, can also hurt themselves, for example hitting or banging their head repeatedly, biting and so forth.
		Kiss or bite any toys or objects
		Immediately close their ears when hearing certain sound
		Do not like touching or hugging
		Feeling very uncomfortable when wearing clothes from rough materials

III. AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

Augmentative and Alternative Communication (AAC) is a method and technology used to compensate individuals in communication competence, in this case AAC can be temporary or permanent [3]. Verbal communication in children with ASD disorders while training focuses on mastering imitation and attention skills as basic skills, while focusing on visual stimuli that are loved, which attract the attention of children with Autism and make them participate positively in training programs, and help them regulate the environment in which interactions with peers occur, and repetition during training sessions by some peers [5].

In children with autism, it is found that melatonin production is so low which causes the severity of social relationships that have been shown by autistic children in the world [6].

It is estimated that between 30% and 50% of individuals with ASD do not use functional communication. There is evidence to suggest that AAC communication can improve the quality of life of children diagnosed with ASD and non verbal, as well as improve their communication [3]. Every child with special needs requires more special education, so that it can be adapted to the learning constraints and needs of each child individually [7].



Figure I. Symbols and images of Basic AAC



Figure II. Stages of AAC Expressive Language

TABLE II. INDEPENDENCE TRAINING PROGRAM

No	Based on images/symbols
1	Understand images and association (image/function/task/category) concept of at least 400-500 learning concept with image
2	Express desire with food
3	Express desire with drink
4	Express desire with verbs/daily activities
5	Express desire with adverb of place

IV. VISUALIZATION PROCESS MODEL

Visual modeling helps to capture the structure and behavior of objects, facilitate the depiction of interactions between elements in the system and maintain consistency between design and implementation in programming. Visual modeling uses a usecase diagram to show the functionality of a system or class and how the system interacts as a communication, learning, and therapeutic aid for children with autism. Application developed is using Indonesian language.

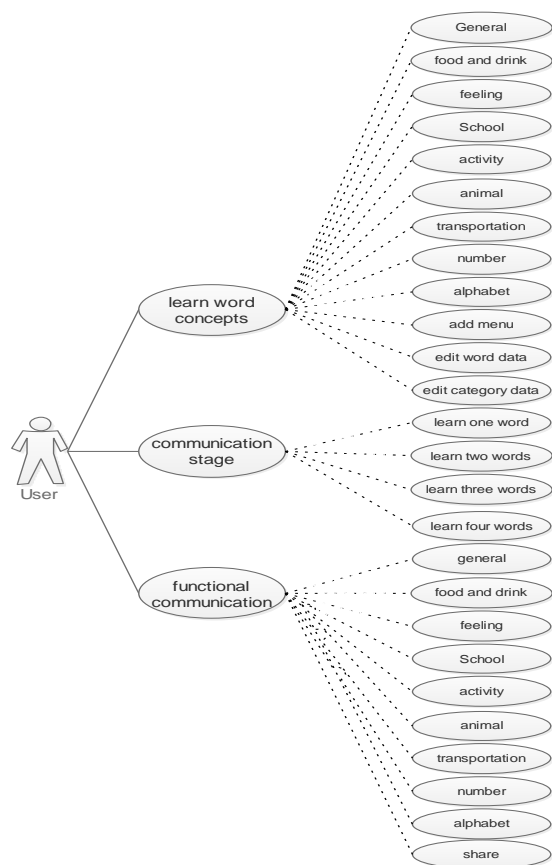


Figure III. Usecase Diagram

TABLE III. DESCRIPTION OF USECASE AND ACTOR IN APPLICATION

No	Actor	Use Case	Description
1	Therapist/ Parents	Learning Word Concept	The concept of the word serves to introduce the patient about types of nouns, adjectives, verbs, recognize objects, places, and feelings. Learning word concepts is pre-conditions before the implementation of learning Stages of functional communication.
		Stages of Communication	The therapist/parent teaches the communication stage which is the stage where the patient begins to be taught to understand how he conveyed what he really felt, through several levels of understanding, starting from the first level where the child starts to understand communication with one word, then goes to level two where the child understands the use of two words. The next level is the patient begins to understand the use of three words, and at the last level the patient is able to compose one perfect sentence.
2.	Patient	Learning Word Concepts	Patients are expected to be able to understand word concepts as the beginning of the communication stage. Patients are taught word pictures one by one, with the hope that patients are able to recognize images or symbols that are used as alternatives in communication.
		Communication	The stage of communication is the stage where the patient begins to be

		Stage	taught to understand how he expresses what he really feels, through several stages of understanding, starting from the first stage where the child begins to understand communication with one word, and then enters the second level where the child understands the use two words. The next level is the patient begins to understand the use of three words, and at the last level the patient is able to compose one perfect sentence.
		Functional Communication	At this stage the child has reached the point he is able to compose perfect sentences to express what he wants and feels.

V. ACTIVITY DIAGRAM

Activity diagram is a diagram that illustrates the activity of a system or workflow which consists of Activity Diagram Menu Learning Concept Word, Activity Diagram Menu Communication Phase, Activity Diagram Functional Communication Menu, Activity Diagram Edit Category, Activity Diagram Edit Image, and Activity Diagram Add Menu.

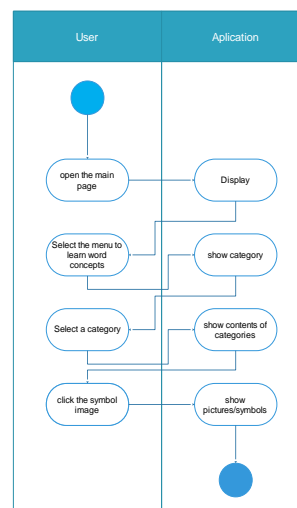


Figure IV. Activity Diagram of Learning Word Concept

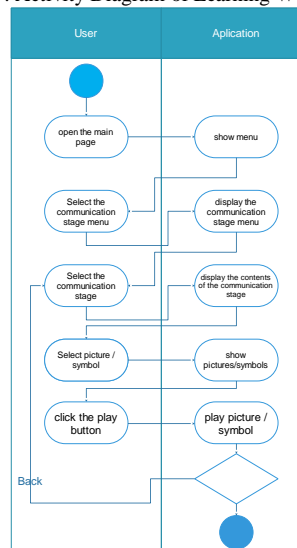


Figure V. Activity Diagram of Communication Stage Menu

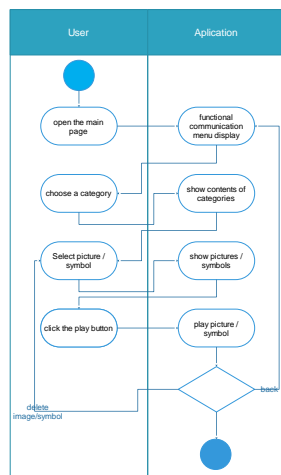


Figure VI. Activity Diagram of Functional Communication Menu

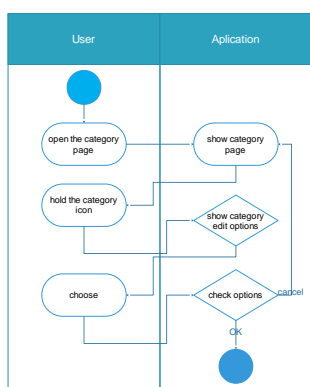


Figure VII. Activity Diagram of Category Edit

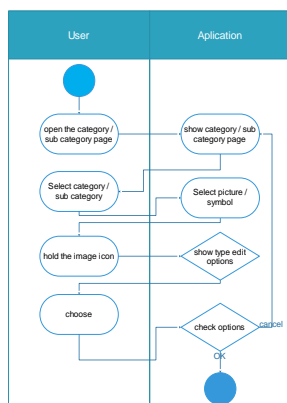


Figure VIII. Activity Diagram of Image Edit

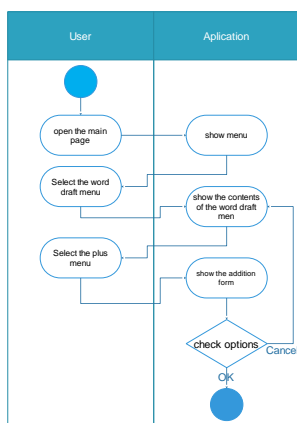


Figure IX. Activity Diagram of Add Menu

VI. SYSTEM IMPLEMENTATION

Implementation of the system is the stage and use of design that has been made. The system implementation consists of displaying the main menu, displaying the word concept menu, communication stage menu, one-word learning menu, two-word learning menu, three-word learning menu, four-word learning menu, functional communication menu, form added category, form added word, and share menu. When opening the application, the application will immediately display the main menu page which can be seen in Figure X.

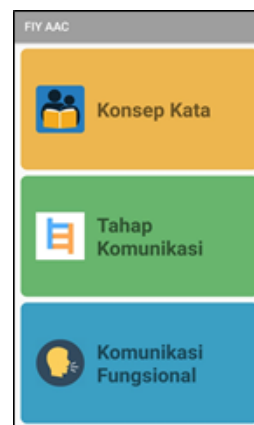


Figure X. Display of Main Menu

The coding implementation of the main menu display can be seen in Figure XI and XII.

```

package com.fiy.aac.template;

import androidx.appcompat.app.AppCompatActivity;

public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main_baru);

        LinearLayout konsep = findViewById(R.id.konsep);
        LinearLayout komunikasi = findViewById(R.id.komunikasi);
        LinearLayout fungsional = findViewById(R.id.fungsional);

        konsep.setOnClickListener();
    }
}
  
```

Figure XI. Coding of Main Menu Display

```

konsep.setOnClickListener() {
    Intent i = new Intent(getApplicationContext(), KataBaru.class);
    startActivity(i);
}

komunikasi.setOnClickListener() {
    Intent i = new Intent(getApplicationContext(), MenuKomunikasi.class);
    startActivity(i);
}

fungsional.setOnClickListener() {
    Intent i = new Intent(getApplicationContext(), TahapKomunikasi.class);
    startActivity(i);
}
  
```

Figure XII. Coding of Main Menu Display

The word concept menu display serves to display the word concepts to be learned in therapy.



Figure XIII. Menu of Word Concept

The coding implementation of the word concept menu display can be seen in Figure XIV.

[illegible]

Figure XIV. Coding of Word Concept Menu Display

If the communication stage button is touched/clicked, a sub menu display will appear. The communication stage menu display serves to display the communication learning stage.



Figure XV. Menu of Communication Stages

The coding implementation of the communication menu display can be seen in Figure XVI.

```
public Button btn_kata, dms_kata, tips_kata, mpqul_kata;

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main_komunikasi);

    btn_kata = findViewById(R.id.btn.kata_kata);
    dms_kata = findViewById(R.id.dms.kata_kata);
    tips_kata = findViewById(R.id.tips.kata_kata);
    mpqul_kata = findViewById(R.id.mpqul.kata_kata);

    if (getSupportActionBar() != null) {
        getSupportActionBar().setTitle("K");
        getSupportActionBar().setDisplayHomeAsUpEnabled(true);
    }
}
```

Figure XVI. Coding of Communication Stage Menu Display

If the button of communication stage of learning 1 word is touched/clicked, 1 word Learning Menu screen will appear.

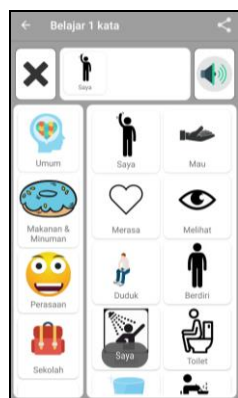


Figure XVII. Menu of Learning 1 Word

The coding implementation of the menu display stages of communication learning 1 word, 2 words, 3 words, and 4 words can be seen in figure XVIII.

```

1  katu_kata.setUcNilaiKategori([0]new = 1
2      Intent = new Intent(getApplicationContext(), TahapDumukmas.class);
3      1.putExtra("nama","koduA", "nama": "1");
4      startActivity(i);
5  })
6
7  dua_kata.setUcNilaiKategori([0]new = 1
8      Intent = new Intent(getApplicationContext(), TahapDumukmas.class);
9      1.putExtra("nama","koduA", "nama": "2");
10     startActivity(i);
11 })
12
13 tiga_kata.setUcNilaiKategori([0]new = 1
14     Intent = new Intent(getApplicationContext(), TahapDumukmas.class);
15     1.putExtra("nama","koduA", "nama": "3");
16     startActivity(i);
17 })
18
19 empat_kata.setUcNilaiKategori([0]new = 1
20     Intent = new Intent(getApplicationContext(), TahapDumukmas.class);
21     1.putExtra("nama","koduA", "nama": "4");
22     startActivity(i);
23 })

```

Figure XVIII. Coding of Communication Stage Sub Menu Display

If the button of communication phase of learning 2 words is touched/clicked, a display like in figure XIX will appear. At this stage, communication is limited to 2 words.



Figure XIX. Menu of Learning 2 Words

If the button of communication phase of learning 3 words is touched/clicked, a display will appear as shown in XX. At this stage, the communication is limited to 3 words.



Figure XX. Menu of Learning 3 Words

If the button of communication stage of learning 4 words is touched/clicked, a display will appear as shown in figure XXI. At this stage, communication is limited to 4 words.

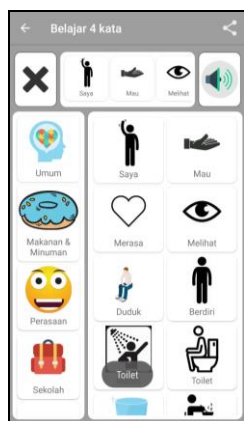


Figure XXI. Menu of Learning 4 Words

If the button of functional communication stage is touched/clicked, a display as shown in figure XXII will appear. At this stage, communication is limited to 10 words. In this menu, the child is considered to understand communication.



Figure XXII. Menu of Functional Communication

VII. SYSTEM TESTING

The results of the validation of the application testing questionnaire in table IV by respondents consisting of parents, teachers and therapists, showed the validity of the mobile application as a communication, learning and therapy tool for autism spectrum disorder patients reaching 82%, with an average score on the 4.088 index with maximum score of 5. The level of validity is in good criteria.

TABLE IV. APPLICATION TESTING RESULTS

No	Indicator	The Score of Each Respondent																									Average Score	Validity Level of the Application	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
1	The appearance of the menu in the application is attractive and easily recognizable	5	3	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.04	81%	
2	The use of menus or application features is easy to use	5	4	4	4	4	3	4	3	5	4	4	4	5	4	5	3	5	4	4	4	3	4	4	4	4	4.04	81%	
3	This application is according to need	5	4	4	4	3	3	4	3	5	4	4	5	3	5	4	4	4	4	4	4	4	4	4	4	4	4	4	80%
4	This application is easy to learn	5	5	4	4	3	3	4	3	5	4	4	4	4	5	4	4	4	4	4	5	4	5	4	5	4	4	4.2	84%
5	This application is easy to operate	5	5	4	4	3	4	4	4	5	4	4	4	4	5	4	4	4	4	4	5	4	4	4	4	4	4	4.16	83%
6	Application helps in the process of communication of children	5	5	4	4	4	3	4	3	5	4	5	5	3	5	3	5	4	4	3	5	4	4	5	4	5	4	4.2	84%
7	The application helps in the learning process and therapy in children	5	5	4	4	4	3	4	3	4	3	4	5	3	5	4	4	4	4	4	4	4	4	4	4	5	4	4.08	82%
8	This application is convenient to use	5	3	4	4	3	4	4	3	4	4	3	4	5	4	4	4	4	4	4	4	4	4	4	3	5	4	3.96	79%
9	The application has the capabilities and functions as expected	5	3	4	4	4	3	4	3	4	4	4	4	5	4	5	3	5	4	4	4	4	4	4	4	4	4	4	80%
10	Overall this application is satisfying	5	4	4	4	3	3	4	3	5	4	4	4	5	4	4	5	4	4	4	4	4	5	4	5	4	4	4.2	84%
Jumlah		50	41	40	40	34	33	40	32	46	39	40	50	36	50	37	46	40	38	43	40	40	43	40	44	40	4.088	82%	

VIII. CONCLUSION AND SUGGESTIONS

Autism Spectrum Disorder (ASD) is a neurobiological development disorder that affects brain function, making it difficult for children to interact and communicate with the outside world. Autism disorders cannot be cured, but with regular treatment, the behavior of children with autism can approach other normal children. In designing the application of communication, learning and therapeutic tools for ASD patients, many aspects must be learned in relation to children with autism themselves, such as the material and the appropriate delivery methods to be given to them, and the design aspects used so that the media can be utilized properly and effective. Applications can help and facilitate autism children express their emotions. Applications that are equipped with picture and sound features make it easier for children with autism in the learning process. The recognition feature of numbers and letters can be an alternative learning in addition to books so as to minimize costs. Communication, learning, and therapy features in one application can provide various facilities and benefits for children with autism.

Suggestion for developing communication, learning and therapeutic applications for ASD patients is to add motion sensors (eyes) for autism children whose sensory functions cannot function totally (they cannot move their hands, feet, or head). Added application functions to adjust image size. It is also necessary to add application functions to manage changing image/category positions. Furthermore, an application functions that make it possible to manipulate sound is suggested.

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