

## Designing a Two - Dimensional Animation for Verbal Apraxia Therapy for Children with Verbal Apraxia of Speech



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### ABSTRACT

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#### Keywords:

*childhood apraxia of speech, verbal dyspraxia, speech and language disorder, 2D animation, visual animation treatment*

Verbal Apraxia, also called Apraxia of Speech (AOS) is a speech sound condition that affects a person's ability to translate conscious speech goals into motor plans, resulting in limited and difficult communication. This article presents an investigation on the designing of a 2D animation and its use as a therapy for Verbal Apraxia. This paper aims to investigate animation principles and to design and develop an animation video as a therapeutic solution. The expected outcome of this paper is a comprehensive analysis of the cognitive training in verbal therapy while focusing on spreading awareness of verbal apraxia towards society. In conclusion, this animation video runs successfully and meets all the objectives completely. Therefore, this proposed 2D animation is expected to contribute as a teaching syllabus for special needs schools and produce great usability for the users.

## 1. INTRODUCTION

Childhood apraxia of speech (CAS) is a speech condition in which a child's brain struggles to coordinate the complex oral motions required to convert speech sounds into syllables, syllables into words, and words into phrases. CAS is sometimes called verbal apraxia or developmental verbal dyspraxia. The speech muscles are not weak in CAS, but do not work as well as they should because the brain has trouble guiding or harmonising the movements. Due to the disturbed transmission from the brain to the mouth, a child with apraxia cannot move his or her lips or tongue to the correct position to utter sounds correctly. An evaluation of the child's expressive and receptive language abilities is required as part of a diagnosis of childhood apraxia of speech; many children with this disorder exhibit language deficiencies [1]. One-on-one speech-language therapy sessions are vital for children with CAS. They need to find alternate ways to express themselves. These might include an extensive treatment depending on the severity of the child's disorder. Children with CAS benefit from multiple repetitions and repeated practice of sound sequences, words, and phrases during therapy, as well as the use of visual prompts to demonstrate how speech sounds become sound sequences and are then combined to form words. Assistive communication methods can also help children with CAS learn to read and better understand verbal language by stimulating areas of the brain involved in language and literacy.

Currently, some verbal therapy solutions for childhood apraxia of speech are available online. For example, an animation video for CAS of an instructor presenting graphics and animations, as a visual way of speech therapy for children, can be found on the Internet. However, because this video is non-interactive and focused entirely on alphabet therapy, it generates less interest among users.

This paper is organised as follows. Section 2 presents previous related work on Verbal Apraxia and existing system of 2D animation. Section 3 describes in detail the overall analysis of this research, while Section 4 presents the design of the proposed system. The implementation of the research project is presented in Section 5. Finally, Section 6 presents some conclusions and future work.

## 2. LITERATURE REVIEW

### 2.1 Verbal apraxia

Autism spectrum disorder (ASD) is a condition related to neurodevelopmental disorders in children. This disorder affects the child's ability to interact, socialise, behave, and communicate verbally and nonverbally, as he grows up. ASD and apraxia of speech (AOS) are often simultaneously present in a patient, but both are not the same disorder. Apraxia of speech (AOS) is also known as acquired apraxia of speech, verbal apraxia, or childhood apraxia of speech (a speech sound disorder). Someone with AOS would have trouble speaking their thoughts correctly and consistently. The brain knows what it wants to say but cannot properly plan and sequence the required speech sound movements.

Childhood apraxia of speech (CAS) is a neurological childhood (paediatric) speech sound disorder in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits (e.g., abnormal reflexes and abnormal tone). CAS may occur as a result of known neurological impairment, in association with complex neurobehavioural disorders of known or unknown origin, or as an idiopathic neurogenic speech sound disorder. The core impairment in planning and / or programming spatiotemporal parameters of movement sequences results in

errors in speech sound production and prosody [2, 3]. CAS has been investigated by many researchers [4-10]. Additionally, there have been several studies reporting on the usage of animation, particularly in educational purpose [11, 12].

## 2.2 Existing system

This topic will be discussed with reference to systems that have common characteristics with this research. There are two existing systems that will be discussed – Speech Therapy Songs Animation by Barefoot Books and Alphabets and Numbers Verbal Therapy by Terapi Autisme Online. There are many more videos on speech therapy available online, but most of the instructors that the authors interviewed suggested these two systems – animation video from Barefoot Books and a verbal therapy video by Terapi Autisme Online. Both of these videos can be found on YouTube.

### 2.2.1 Barefoot Books

Barefoot Books is a publisher of children's books based in Concord, Massachusetts, United States. They created videos in their YouTube channel that come with "watch and sing along" CDs with entertaining animated video animations. The animation technique used by them is the "2D Animation" technique. Barefoot Books animation used vector-based animation, a type of animation that is cheap and easy to access both by viewer and animator.

In their animation video, they use colourful moving images that can attract children's attention. Accompanied by the strains of interesting songs as the video background sound with an additional sing-along lyric, they managed to make an interesting animated video that can stimulate the brains of children with speech therapy disease. Figure 1 shows the screenshot of the Barefoot Books animation.

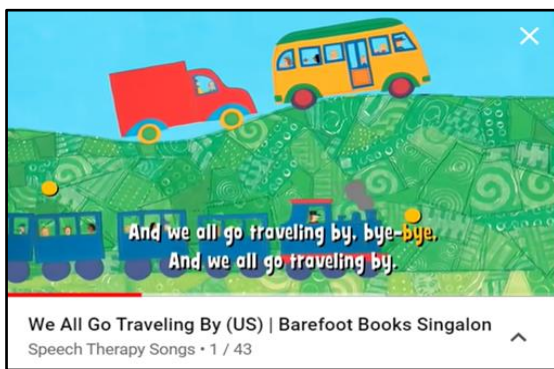


Figure 1. Barefoot Books animation [13]

### 2.2.2 Terapi Autisme Online

Terapi Autisme Online is a YouTube account with a total of fifteen videos, 7,143 video views, and 193 subscribers. This account provides therapy videos that aim to make their videos available to children with autism and autism spectrum disorders. It is hoped that children will be guided by their parents or teachers to watch this video.

In their video, along with attractive and colourful animated alphabets and numbers, they present learning videos about verbal letter therapy, verbal number therapy, and speech therapy. With a host acting as an instructor, she is in charge of guiding the audience to learn and get educational and therapeutic services for children with autism spectrum disorders (ASD). In their videos, attractive colourful

animations according to the topics discussed are used. Figure 2 shows the screenshot of the Terapi Autisme Online video.



Figure 2. Terapi Autisme Online [14]

## 2.3 Project methodology

The methodology used for this project is the Multimedia Production Process. Multimedia has improved our ability to learn and comprehend information. The Multimedia Production Process model was chosen for this project as illustrated in Figure 3 because it is concerned with the incorporation of multiple media, such as text, audio, video, image, and animation to increase the message's effect.

Development involves deciding the project's goals and objectives, as well as the intended audience. After deciding on a theme for a multimedia project, basic goals, objectives, and an activity matrix must be created. Specific targets and general statements of expected project results are typically more global in nature in multimedia projects, while objectives from project goals are to add user interaction to a 2D animation using digital animation method.

Preproduction is the process of demonstrating intelligence by creating a coherent plan for the entire multimedia project, including material, technological execution, and promotion. The multimedia producer starts putting together the resources and talent required to create the multimedia application at this stage.

The next step is the production phase, which is to build and implement the storyboard into a multimedia project. In this phase, all required hardware was set up, assets were exported to unit, coding and so on. The technology to be used, analysis of the existing system, and lack of the current system that are part of the requirement will be implemented from every multimedia element used, and will be determined with project flow charts and storyboards created on this project.

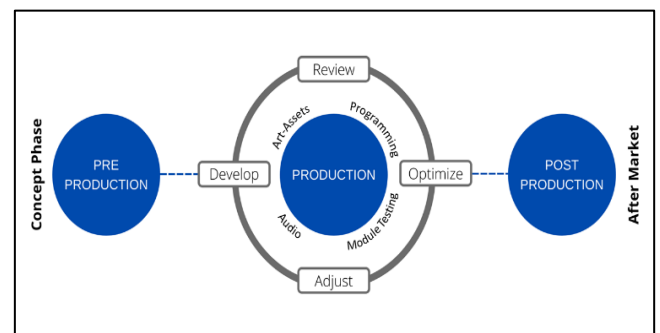


Figure 3. Multimedia production process

The postproduction phase is when the multimedia application goes through the alpha and beta testing phase. The application moves to the packaging stage after it has been

tested and updated. It could be burned to a CD-ROM or DVD, or it could be uploaded to the Internet and published in a free video sharing website like YouTube.

### 3. ANALYSIS

#### 3.1 Current scenario analysis

Two interactive videos with animation entitled ‘Terapi Verbal Angka’ and ‘Terapi Verbal Huruf’ by Terapi Autisme Online in YouTube that were uploaded in 2017, will be the inspiration of the animation for this project. The reason is because the content displayed in both videos are very easy to understand, and with the help of some attractive animation, the presentation of the content becomes attractive and memorable for the viewers.

Quality research shows that video-modelling is an effective method to teach a plethora of skills to autistic children. These skills include communication, social, behaviour, daily living, and play skills. Video-modelling is based on Albert Bandura’s social learning theory. According to this theory, people learn from each other by watching and copying. For autistic children, video-modelling seems to be more motivating and less threatening than face-to-face modelling. It also allows autistic children to focus on an aspect of a skill or behaviour each time. They can watch the video multiple times to fully grasp on the skill. Table 1 presents the comparison of existing system.

#### 3.2 Requirement analysis

##### 3.2.1 Project requirement

The proposed framework is examined in the project requirements. It will highlight the actions, procedures, and other conditions that the project must fulfil. It will be evaluated based on the requirements gathered and the basic methodology

employed in this project. This project’s requirements will provide a clear understanding of the tasks that must be completed.

##### 3.2.2 Requirement gathering

Requirement gathering is arguably the most important step in the data transmission and organisation process. Qualitative and quantitative requirements gathering are the two types of requirements gathering. To communicate risk, expense, and impact; subjective assessments use terms or relative qualities. When there is not enough time, resources, or data to conduct a quantitative assessment, a quality assessment is the best option. In most cases, a qualitative appraisal is conducted during an interview. The interview will be performed with an Autism Therapy Center Instructor / Practitioner. During requirement gathering, all of the project’s features, proposed interactions, raw data, and source analysis will be addressed. The basic methodology used to create this project will also be examined.

##### 3.2.3 Analysis of system to be developed

The duration of this project lasts about 3 minutes to avoid the children losing their focus from the video. The storyline of the project stars a teacher or a host teaching and assisting the children about the syllabus and subjects that will be learned. All the characters and objects are newly designed. Consequently, the researcher should conduct a requirement review during the analysis process. Interviewing the consumer, target user, and stockholder may be applicable to conduct the research. In this project, the researcher conducted an interview with a practitioner who teaches an autistic child in a counselling and autism therapy centre in Jakarta.

In addition, the expert also suggested that the duration of the video should not exceed 5 minutes because the children will feel bored and cannot focus on the application. The interviewee’s details are shown in Table 2.

**Table 1.** Comparison of existing system

Comparison	Barefoot Books	Terapi Autisme Online	2D Animation Therapy
Interaction	Non-interactive	Interactive	Non-interactive
Types of Products	Company / Stand Alone	Stand-alone	Stand-alone
Types of Visualisation	2D Animation	Video Modelling with 2D animation	Video Modelling with 2D Animation
Interface	Simple and Attractive	Outdated by current standard syllabus but not attractive	Quality animation for children with Verbal Apraxia
Sound	Good audio quality	Too much talking, bad audio quality	Background music is fit for the animation
Scope	General	Autism and Spectrum Disorder	Autism and Verbal Apraxia Disorder
Language	English	Indonesian	English & Indonesian
Strength	Very attractive animation	Interactive and good explanation from the host	Good graphical design, attractive animation, and background music
Limitation	Only English language provided	Bad quality of audio and video, plus constant shaky camera	-

**Table 2.** Content verification form

Component	Details
Name	Hilmi Abdul Aziz
Company Name	EDUfa Autism Therapy Centre Jakarta Timur
Position	Practitioner
Venue	Cimanggis, Depok, West Java, Indonesia
Email	hlazizz81@gmail.com
Phone Number	+62 8961 8971 193
Date	27 April 2021
Type of Meeting	Online Meeting via Zoom
Comments	Use plain background, no offensive words, always reward with supportive intonation

#### 4. DESIGN

A storyboard is a collection of illustrations or images intended for animation or motion graphics. Graphics, music, durations, shots, tests, description colour, interaction, and video are all included in the storyboard. Table 3 to Table 4 shows the storyboard and character details contained within each scene shown.

Figures 4, 5, and 6 show some of the interfaces used in the project.

**Table 3.** Storyboard of number module

	<p><b>Scene:</b> Main Title  <b>Description:</b> Introduction of numbers  <b>Time:</b> 3 Seconds  <b>Voice Over:</b> "Ayo Belajar, Angka!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Introduction  <b>Description:</b> Presenter greet viewer  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Halo adik-adik! Kali ini kita akan belajar angka. Sudah tahu dong apa itu angka?"</p>
	<p><b>Scene:</b> Number 1 intro  <b>Description:</b> Number 1 popup (presenter shock)  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Siapa ini? Ternyata, ini adalah Angka Satu!"</p>
	<p><b>Scene:</b> Number 1 sing-along  <b>Description:</b> Sing-along with number 1  <b>Time:</b> 10 Seconds  <b>Sound:</b> Sing-along with music</p>
	<p><b>Scene:</b> Number 1 done  <b>Description:</b> Compliment the viewer  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Hebat! Pintar Sekali!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Number 2 intro  <b>Description:</b> Number 2 popup (presenter shock)  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Siapa ini? Ternyata, Angka Dua!"  <b>Sound:</b> Background Sound</p>










**Table 4.** Storyboard of letter module

	<p><b>Scene:</b> Main Title  <b>Description:</b> Introduction of letters  <b>Time:</b> 3 Seconds  <b>Voice Over:</b> "Ayo Belajar, Huruf!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Introduction  <b>Description:</b> Presenter greet viewer  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Halo adik-adik! Kali ini kita akan belajar huruf. Sudah tahu dong apa itu huruf?"</p>
	<p><b>Scene:</b> Letter A intro  <b>Description:</b> Letter A popup (presenter shock)  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Siapa ini? Ternyata, ini Huruf A!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Letter A sing-along  <b>Description:</b> Sing-along with letter A  <b>Time:</b> 10 Seconds  <b>Sound:</b> Sing-along with music</p>
	<p><b>Scene:</b> Letter A done  <b>Description:</b> Compliment the viewer  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Hebat! Pintar Sekali!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Letter B intro  <b>Description:</b> Letter B popup (presenter shock)  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Siapa ini? Ternyata, ini adalah Huruf B!"  <b>Sound:</b> Background Sound</p>
	<p><b>Scene:</b> Letter B sing-along  <b>Description:</b> Sing-along with letter B  <b>Time:</b> 10 Seconds  <b>Sound:</b> Sing-along with music</p>
	<p><b>Scene:</b> Letter B done  <b>Description:</b> Compliment the viewer  <b>Time:</b> 5 Seconds  <b>Voice Over:</b> "Wah! Hebat! Pintar Sekali!"  <b>Sound:</b> Background Sound</p>






Characters play an important part to deliver the message to the viewer. If the character failed to do so, the story will become dull and ineffective. The design was created using Adobe Illustrator for better quality. Table 5 to Table 6 show character names, and designs of Letters and Numbers.



**Table 5.** Character names and designs of numbers

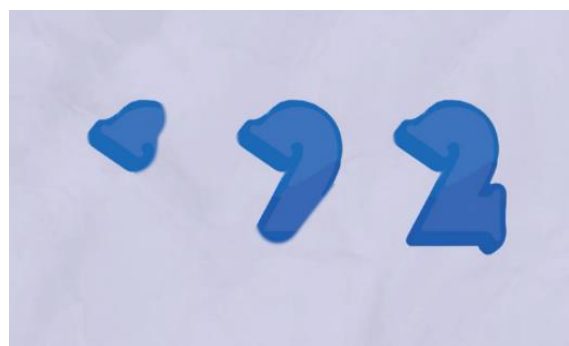
Module	Character
Numbers	 Number One
	 Number Two
	 Number Three
	 Number Four
	 Number Five
	 Number Six
	 Number Seven
	 Number Eight
	 Number Nine

**Table 6.** Character names and design of letters

Module	Character
Letters	 Letter A
	 Letter B
	 Letter C
	 Letter D
	 Letter E



**Figure 4.** Interface of Introduction module



**Figure 5.** Interface of numbers module



Figure 6. Interface of letters module

## 5. IMPLEMENTATION

### 5.1 Media creation

#### 5.1.1 Production of text

Adobe After Effects and Adobe Premiere Pro were used to create the text for this 2D animation. Text is necessary in animation because it provides information to the viewers to help them grasp on the topic. The text, graphics, and audio for the animation were created during the design process and will be put together during this phase. The product, which is the animation, and the report are generated in this phase to ensure the target user understands the project thoroughly. The font type, Agency FB, was used to create the typewriting style font.

#### 5.1.2 Production of graphics

The designing and editing process is a phase of the graphic production for a 2D animation, in which the image is used. Characters and surroundings are shaped. The bitmap image that is formed in a 2D image was created using Adobe Illustrator. The graphics were created with Adobe Illustrator, and some of the background was taken from the Freepik website. In order to create this animation, 2D photos were used.

#### 5.1.3 Production of animation

In this part, the environment was created according to the storyboard that was used in the preproduction phase. Both the environment and colouring were created and done using Adobe Illustrator. The movement of environment was created in Adobe After Effects. All the environments are saved in the movie clip, in Adobe After Effects library.

For the characters in this animation, the characters' eyes and bodies were done like so to make the animate process easier. All the parts that were already separated in one piece were saved in the Adobe Illustrator, and then exported to Adobe Character Animator to make a movement from it.

Besides, the motion tween used for the character movements worked more smoothly than using each frame with different position techniques in Adobe After Effects. All the combining files and movie clips are done in Adobe Premier Pro. The final rendering and publishing are formatted in the form of mp4. Users can play all the outputs in their computers, laptops, or any smartphone.

#### 5.1.4 Production of audio

Audio also plays an important part to produce a quality animation that can attract an audience. The audio file format for this project is in MP3. The audio for the background sound is taken from online sources. An online video converter was

used to convert the video clip file to an audio file, and then saved in MP3 format. The audio editing software used to cut and compress the audio file is the Audacity software.

### 5.2 Media integration

The animation consists of various multimedia elements. The graphic and animation elements that were produced were all drawn from the clip studio. The characters and objects were animated in clip studio, and then imported to Adobe After Effect to input the subtitle. Subsequently, all the animations included the subtitle, and then converted into mp4.

### 5.3 Product configuration management

Adobe Illustrator was used to illustrate and draw the characters and objects. They were drawn in vector layer. Then, Adobe Character Animator was used to animate the characters frame by frame. All the colouring and shading was done here. After finishing with the animation, it is then exported to Adobe After Effects to put the text of the subtitle. Lastly, the project will be exported into the mp4 video format.

### 5.4 Implementation status

The implementation status is used to monitor and record the development process of this project. This section discusses the development progress of each module based on the Gantt chart. Table 7 shows the implementation status in the form of a table.

Table 7. Implementation status

Module	Duration	Description
Design character and model	1 week	The characters and objects that will be used such as numbers and letters will be designed
Create animated scenes	2 weeks	Created the animation frame by frames by using Adobe Animate
Input the sound effect and sound background	1 week	Sound effects and sound background will be searched and inputted into the animation to increase the user's focus when using the system
Input the text and subtitle in the animation	1 week	The text media and animation will be inputted into the animation by using Adobe After Effects
Compile all the scenes in Adobe After Effects	1 week	Compile all the animated scenes in Adobe After Effects

## 6. CONCLUSIONS

This animation has been successfully produced and run for the target user – children with verbal apraxia. In the literature review chapter, the comparison of existing system and project requirements are aligned with this animation.

This project also meets the objectives, which is to develop an animation video as a therapeutic solution for children with verbal apraxia, and to evaluate the effectiveness of this animation. It is very useful and can serve as an alternative for

therapists, instructors, doctors, and parents who have children diagnosed with verbal apraxia; for them to learn using a new, fun, and captivating method.

The children were entertained by the visuals of the animation, which motivates them to learn and study new things. If this project is developed carefully with more research in accordance with the criteria recommended by medical experts, multimedia experts, and parents, this project will create a major impact on the field of science and education, if developed carefully, because the 2D animation project was developed for all of society, and can reach out to other scopes such as social, community, even on science and technology.

This concept paper described the analysis and design phases of the 2D animation of Verbal Apraxia. The next phase will be the development and testing phases of the proposed system. It is envisaged that this proposed system will assist the children and the teachers in learning.

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