ISSN: 2634 - 8853

Journal of Engineering and Applied Sciences Technology

SCIENTIFIC Research and Community

Review Article

Open Access

Gamifying Jellow: A Communication Aid for Children with Developmental Disabilities

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ABSTRACT

This paper explores enhancing the Jellow Basic Communicator, an AAC app for children with speech disabilities, through gamification. It examines user feedback, revealing low engagement and difficulties in memory retention. The study integrates Information Processing Theory into game design to improve attention and learning. Key findings suggest that gamification, including icon-based activities and multi-sensory techniques, can significantly enhance the app's effectiveness. The paper discusses the potential impact of these features on cognitive development and suggests areas for future research, including diverse user testing and long-term effectiveness studies.

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Received: August 06, 2021; **Accepted:** August 14, 2021; **Published:** August 23, 2021

Keywords: Augmentative and Alternative Communication (AAC), Gamification, Speech Disabilities in Children, Information Processing Theory, User Engagement

Introduction

There are currently over 1.9 million individuals with a speech disability in India. Speech impairments are either evident at birth or before 9 years of age in around 37% of individuals with a speech disability. Overall, over 80% of individuals with speech disabilities completely lack speech, speak only in single words, or have unintelligible speech. A lot of children with developmental disabilities, such as autism and cerebral palsy, have difficulties producing functional speech. For example, approximately 14-20% of children with autism are estimated to produce little or no functional speech. To help these heterogeneous groups effectively communicate with adults and their peers, augmentative and alternative communication (AAC) devices have been widely used, where non- verbal children can click symbols displayed on the device to generate synthetic speech through text-to-speech (TTS) technology [1-3].

Jellow Basic Communicator is a free, user-friendly Augmentative and Alternative Communication (AAC) system aimed at aiding individuals, particularly children, who have speech and language difficulties or are learning to speak. It's particularly beneficial for non-verbal children with conditions like Autism, Cerebral Palsy, and Down's Syndrome, helping them communicate and learn to speak. Designed with vibrant icons and images, Jellow Basic is suitable for children, todlers aged 3+, and early learners, assisting them in developing associations between pictures and words used in everyday life [1,2].

The app features an intuitive interface with central category buttons and expressive side buttons, allowing users to create sentences by simply selecting icons. It includes about 1200 icons and over 10,000 pre-made sentences, complemented by a keyboard feature for generating new sentences. Jellow Basic supports multiple languages, including English, Hindi, Bengali, and several European languages, with various accents and voices. Developed by the IDC School of Design at IIT Bombay and supported by organizations like UNICEF, it has been iteratively refined based on feedback from children, parents, therapists, and teachers, ensuring its effectiveness and user-friendliness [1,2,4].

In this paper, we report the user feedback evaluation of the app. After talking to parents whose kids are using the Jellow app, we realized the engagement of this app is pretty low, and it's hard for the children to remember the sentences for a longer time. Kids also have a short attention period, making it difficult for parents to make their kids sit and learn. So the research question addressed in this study is as follows: How can we make Jellow more engaging and increase the attention span of children to augment their memory and learning process with the help of gamification?

Thus, the contributions of the paper are as follows:

- In-depth user feedback analysis of Jellow users that revealed challenges for caregivers to facilitate the successful and engaging communication of a child using AAC
- Learning model as a framework for Game Design to make the Jellow application more engaging, and motivating for children learning to speak

Related Work and Background

AAC

Alternative and Augmentative Communication (AAC) systems are essential tools designed to support or replace nat ural speech for children with developmental disabilities like Cerebral Palsy, Down Syndrome, Autism Spectrum Disorder, and Intellectual Disability.

These children often struggle with expressive speech impairments, leading to challenges in interaction, forming friendships, and engaging in play, which are vital for learning.

Figure 1: Jellow Communicator

AAC systems, used either temporarily or permanently, enhance their functional communication abilities. These systems are broadly categorized into two types: unaided and aided. Unaided AAC systems rely on gestures, facial expressions, eye contact, and manual signing. They are quick, portable, and effective for conveying new content but are limited by the need for the recipient to understand sign or gestural communication. However, they can be challenging for children with motor and cognitive impairments due to the required fine motor skills and memory [5,6].

Aided AAC systems, on the other hand, utilize external aids like graphic symbols, Picture Exchange Communication Systems (PECS), or high-tech Speech-Generating Devices (SGDs) and Voice Output Communication Aids (VOCAs). Low-tech aided systems are easy to learn and understand by a wider audience but are cumbersome due to the need to carry physical communication tools. High-tech devices, increasingly popular due to advancements in electronics and computer science, offer ease of use and effective communication through tablet or smartphone applications. These high- tech AAC systems, especially SGDs and VOCAs, are known for their ability to attract attention and facilitate understanding. Contrary to earlier concerns, evidence suggests that early use of AAC systems can promote speech development in children. Preferences among individuals with disabilities tend to lean towards aided systems, particularly SGDs, over unaided ones, due to their effectiveness in enhancing communication and teaching language skills [5].

Emotional Language Protocol

In the context of the Jellow Communicator app, the Emotional Language Protocol (ELP) is a specialized approach designed to enhance communication for children with speech impairments. ELP focuses on integrating emotional expressions into the communication system, enabling children to convey a wide range of emotions such as happy, sad, anger, affection, fear, and hate alongside their daily needs and thoughts. This approach emphasizes a user-friendly interface with intuitive and colorful icons, making it accessible and engaging for children. Additionally, Jellow incorporates sensory experience with touch and sound to suit the ability and understanding of kids. It not only aids in functional communication but also supports the emotional development of children, making it a holistic tool for both expressing and learning about emotions in a way that is empathetic and effective for young users [4].

Gamification and Learning

Gamification involves incorporating gaming elements (e.g., points, badges, leaderboards, challenges, rewards, feedback, avatars) into nongame contexts. Research on gamification is expanding, particularly in education, due to its success as a motivator in school contexts. For example, gamification enables experimentation and learning through trials, which is a promising feature to engage and encourage students to try again. The stakes of learning through gamified applications are low because it is only possible to learn and progress in some games by experimenting and failing; this is contrary to exams and tests in school, where it is possible to fail; hence the stakes are high. Furthermore, gamification can play an active role in engaging, motivating and helping students connect associating language constructs with real-life situations. The study of Ding et al. suggests that game elements such as badges, feedback, progress bars, and avatars promoted student engagement. Similarly, Brewer et al. also pointed out that points and prizes can motivate students even in a non-competitive environment. Based on that, they suggested future research considering in- creasing challenges and adding narratives when implementing gamification elements in a learning environment [7-9].

Method

To make the learning process engaging, it is essential to understand the mental learning model of the kids, observe kids and identify those interactions that create a feeling of joy and excitement among them. We collected app usage data in Firebase and analyzed it in Microsoft Excel.

Also, we interviewed 5 parents to learn more about their kids' problems while using the Jellow app. This would help us to get more context and allow us to lay the foundation for the design of the game

Findings

Understanding the Learning Process of Kids

- The use of symbols and images augments the learning process: Kids begin to think symbolically and learn to use words and pictures to represent objects and manipulate those symbols to mean something else.
- Multisensory learning enhances the attention span: Multi-sensory learning includes visual, auditory, and kinesthetic learning. It increases the attention span toward letters and numbers, especially for kids with learning and speaking deficits.
- Semantic encoding helps in remembering the information: Kids try to understand the word's meaning or relate to themselves compared to a material that has less personal relevance.

Challenges Faced by Kids with Learning Disabilities

- Kids generally have a short span of attention period.
- The current way of learning becomes monotonous and isn't perceived as 'fun' by children
- Children have creative minds so they wish to express those freely
- They enjoy varied sounds & wish to hear them repetitively. Funny sounds like beep-bop even exaggerate their movements & act as an excellent medium for engaging.
- Almost all kids love to play video games for long hours and have fun due to exciting sounds and interesting tasks; the game asks kids to complete different levels.

Parents
Jellow app produces sounds when the user clicks on different icons. For example: If I click on a picture of an apple in-app, it produces the sound, "I want to eat an Apple." So, the Jellow app would work best if kids click the right images in the proper context with the help of parents. For example: If a kid wants to eat an orange, they could click on the image of an orange, which would translate their feeling into an audio message. It would say, "I want to eat oranges." The problem is that it requires the parents to continuously identify the situations in which they can plug in Jellow App. This is not possible all the time.

Game Design Framework
Based on the user insights and applying Information Processing theory, we developed a learning model for the game that can serve as a foundation for the game design and children's learning process.

This model captures what the design of the game for kids with speech impairment inside the Jellow app should consider: This model captures what the design of the game for kids with speech impairment inside the Jellow app should consider:

Sensory Input
The kids can touch on the icons/images in the game similar to the action they are familiar with using Jellow and receive input from the game that we design. The input could be visual and auditory.

Sensory Memory
It is essential to grab the kids' attention and engage them for a more extended time, otherwise at this stage the unattended memory gets lost. The framework recommends incorporating three core multi-sensory learning techniques. These were as follows:

- **Visual:** Illustrations of everyday things can be designed so that the kids can connect them with the real-world context, for example, a game can utilize kitchen illustrations specific to kid's culture. It will improve their learning experience and will make things easier for them to learn. One can focus on the visual learning aspect by leveraging the existing icons in the Jellow app instead of simply writing the words in text format.
- **Audio:** While performing actions with an avatar like moving right, left, and up, the game can generate childish or age-appropriate sounds to grab the users' attention. For example, if a game involves eating the favorite and disliked food, pressing on the food icon should produce "Yummy!!" and "Eww!!" sounds, respectively, reflecting the child's emotions.
- **Kinesthetic:** The game should mimic the authentic experience of an activity so that a kid can directly use this app while performing the activities in the real-life world to learn how to articulate their feelings and deliver them in the form of speech. For example, a realistic morning routine would help kids learn sequential activities.

Working Memory
Anything that a person is currently doing is stored temporarily in the working memory. For the kids, it's essential to convert the information present in working memory to long-term memory with the help of encoding. Three things are performed mainly in the working memory, which will help in an encoding

Repetition
Continuous repeating of outputs with the help of audio and visuals will lead to semantic encoding. But also, monotonous repeating may turn out to be boring. Therefore, it is necessary to use the audio at the right time. For example, if "I want to eat four oranges" is one dialogue that the system

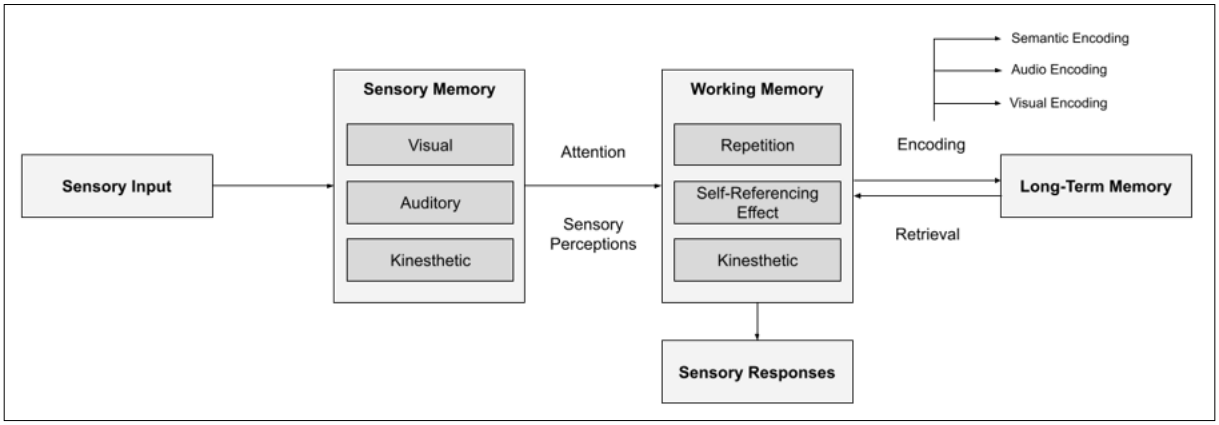

Figure 2: Game Design Framework Based on Information Processing Theory

will verbalize, and after eating one more orange, it should show and spell "I want to eat three more oranges," therefore in this way, we should provide the information at the right point of time and not sounding monotonous.

Self-Reference Effect
According to the in- formation processing theory, it's a tendency for an individual to have better memory for information that relates to oneself compared to the material that has less personal relevance. This idea can inspire the development of the game on a real-life experience of how a kid likes a particular type of activity and dislikes the other in everyday tasks.

Active Learning
As mentioned by Piaget's Theory, active learning allows kids to explore and shape things in their own way, allowing them to interact with the creative things in whatever way they want and enhance their symbolic understanding.

Long-Term Memory
It stores the information for a longer period and can be retrieved when needed.

Sensory Responses
While playing the game, kids react differently and use various sensory organs to show their emotions. While playing the game, their different sensory organs will come into the picture, increasing the performance of sensory and cognitive abilities.

Ideation
1. Based on the model above we identified a few design requirements:
2. To establish a way of learning style that provides a gradual increase in attention and sensory perceptions.
3. A system that helps them store more information easily.
4. Providing fun and engaging ways of learning by incorporating various media.
5. Developing a story in the game such that they could relate to themselves while learning.

Empower their learning process and allow them to express and mold things on their own.

Thus, in exploring potential game designs for the Jellow app, several icon-based avenues could be considered. These include activities focusing on icon movement and matching, encouraging children to recognize similarities and categorize items such as alphabets and familiar objects. Grouping exercises can be designed around themes like home, school, or food. Creative elements like coloring tasks can aid in recognition and artistic expression. Logical sequencing games using alphabets, numbers, or qualitative arrangements can develop cognitive skills, while introductory calculations, including basic addition and subtraction, can help instill fundamental math concepts.

Tying these game design explorations to the learning model based on Information Processing Theory, the focus should be on enhancing sensory input, working memory, and long- term memory retention. This gamification approach should align with the principles of Information Processing Theory by facilitating the transition of learning from sensory input to long-term storage, enhancing cognitive development in children with developmental disabilities.

Conclusion
In conclusion, this study on "Gamifying Jellow: A Communication Aid for Children with Developmental Disabilities" presents key findings on enhancing engagement and memory retention in children using gamification strategies.

While user feedback has highlighted the app's low engagement and challenges in memory retention, the application of Information Processing Theory in game design shows promise in addressing these issues. However, limitations include the need for more diverse user testing and long-term effectiveness studies. Future research should focus on the scalability of these gamified features and their impact on different developmental disabilities, potentially leading to broader applications in educational technology and therapy [10].

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