Exploring Emotional Engagement in Augmented Reality Simulation of the Seven Dyslexia Visual Distortion

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Abstract
Dyslexia is a phonological learning difficulty that affects an individual's ability to process linguistic codes despite having high cognitive ability and keen vision. People with visual dyslexia also experience seven visual distortions in reading: words that jump out of the page, melt away, blurry, shaky, and others. Regardless of dyslexia's high prevalence rate (1 out of 5 people), awareness of dyslexia is inadequate, which results in misperception and discrimination in society as they cannot perceive or imagine the visual distortion that people with dyslexia face every day. The lack of understanding of dyslexia has become the root of the issues of empathy and equality in society. This concern is explored through this research project in the form of an augmented reality simulation of the dyslexic's seven visual distortions. This research examines the effectiveness of augmented reality as an unconventional medium to put participants in dyslexics' shoes in a more memorable manner. Guided by the event sampling method, the simulation's impacts were explained through a measurable approach by exploring participants' engagement, comprehension, and perception levels. This research project also demonstrated the potential of multi-sensory and interactive media in provoking emotion and generating profound experiences in learning about indescribable issues, such as dyslexia.

Keywords: Dyslexia, Augmented Reality, Engagement, Comprehension, Perception

Introduction

Although plenty of definitions exist, dyslexia can be simply addressed as a multi-faceted neurological disorder that affects the development of phonological understanding (Mather & Wendling, 2012). Based on the interview with Dr. Eng. Sumarsono, S.T., MT, OCP (2021), most cases of dyslexia don't occur alone, as dyscalculia, dysgraphia, ADHD, and dyspraxia most probably accompany dyslexia. The symptoms of dyslexia such as reading, word recognition, writing and spelling, memory, and motor difficulties were not conclusive considering external and internal factors that occurred or changed through the years. The individual must exhibit a collection of the following behaviors, continually, over time, in various situations to be addressed potentially having dyslexia (Shannon, 2006).

Reading Experience of Dyslexia

Although the prevalence rate of dyslexia in Southeast Asia is remarkably high and keep increasing year by year, the awareness and understanding of the true nature of dyslexia is still inadequate (Oga &. Haron, 2012). In general, there are three types of dyslexia: *dysnemkinetic* (writing and printing), *dysphonetic* (an auditory problem in reading and spelling), and *dyseidetic* (a visual problem in reading and spelling). Among those three, visual/ surface dyslexia (*dyseidetic*), commonly known as Meares-Irlen syndrome, exhibits the most distinct symptom called visual perceptual distortion (Hermijanto, 2016). There are seven observable distortions in the reading experience of people with this type of dyslexia: halo (multiplying), blurry (overlapping), rivers (irregular), shaky (trembling), wash-out (fading), swirl (twisting), seesaw (bouncing over or out of the page). These distortions worsen if the environment or the media are not friendly: small font size, narrow kerning and line spacing, extreme lighting, excessive contrast, and noisy ambiance (Stein & Kapoula, 2012).

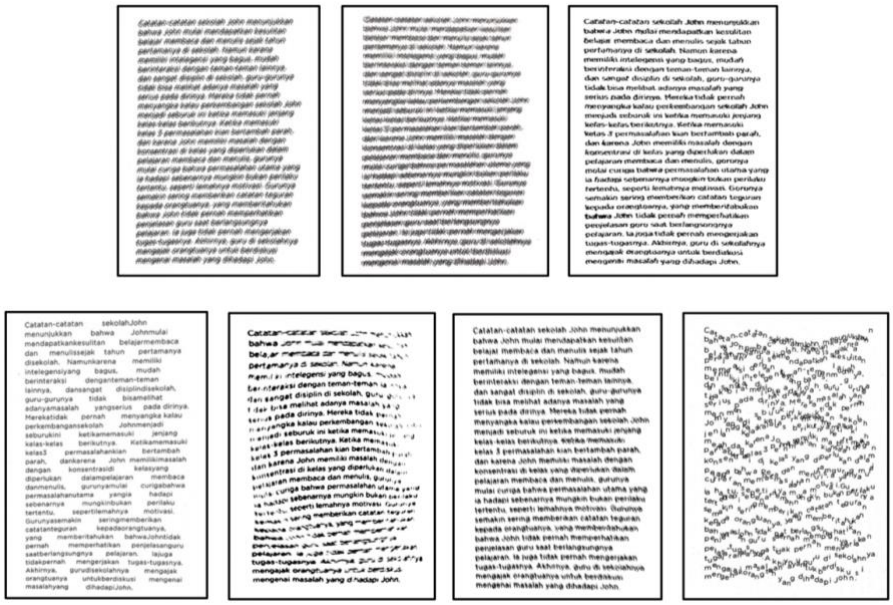

Figure 1: The Seven Visual Distortions of Dyslexia

Experience in Augmented Reality

In raising people's level of engagement, a simulated environment can be one of the alternatives. Using the visual aspects and immersive media enables them to generate personal

experiences, which later enhance motivation, attention, engagement, and enjoyment in the learning process (Lilian, Lee, Dolah, & Bakhir, 2018).

Nevertheless, the effects can differ because the personal experience that results from this process is linked to experience and environment, such as local culture, gender, area, education, etc. Based on Wright, a visual image is examined by an internal and an external narrative. An internal narrative is the content of an image, which each individual may perceive differently depending on their perception. In contrast, an external narrative can be considered factual context, such as where, when, and how it is situated (Lynn & Susan, 2005).

Augmented reality (AR) is not simply a new technology but a concept that combines internal and external narratives to create real simulated/ synthetic project images and information (Furht, 2018). Edgar Dale's Cone of Experience illustrated the importance of concrete experience and direct participation to provide the foundation of permanent learning and communication. Based on this, augmented reality is considered capable of enhancing the information level, so users can have more engaging perceptions and interactions by gaining experiences virtually (Peddie, 2017).

Augmented Campaign of Dyslexia

An augmented campaign is a new approach to empathizing with dyslexics by developing a more profound comprehension and bringing a virtual experience of how people with dyslexia see the world through the augmented reality-based exhibition. The main display consists of 24 AR pages, animated and compiled in the form of a giant book (1.5x2 meter) where visitors can experience the seven visual distortions of dyslexia through each page of the book. The utilization of storytelling highlighted the journey and experience of people with dyslexia in perceiving words and sentences. The story revolves around a character who adventures in search of his true identity. He decided to wander to seven locations, which are related to the seven symptoms of visual distortion, to collect the hints of himself. From the beginning to the end of the story, the character is in silhouette to point out the message that it can be anyone.

Each illustration was composed of animated text according to the seven distortions that can be seen through AR. The text was presented as a poem to emphasize the dyslexic's weakness in spelling and reading rhyming words. This approach is expected to facilitate people to grasp the core of this campaign which aims to educate, entertain, and raise engagement of people toward dyslexia. According to the research of Rello (2012), the most difficult colors to perceive by dyslexics are black and yellow so in order to highlight the difficulties experienced by dyslexics, the primary colors of this project are black, yellow, and white.

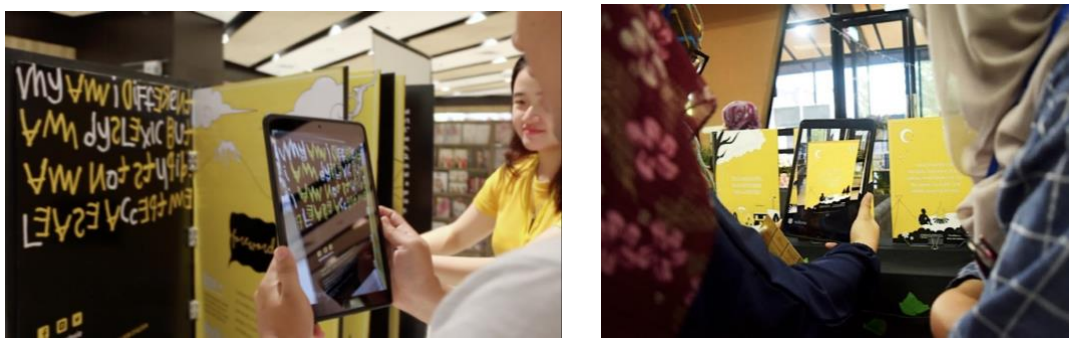

Figure 2: Dyslexia Campaign Exhibition

Results

The exhibition's journey could be divided into three phases: pre-test, AR simulation, and post-test. There were 215 purposive samples from visitors that were heavily related to the dyslexia family and the education field. Firstly, the samples were asked demographic questions (age, gender, marital status) and basic knowledge of dyslexia in the registration corner. Next, they were invited to experience the visual distortion simulation through each page of the AR book. An installed device was provided, so the participants didn't have to download and install the application to participate in this project. Lastly, they were asked to answer three questions about dyslexia and two questions about the experience in the exhibition. Based on the results of the tests, three statistical formulas of the impact rate were calculated and analyzed using the evaluation method for the survey by Krosnick and Presser (Kroscnick & Presser, 2010).

Principally, this research project endeavors to find an alternative method of a social campaign by transferring the conventional descriptive manner to a contemporary interactive manner and verifying its potency through a measurable method. Throughout the process, there were several shifted variables found which were grounded on existing studies, observation, interviews, and surveys of the exhibition. Those differences can be either a beneficial factor or an unfavorable factor depending on the aim and execution of a specific social campaign.

Referring to the exhibition flow, there were several possible scenarios of the participation which were caused by internal factors (such as preferences, motivations, perceptions, behaviors, feelings, abilities, and knowledge) and external factors (such as time, location, crowd, technical issues, social-cultural issues). In this case, the event sampling method was performed to provide an objective parameter of the ‘success’ and ‘failure’. In this research parameter, there are three quantitative findings:

1. Engagement Rate
   This rate measured the level of people's interest and excitement throughout the exhibition which could be seen in how engaged the participants were in the simulation.
2. Comprehension Rate
   Based on the post-test given, there were questions about dyslexia with different levels of difficulty to test the participants' knowledge after taking part in this campaign project.
3. Perception Rate
   In this calculation, participants were asked to fill in two questions about their experience in this research project, ranging from 1 to 4 (1 is poor and 4 is high).

Engagement Rate (Activities Q) ((X1x0)+(X2x0.5)+X3)/n	0-50% Failure 50-70% Success >70 Satisfactory

Comprehension Rate (Dyslexia Q) ((X1x0)+(X2x0.5)+X3)/n	0-50% Failure 50-70% Success >70% Satisfactory

Perception Rate (Exhibition Q) ((X1x0)+(X2x0.5)+X3)/n	0-50% Failure 50-70% Success >70% Satisfactory

Figure 3: Engagement Rate

Engagement Rate

Engagement Rate Formula = (Σ Xi) / n
Xi is (X1 x 0) + (X2 x 0.5) + (X3 x 1)
X1 is participants who engaged as observers only
X2 is participants who engaged partially with the AR book
X3 is participants who engaged fully with the AR book
Engagement Rate (4 x 0) + (108 x 0.5) + (103 x 1)/ 215 = 73.02%

Based on the stated results, the Engagement Rate is above 70%, considered 'satisfactory'. Most of the participants who showed a high Engagement Rate and contributed to all activities were young adults (20-29 years) at 45,68%, followed by adults (30-39 years) at 25,93%. This data confirmed that people in this maturational phase exhibited higher curiosity and deeper engagement toward social, parental, and developmental issues, making them a perfect target. At this stage, they tended to become more adept at complex thinking, expressing emotions, showing empathy, and taking responsibility when making decisions independently.

As seen in the chart above, the number of thoroughly engaged participants is considerably high. The number implied that interactive media such as augmented reality was advantageous in attracting people's interest and curiosity.

Comprehension Rate

Comprehension Rate Formula = (Σ Xi) / n
Xi is (X1 x 0) + (X2 x 0.5) + (X3 x 1)
X1 is participants who answered 0-1 question correctly
X2 is participants who answered 2 questions correctly
X3 is participants who answered 3 questions correctly
Comprehension Rate (13 x 0) + (59 x 0.5) + (143 x 1)/ 215 = 80.23%

Figure 4: Comprehension Rate

In the pre-test, the participants were asked three basic questions about dyslexia, and the rate was 52.62% using the same formula above. After experiencing the AR simulation, the participants went through the post-test, which consisted of questions about dyslexia awareness month, seven visual distortions, and false-true statements. All of the questions aimed to verify the depth of their understanding before and after the experience.

The comparison data between the pre-test and post-test showed a significant rise (27,61%). Based on this data, the relation between Engagement Rate and the number of correct answers conducted in the post-test was examined. The result was proportional to the Engagement Rate.

Perception Rate

Perception Rate Formula = (Σ Xi) / n
Xi is (X1 x 0) + (X2 x 0.5) + (X3 x 1)
X1 is participants who stated this campaign was poor
X2 is participants who stated this campaign was ordinary and good
X3 is participants who stated this campaign was great
Perception Rate Indonesia (0 x 0) + (50 x 0.5) + (165 x 1)/ 215 = 88,4% (C)
Perception Rate Indonesia (0 x 0) + (24 x 0.5) + (191 x 1)/ 215 = 94,4% (E)

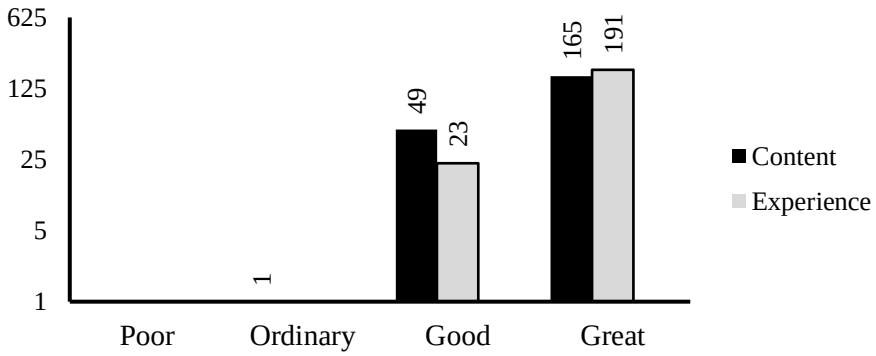

Figure 5: Perception Rate

Based on this sampling method, the participant's level of satisfaction was remarkably positive, which is also proven by the spoken opinion of the visitors. As seen in the calculation above, most participants gave a higher score for interactivity and experience than the content, which was undeniably a strong point of this campaign project.

Discussion

According to this research project, a visual-based approach and interactive media enhanced 215 participants' motivation, attention, engagement, and enjoyment in the learning process to a certain level in the augmented exhibition. Below are the findings from this project:

- Young adults (18-35) were the most appropriate group for a social campaign, especially in social, education, parental, and self-improvement issues.
- Based on the Engagement Rate, young adults, teenagers, and kids are more enticed to things that provoke curiosity and generate experience, which is considered more valuable than material things or cognitive information.
- Based on the Comprehension and Perception Rate, being exposed to multi-sensory and interactive media enhanced participants' motivation, attention, engagement, and enjoyment in the learning process.
- Regarding the research process, fact-based illustration to describe dyslexic perspective was essential to avoid misconceptions about visual dyslexia. In this regard, direct observation and participatory design were highly favorable.
- An adequate campaign period should be considered proportional to the engagement and awareness inflicted.

Table 1: Discussion

Descriptive Social Campaign (Common)	Interactive Social Campaign (BOOX)
Focusing on content, such as comprehensive information and persuasive message.	Focusing on visual and interactivity with motivational messages.
Depending mainly on how the campaigner interacts and persuades the participants.	Depending mainly on the user experience design and flow of the exhibition.
Offering general knowledge to help participants understand the real meaning of visual dyslexia.	Offering an intimate personal experience of visual dyslexia to evoke participants' empathy.
More focusing on cognitive (facts and concepts) and affective (value and response).	More focusing on psychomotor (perception and adaptation) and affective (value and response).
Targeting a specific age group at one particular event as the content must be adjusted suitably.	Reaching several age groups at one time as the content is more visual-based.
The participants need no particular capability.	A sufficient amount of ability to operate interactive media or devices is needed.
A longer duration is needed to comprehend. Further course of action is complementary.	A shorter duration is needed to comprehend. A further course of action is necessary.
Initial interest in visual dyslexia leads to participation and ends with a more profound comprehension of dyslexia.	An initial curiosity of the interactive media (AR) leads to participation and ends with a deeper understanding of visual dyslexia.

Referring to this summary, augmented reality-based media holds a noticeable potential to provoke curiosity and long-term experience, compared to the conventional approach. This is aligned with Wadlington's statement (Wadlington, Elliot & Kirylo, 2008) that putting people in a place where they could never be through immersive simulation rather than just explaining a series of information and directing them to do a particular action in a social campaign excites the participants in a more impactful and meaningful way.

Conclusion

Although the research had reached its aims, there were some avoidable limitations. Firstly, due to the time limit of the study, this research was limited to a small sample from a representative country, Indonesia. Other limitations of this research were primarily the limited source of the literature and expertise, the validity of the statistical data, and how it affected the research outcome. In this regard, this project was hoped to be able to encourage academicians, researchers, educators, and experts to carry out more research and resolve the issue of dyslexia.

In summary, this research has the potency to be developed and improved in many ways to be an unconventional alternative manner of a social campaign. To fulfill that, I would like to recommend refining and testing this method on a larger scale and various perspectives in collaboration with several practitioners and academicians from different fields.

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