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Research Article

Evaluation of the Gamification Effectiveness of an Application for Reducing Dizziness Disability in Children

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Abstract

Objective: To verify the effectiveness of the use of gamified elements in the Dizziness Kids application, based on the analysis of the results obtained by the patients' performance, interactivity, and productivity.

Methodology: This is a descriptive, exploratory study with a quantitative approach, consisting of a convenience sample of twelve male and female children up to 12 years old with the symptom of dizziness. The sample was divided into 2 groups: Study Group, composed of 6 children who were submitted to the stimuli of the Dizziness App Kids and Control Group, composed of 6 children who interacted with the Dizziness App version.

Results: Therapy through the Dizziness Kids App made it possible to reduce the score on the DHI-CA / SF questionnaire, improve the symptoms and quality of life of the children studied.

Conclusion: The inclusion of gamification elements in the mobile application Dizziness App Kids showed the motivation of the participants in the intervention, signaling positive results.

Keywords: Dizziness; kids; exercise therapy; applications

Introduction

The vestibular, proprioceptive, and visual systems are responsible for body balance and are processed by spinal and ocular reflexes, with ocular reflexes composed of vestibulo-ocular (RVO), cervical-ocular and optokinetic reflexes [1]. The RVO is responsible for stabilizing a visual image, during head movement, that is, it causes the images of the retina to stabilize in the last visual field [2,3]. Motion sickness is characterized by intolerance to movement, generated by a sensory conflict between the visual, proprioceptive, and vestibular systems during passive locomotion in different means of transport. This can cause nausea, sweating, vomiting, excessive salivation, decreased appetite, malaise, and hypotension [4,5]. Therefore, it is seen as a physiological vertigo, not being classified as a disease, as it is a common response to an abnormal situation [6]. Functional changes in the child's vestibular system can cause disorders in motor development and language acquisition, leading to impairments in psychological behavior, communication skills and school performance. Such changes cause difficulties to perform coordinated movements and favor an imprecise conception of the spatial position, which would justify the learning difficulties in children [7-10]. In Brazil, a population-based survey of 831 children aged 7 to 12 years, conducted in the city of Diamantina, in the state of Minas Gerais, with the aim of determining the prevalence of motion dizziness in schoolchildren, it was observed that dizziness and nausea they are greater when in a car or on a bus when correlating them with postural balance tests, in addition to the Dizziness Handicap Inventory - DHI - to assess quality of life [11]. Several clinical studies on vestibular disorders in children show agreement on its primary causes.

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However, the number of published investigations is quite limited, which reveals some neglect of the suffering caused by dizziness in the child population [12]. The subjectivity of vestibular symptoms, the children's inability to characterize them and the difficulty in reporting such symptoms, lead to a difficulty in diagnosing vestibular function in this age group [13,14]. In vestibular rehabilitation (VR), exercises tend to improve the visual vestibule interaction during head movement, in addition to increasing postural stability, in conditions that produce conflicts in sensory information [15].

VR has been shown to be an excellent therapeutic resource in the recovery of body balance [13]. When performed exclusively through RVO stimulation, Simoceli and collaborators [16], demonstrated in a study that the reestablishment of balance was equivalent when comparing the results of conventional VR. It should be noted that the earlier the intervention, the better the prognosis, especially in children [17]. The mediation of mobile devices as a proposal for entertainment activities in the health area has grown significantly today, contributing to learning situations [18]. This growth in the use of applications has adopted gamified strategies in order to maintain more effective stimulation practices and interventions [19]. The application especially in the health area contributes so that the treatment is aimed at stimulation or rehabilitation, which goes beyond the environment of the outpatient clinics, allowing patients to intensify their training [18]. The concept of gamification is defined as the application of elements that provide engagement, motivation, interest, attention, and that facilitate the learning of individuals. The development of goals with feedback and rewards are the elements most used in these cases [20,21]. Within this context, the Dizziness App Kids was created, with the purpose of expanding the therapeutic strategies that have been commonly used to recover body balance, when associated with the application of exercise protocols for eyes, head and trunk, as well as the use of stimulation otovestibular and optokinetic (Figure 1). The main interest in conducting this study is to verify the efficacy of gamification, in the mobile application, based on the reduction of dizziness incapacity in the tested children.

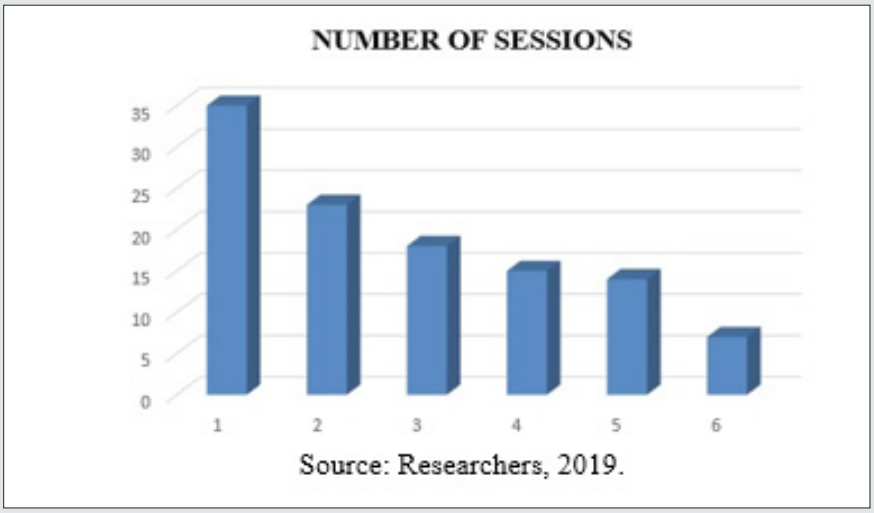

Figure 1: Graphical representation the number of GE sessions, with the Dizziness Kids App.

Methodology

Study Design

This is a descriptive, exploratory, case-control study with a quantitative character.

Study Participants

Children participated in the study, withreport dthe dizziness symptom, mainly motion dizziness (motion sickness), setting up a convenience sample.

Inclusion Criteria

Children were included in the study male and female with up to 12 years old and with report of dizziness symptom.

Exclusion Criteria

Exclusion criteria were the presentation of any cognitive and visual impairment that prevented the children from using the applications and answering the questionnaires. In addition, patients outside the established age group, who had reports of dizziness with isolated episodes or who used other types of treatment, such as the use of drugs, were excluded.

Ethical Aspects

This research followed the norms established by Resolution No. 466, of December 12, 2012, of the National Health Council. It was inserted in Plataforma Brasil for submission to the Ethics and Research Committee (CEP) of UNEB, with opinion number: 2,956

.935. And because they are seen at the clinic, those responsible for the patients signed a term that authorized a possible disclosure of the data for scientific purposes of the institution itself. The volunteers who participated in the survey were free to remain or not in the survey.

Location and Period

The study was carried out at Clínica Escola de Fonoaudiologia (CEFON) of the State University of Bahia - UNEB, from May 13 to July 26, 2019.

Collection Instruments

To achieve the objectives of this research, the following materials were used: thequiz sociodemographic (elaborated by the researchers), the instrument called Dizziness Handicap Inventory Child / Adolescent Short Form (DHI-CA / SF) and the Dizziness Kids App (gamified version) as well as the Dizziness App (non-gamified version).

DHI-CA / SF isa Brazilian version adapted from the Dizziness Handicap Inventory (DHI) in its semantic aspect, which relied on adapting the items to the vocabulary of school-age children and adolescents, to ensure a good understanding of the issues [22]. DHI consists of 25 questions, organized into three subscales: functional (nine items), emotional (nine items) and physical (seven items). The response scale varies between 0 ("no") and 4 ("yes"), also contemplating the intermediate value 2 ("sometimes") [23]. DHI-CA / SF is composed of 15 objective questions, also divided into subscales corresponding to emotional, physical and functional aspects. It is an instrument with a lower number of questions, which favors more reliable answers, since the attention capacity in this age group is limited / reduced. It is also noteworthy that DHI / CA-SF, in addition to providing greater speed in its applicability, can be used for screening in schools and / or health services, when reporting the dizziness symptom by children and adolescents, having considered that this symptom has a high prevalence in this age group, according to national and international literature [22]. The DHI-CA / SF handicap level for the full-scale scores are: mild disability (0-18), moderate (18-36) and severe (36-60). For the physical, functional and emotional domains, the handicap level was classified as: light level corresponding to (0-4.8), moderate level (4.8-9.6) and severe (9.6-16) for the Physical domain; For the Functional domain, the level of mild disability corresponds to (0-8.4), moderate (8.4-16.8) and severe (16.8-24). In the Emotional domain, the level of mild, moderate and severe disability corresponds to (0-4.8), (4.8-9.6) and (9.6-16), respectively, as shown in Table 1.

Table 1: DHI / CA / SF handicap level.

Handicap Level	Total DHI-CA / SF Score	Physical Domain	Emotional Mastery	Functional Domain
Mild disability	0 - 18	0 - 4.8	0 - 4.8	0 - 8.4
Moderate disability	18 - 36	4.8 - 9.6	4.8 - 9.6	8.4 - 16.8
Severe disability	36 - 60	9.6 - 16	9.6 - 16	16.8 - 28

Source: Researchers, 2020.

Sociodemographic Questionnaire

The sociodemographic questionnaire was designed and applied in order to collect data about the subjects about information related to sex, age, skin color, school year and place of birth, which were obtained in the face-to-face stage of the research.

Dizziness App Kids X Dizziness App

The Kids Dizziness Appit is a software developed for optokinetic stimulation used, as a supporting instrument, in the therapy of rehabilitation of body balance. It provides an optokinetic stimulus through black and white stripes where the patient will only follow the black stripe that passes in front of him, thus promoting an optokinetic stimulus and triggering the vestibular ocular reflex (VOR). This stimulus is widely used in the treatment of individuals with the dizziness symptom. The gamified version of the app encouraged users with challenges, missions, rules, feedback, and reward systems to keep patients motivated and persist in treating dizziness. Among the various functions of the App, the database contained therein allows the speech-language pathologist to monitor and monitor training, making it possible to observe the evolution of cases through the efficiency of the system, supporting new therapeutic interventions. THE Dizziness App also has the objective to assist in the treatment of dizziness by stimulating the RVO and was initially tested on a 29-year-old female volunteer who had the symptom [18]. However, this version differs from the Dizziness Kids App only in that it lacks the elements of gamification.

Data Collection Procedure

In order to carry out this research, dissemination was carried out through social media by calling children with dizziness to participate in the study, during the period from March to May 2019. Those responsible who presented themselves for interview and that their children met the criteria of inclusion were registered at the Clinical School of Speech Therapy at UNEB - CEFON for interview and subsequent scheduling of dizziness therapy sessions through the Dizziness App. Once the patients who presented the symptom were identified, it was given to the parents The Informed Consent Form (ICF) and the Term of Assent, in addition to an explanatory leaflet about dizziness and its impact on school learning. Those parents / guardians who agreed with the research signed the documents, in order to inform about the study, as well as to authorize it. After the selection of the children and the consent of the parents or guardians, a meeting was scheduled for the purpose of clarifying the research objectives, about the dizziness symptom, its causes and treatments.

As well, they were informed how vestibular rehabilitation can help in the treatment of dizziness and its repercussion in school learning. Afterwards, the sociodemographic questionnaire was applied in order to collect data about information related to sex, age, skin color, school year and place of birth. Then, parents / guardians together with the children responded to the DHI-CA / SF in the first session, expressed in the use of an automated and simplified digital process of applications. At this stage, the sample was divided into 2 groups: the study group (EG), composed of 6 children who were submitted to stimuli from the Dizziness App Kids and the control group (CG), composed of 6 children who interacted with the non-gamified version of the application (Dizziness App). The proposed therapy consisted of the interaction with both applications for training the RVO with stimuli in the horizontal, vertical and oblique plane. The stimuli lasted three minutes for each plan mentioned. Thus, session 1 had 3 stages of interaction per cylinder position, with each interaction recorded as an optokinetic training session. At the end of the sessions, DHI-CA / SF was reapplied for comparison before and after treatment, in order to verify the effectiveness of the application on children's dizziness.

Data Analysis Procedure

Were descriptive statistical measures were used for sample characterization, through measures of central tendency (mean) and dispersion (minimum and maximum standard deviations). Furthermore, DHI-CA / SF scores were analyzed by comparison, based on information between the total pre-treatment and post-treatment scores.

Results

With the application of the instrument, the results on screen corresponded to the SG, composed of a total of six children with reports of dizziness, two of whom were male (33.3%) and four were female (66.6%). With regard to sociodemographic characteristics, 66.6% of the participants declared themselves to be brown and 33.3%, white. As for the school year, 33.3% were in the 7th year and the percentage for groups IV, 3rd, 4th and 6th year was 16.6% each. In relation to naturalness, 66.6% were from the capital and 33.3% from the interior of the state (Table 2). The results below corresponded to the CG, composed of a total of six children with reports of dizziness, three of whom were male (50.0%) and three were female (50.0%). With regard to sociodemographic characteristics, 50.0% of the participants declared themselves to be brown, 33.3% white and 16.6% black. As for the school year, 16.6% were in Group 3, 33.3% were in the 1st year and 33.3% were in the 5th year. In relation to naturalness, 66.6% were from the capital and 33.3% from the interior of the state (Table 3). The Table 4 refers to the distribution of subjects (SG) according to age, the DHI-CA / SF score before and after using the Dizziness App Kids application and the number of sessions. According to the information contained in Table 4, the age group varied from four (minimum value) to 12 years (maximum value), with an average of nine years. The number of patient interaction sessions with the gamified version of the application ranged from seven to 35 sessions. The application of DHI-CA / SF pre-treatment in the EG showed that 33.3% of the patients had scores between 0 and 18 points, 33.33% between 18 and 36 points, and 33.3% between 36 and 60 points. When applying DHI-CA / SF after the sessions, 66.6% of the patients had scores between 0 and 18 points, 17% between 18 and 36 points, and 17% between 36 and 60 points. The average pre-training score with the Dizziness App Kids was 30 points, which represents a moderate degree of disability, according to the DHI / CA / SF handicap level (Table 4). The average score after use of the gamified application showed a lower value, ie, 19 points corresponding to the degree of mild disability indicating that there was an improvement in symptoms.

Table 2: Characterization of the EG sample according to the data from the sociodemographic questionnaire.

Variables	CALL US	Absolute Frequency (n = 06)	Relative Frequency (n = 06)%
Sex	Female	4	66.6
	Male	2	33.3
Skin color	White	2	33.3
	Parda	4	66.6
School year	Group IV	1	16.6
	3rd year	1	16.6
	4th year	1	16.6
	6th year	1	16.6
	7th Year	2	33.3
Naturalness	Capital	4	66.6
	Interior	2	33.3

Table 3: Characterization of the CG sample according to the data from the sociodemographic questionnaire.

Variables	CALL US	Absolute Frequency (n = 06)	Relative Frequency (n = 06)%
Sex	Female	3	50
	Male	3	50
Skin color	White	2	33.3
	Parda	3	50
	Black	1	16.6
School year	Group III	1	16.6
	1st year	2	33.3
	5th Year	2	33.3
	7th Year	1	16.6
Naturalness	Capital	6	100

Table 4: Distribution of the number of GE sessions, with Dizziness App Kids.

Patients	Age	Number of Sessions	Punctuation Pre and Post DHI-CA / SF
Patient 1	12 years	35 Sessions	14 points - 04 points
Patient 2	08 years	23 Sessions	14 points - 08 points
Patient 3	12 years	18 Sessions	30 points - 16 points
Patient 4	11 years	15 Sessions	60 points - 54 points
Patient 5	08 years	14 Sessions	44 points - 22 points
Patient 6	4 years	07 Sessions	20 points - 12 points

Table 5: Distribution of the number of GC sessions, with Dizziness App.

Patients	Age	Number of Sessions	Pre and Post Score DHI-CA / SF
Patient 1	07 years	1 Session	06 points - did not respond to DHI-CA / SF post
Patient 2	03 years	1 Session	04 points - did not respond to DHI-CA / SF post
Patient 3	10 years	18 Sessions	54 points - 56 points
Patient 4	07 years	33 Sessions	48 points - 0 points
Patient 5	12 years	35 Sessions	02 points - did not respond to DHI-CA / SF post
Patient 6	11 years	11 Sessions	44 points - did not respond to DHI-CA / SF post

It is possible to observe that the greater the number of sessions held by the child and adolescents, the lower the score of the DHI-CA / SF, which resulted in an improvement of the referred symptoms. From a subjective point of view, this reduction in the score means that actions such as: looking up, lying down or getting out of bed, dancing, playing sports, among other activities, no longer triggered dizziness. It was also verified that the younger children interacted less with the application, and obtained a smaller difference between the pre and after treatment when answering the DHI-CA / SF.

The database contained in the applications allowed, on the part of the speech therapist, the monitoring and monitoring of optokinetic training, the evolution of the cases and the analysis of the results, by providing information such as the performance graphs of each user that were stored in the system itself throughout the therapeutic process developed in both groups. That is, the weekly, daily and monthly reports contributed with statistics to assess the degree of interactivity and productivity of the children, being a satisfactory factor that served as a parameter for the modeling of the implemented methodology. Table 5 was elaborated based on the information from the CG, such as: age, DHI-CA / SF score before and after using the Dizziness App, the number of sessions and the percentage of improvement in the dizziness symptom, according to the DHI -CA / SF. The age group of the CG sample varied from three years old (minimum value) to 12 years (maximum value), and the average was eight years. The number of children's interaction sessions with the non-gamified version of the app ranged from 1 to 35 sessions. The application of DHI-CA / SF pretreatment in the CG showed that 50% of the patients had scores between 0 and 18 points, and 50% between 36 and 60 points. The average pre-training score with the Dizziness App was 26 points, which also represents a moderate degree of disability, according to the DHI / CA / SF handicap level (Table 1). The data related to the application

of DHI-CA / SF after the sessions were not obtained in 66.6% of the sample, due to the low adherence of the subjects to the treatment. It was possible to collect information only in 33.3% of the population, of these, 16.6% scored for the degree of mild disability and 16.6% remained in the degree of severe disability (Table 1).

Discussion

The literature describes how vestibular symptoms can alter the subjects' routine, impacting quality of life [24], and how interventions allow repercussions on the child's cognitive and motor development to be avoided [25]. In these cases, optoninetic training has become a great ally for providing the adaptation of vestibular responses, causing the brain to reduce the displacement of the image in the retina and increase the gain of the vestibulo-ocular reflex to reduce the asymmetry of optoninetic nystagmus [26,27]. The data found through the Dizziness Kids App brought positive results for the children and adolescents who most interacted, and, therefore, were more exposed to stimuli, which led to a reduction in the questionnaire score. DHI-CA / SF, as well as improvement in symptoms and quality of life. Result that corroborates the study carried out with digital image stimulation as a new treatment option for vestibular disorders, where elucidated benefits for quality of life, with reduced dizziness and improvement in body balance [28]. It was also found that the younger children interacted less with the applications, such as patient 6 (four years old), participant in the EG and patient 2 (three years old), who composed the CG. This difficulty may be directly associated with the attention skill, defined as the ability to direct mental processes, so that the individual selects stimuli considered relevant and ignores those irrelevant to the activity performed [29]. Lima and collaborators [29], sought to analyze the performance of a sample of students without learning difficulties, in tests that assess attention and some aspects of executive functions, the results indicated the performance was better due to the increase in age and level schooling. It was observed that the highest percentages of improvement in dizziness symptoms were directly related to the number of sessions that users performed, implying that adherence to the therapeutic process is essential to obtain good results. It is worth mentioning that adherence to treatment was more satisfactory in the GE, which used the Dizziness Kids App. Thus, recent studies have appropriated gamification to promote involvement, as well as patients' adherence to treatment [30]. With regard to sex, in the CG most of the children were female. The study by Sousa et al. [7] revealed that female patients achieved higher scores on the three subscales of the DHI-CA and on the total score, when compared to males. However, recent research has indicated that the prevalence of dizziness did not vary as to sex [31]. Which incites the need for further investigations of this differentiation in the results, regarding gender.

Gamification has been increasingly applied with the aim of inserting users in the process of behavior change, relying on the use of game elements, emblems, rules systems, rewards, animations, challenges, and surprises [32,33]. It is believed that by incorporating these resources into applications, it is possible to provide motivation, encourage children to develop creativity, improve memory and assist them in solving problems [34,35]. When interacting with the application, children they need to exercise their inhibitory control, that is, learn to control their impulses and actions for "appropriate" moments; cognitive flexibility will be another stimulated function, as children should be attentive, to shift the focus / stimuli towards the required goal during training; planning is another important function to be stimulated when interacting with applications, as users must manage and plan their daily time for training [36]. In this sense, the aspects mentioned above have an adaptive character for the subject, as it facilitates coordination with regard to other cognitive skills [37]. The stimulation of executive functions can be effective for the good performance of the child population in daily and school tasks, therefore, the sooner it is implemented, the greater contribution it will make possible for future learning [38]. The interaction of children with Dizziness Kids goes beyond optokinetic stimulation for the treatment of motion dizziness, since it is a gamified application, it makes it possible in a playful way, that these subjects also develop their executive functions. Second Fonseca [38], the executive functions they are considered the "teacher of the cognitive system", these functions being essential for the schooling process.

During the application of Dizziness Kids App, it was possible to notice that the patients had an easy interaction with the proposed virtual environment. In this perspective, studies indicate that the games themselves, through the various interactive and immersive proposals, appear as one of the strategies that can favor the development of new connections and the reorganization of essential brain functions [39]. This study had some limitations, among them, the difficulty in making predictions and generalizing the results, in view of the sample size of participants. Another limitation found was the possibility the observed therapeutic effect was the result of the natural course of improvement of the disorder. Finally, studies on the application of games in the context of vestibular rehabilitation in children and adolescents are scarce, which reiterates the importance of projects like this, which may serve as a support for future more accurate analyzes.

Conclusion

The inclusion of gamification elements in the mobile application Dizziness App, turning it into Dizziness Kids App, demonstrated satisfactory effects when using devices furniture for rehabilitation of body balance children and adolescents included in this study. Through the monitoring of interactivity, when using the Dizziness Kids App for rehabilitation of body balance, through optokinetic training, there was a minimization and even remission of dizziness symptom, offering improvement in the sample's quality of life studied. Therefore, it is necessary to deepen the studies in this area, with the intention of aiding speech therapists in the search for appropriate treatment, which provides good physical, social and mental development for children and adolescents with movement dizziness.

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