The Cook Sorcerer: a game to assist in the treatment of symbolic behavior, favoring generalized recombinative reading in autistic children

O Cozinheiro Feiticeiro: um jogo para auxiliar no tratamento do comportamento simbólico, favorecendo a leitura recombinativa generalizada em crianças autistas

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Fernanda Aline Costa França
Master in Teaching, Line of Research in Educational Practices in Professional and Technological Education (IFMA)
Institution: Secretaria Municipal de Educação (SEMED) – Paço do Lumiar
Address: Av. 13 Quadra 145, Nº 5, Conjunto Maiobão, Paço do Lumiar – MA, CEP: 65130-000
E-mail: fernanda.aline.franca@gmail.com

Francisco Adelton Alves Ribeiro
PhD in Biotechnology
Institution: Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA)
Address: Estrada Puraque, s/n, Zona Rural, Codó – MA, CEP: 65400-000
E-mail: adelton@ifma.edu.br

Alvaro Itauna Schalcher Pereira
PhD in Food Science and Engineering
Institution: Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA)
Address: Estrada Puraque, s/n, Zona Rural, Codó – MA, CEP: 65400-000
E-mail: alvaro.pereira@ifma.edu.br

Dina Karla Placido Nascimento
Master in Accounting and Administration
Institution: Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA)
Address: R. José de Alencar, s/n, Cumprida, Araioses – MA, CEP: 65570-000
E-mail: dina.nascimento@ifma.edu.br

Luis Fernando Maia Santos Silva
PhD in Computer Science
Institution: Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA)
Address: Povoado Lamego, Zona Rural, Caxias – MA, CEP: 65600-000
E-mail: luis.maia@ifma.edu.br
ABSTRACT
This article presents a game developed as an Educational Product resulting from the research of a Professional Master's Degree in Professional and Technological Education with the aim of assisting professionals in the field of Education and Health in teaching symbolic behavior, specifically the development of reading through discrimination and the recombination of syllabic units of words with students with Autism Spectrum Disorder (ASD) and other neurodevelopmental delays. The game was developed from collaborative work with students from the IT Technical High School at the Federal Institute of Education, Science and Technology of Maranhão (IFMA) Campus Codó, and is divided into tasks involving learning arrangements of two-syllable and three-syllable words, and positive reinforcement for teaching discrimination and recombination of syllables essential for literacy. Bibliographical research was carried out as a research methodology, using Applied Behavior as theoretical contributions. Analysis (ABA—Applied Behavior Analysis) and applied field research with students with ASD attended in the first literacy cycle in the Multifunctional Resource Room of the Emanuel Aroso Basic Education Unit. As results, we obtained an understanding of the way in which the teaching of relationships between stimuli and expansion for teaching reading and writing procedures in ASD is organized, such as: CRMTS (Constructed Response Matching to Sample – Matching to the model by constructed response) through the game. It is noteworthy that the aforementioned project covers the Priority Area of Technologies for Quality of Life, in the Health and Assistive Technologies sectors, established by ORDINANCE No. 1,122, OF MARCH 19, 2020, of the Ministry of Science, Technology, Innovations and Communications (MCTIC).

Keywords: autism, reading, educational games, applied behavior analysis.
RESUMO
O presente artigo apresenta um game desenvolvido como Produto Educacional fruto da pesquisa de Mestrado Profissional em Educação Profissional e Tecnológica com o fim de auxiliar profissionais da área da Educação e da Saúde no ensino do comportamento simbólico, especificamente ao desenvolvimento da leitura por meio da discriminação e da recombinação de unidades silábicas das palavras com estudantes com Transtorno do Espectro Autista (TEA) e outros atrasos do neurodesenvolvimento. O game foi desenvolvido a partir do trabalho colaborativo com os estudantes do Ensino Médio Técnico em Informática do Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA) Campus Codó, e se divide em tarefas com aprendizado de arranjos de palavras dissílabas e trissílabas, e reforço positivo para o ensino da discriminação e da recombinação de sílabas essenciais para a alfabetização. Foi realizada pesquisa bibliográfica como metodologia da pesquisa, tendo como aportes teóricos da Applied Behavior Analysis (ABA–Análise do Comportamento Aplicada) e da pesquisa de campo aplicada com estudantes com TEA atendidos no primeiro ciclo de alfabetização em Sala de Recurso Multifuncional da Unidade de Educação Básica Emanuel Aroso. Como resultados, obtivemos o entendimento da forma de organização do ensino das relações entre estímulos e ampliação para os procedimentos de ensino da leitura e escrita no TEA como do: CRMTS (Constructed Response Matching to Sample-Pareamento ao modelo por resposta construída) por meio do game. Ressalta-se que o referido projeto contempla a Área Prioritária das Tecnologias para Qualidade de Vida, nos setores da Saúde e Tecnologias Assistivas, estabelecidas pela PORTARIA Nº 1.122, DE 19 DE MARÇO DE 2020, do Ministério da Ciência, Tecnologia, Inovações e Comunicações (MCTIC).

Palavras-chave: autismo, leitura, jogos educativos, análise aplicada do comportamento.

1 INTRODUCTION

In Brazil, there have been decades of struggle in defense of Inclusive Education for all, regardless of their particularities, the formal learning context must design methodologies, strategies, resources and spaces in order to mitigate barriers and enable accessibility as a guarantee of rights and equity in learning. The Brazilian Inclusion Law – LBI (Brazil, Art. 2, 2015) mentions the barriers that prevent the full and effective participation of people with disabilities in society on equal terms with other individuals. In view of this, the issue is not just about offering access through vacancies, it is about generating elimination measures through accessibility and social transformation.
People with disabilities do not need to adapt to the educational and social context, but society needs to understand human diversities and adapt them to equity in learning and inclusion for all (Sassaki, 1997). An inclusive school is one that guarantees the quality of educational teaching to each of its students, providing recognition of singularities and respect for diversities, in addition to developing actions and resources that guarantee not only access, but permanence and learning for everyone, considering everyone as unique, according to their potential and learning styles.

The inclusion of students with Autism Spectrum Disorders (ASD) aims to raise awareness about the characteristics of this neurodevelopmental disorder, recognizing their interests and forms of mediation in areas such as language and communication, and repetitive and restricted behaviors. ASD presents persistent deficits in social communication and restricted and repetitive patterns of behavior, interests or activities (APA, 2014). These characteristics can present difficulties in motivation, symbolic behavior and discriminative and recombinative relationships essential for the development of teaching and learning reading. Therefore, it becomes a daily challenge to develop procedures and strategies in the family and educational context, whether in their assessment or intervention processes, in which they can minimize barriers and enhance these areas affected by these disorders. To this end, we must offer resources that mitigate difficulties in a learning environment with effective strategies for the inclusion of this audience.

Students who present with this neurodevelopmental delay should receive specialized attention in their educational inclusion process, given that their behavioral manifestations can sometimes represent barriers in the teaching-learning process, requiring an adequate environment for the development of their autonomy and independence and mainly to ensure accessibility to peculiarities. People affected by ASD may present significant impairments in language, present regressions with a reduction in their vocabulary repertoire, absence of the speech of previously learned words, appearance of words without meaning, sometimes with repetitions of sounds without social function or communicative intention. In addition to communicative and social difficulties, children with ASD
may have restricted and repetitive interests, which are barriers to learning through conventional teaching methods.

In this way, a "coherent attempt must be made to present the history of the development of written language as a historical process, as a single process of development" (Vygotski, 2000, p. 185). Language is a skill that establishes relationships with the elements that make up the world, so the communication of people with ASD may be impaired, requiring support for its acquisition. Digital technologies present a wide variety of resources and possibilities to provide access to content and information, as well as mitigate barriers and enhance areas of human development. As Santiago (2021) highlights about the use of digital technologies with people with disabilities (PWD), “it must be taken into account that each disability has different characteristics and will bring different needs, and, therefore, it is necessary to propose inclusion, taking into account in view of the difficulty that that individual experiences”. In this sense, we must plan technology resources in a way that considers individual elements. Given these facts, the development of a game as a pedagogical resource for teaching reading with ASD, which considers the characteristics of ASD and methodological and digital accessibility, contributes to the process of teaching and learning reading in an inclusive and motivating way.

Therefore, this project aims to present the research carried out to develop the game “O Cozinheiro Feiticeiro” as a resource for teaching reading to students with ASD. It is noteworthy that developing digital educational games from an ABA perspective, with teaching procedures based on scientifically proven evidence such as CRMTS, contributes to an improvement in the prognosis of skills of this neurodevelopmental disorder, becoming an innovative and encouraging project for a long time. Accessible teaching culture.

2 MATERIALS AND METHODS

The methodology to be used was based on bibliographical study to promote knowledge about equivalence relationships through the development of the game “O Cozinheiro feiticeiro” as support for teaching reading to students with Autism Spectrum Disorder. In this way, “[...] bibliographical research is not a
mere repetition of what has already been said or written on a certain subject, but rather provides the examination of a topic under a new focus or approach, reaching innovative conclusions.” (Lakatos and Marconi, 2003, p. 183). A priori, a search was carried out related to Autism Spectrum Disorders (ASD), in which we collected information on Brazilian research with a time frame between the years 2018 and 2022 on Google Scholar® (Google Scholar) and Scientific Electronic Library Online (SciELO), with the descriptors “autism”, “literacy” and “digital accessibility” to compose the bibliographical survey, coming to understand the specificities of ASD and the contributions of educational games in the development of areas affected by ASD.

In this sense, the scientific research schedule followed criteria for the development of the game based on computational applications, proposed by Schermach (2015), which consist of: definition of the problem; data collection and analysis; development; select; production; presentation and solution. Therefore, weekly meetings were held with the team of Technical High School students from the IT course and Stricto Sensu Postgraduate students in the months of January to July 2022, after alignments regarding bibliographical and field research, began game prototyping.

It is worth mentioning that, to achieve the proposed results, it was necessary to carry out field research by collecting the word bank used to teach syllabic units to students with ASD attended in the Multifunctional Resource Room of the Emanuel Aroso Basic Education Unit, located in the municipality of Paço do Lumiar, therefore, this data was used to base and compose the game.

The methodology described in the next paragraphs aims to present the process of development and application of the innovative game for the priority area of Technologies for quality of life, in accordance with ordinance no. 1,122, of 03/19/2020, of the Ministry of Science and Technology, Innovations and Communications (MCTIC).

The bibliographic review was carried out in the CAPES Portal databases, through the CAFé (Federated Academic Community) login by the Federal Institute of Education, Science and Technology of Maranhão, the search data found in Google Scholar® (Google Scholar) and Scientific Electronic Library
Online (SciELO), the base where the largest number of productions was found, making it necessary to filter them with productions in Portuguese and with the addition of the Boolean ‘and’ to each descriptor “literacy” ‘and’ “digital accessibility” ‘and’ “autism”, resulting in 26 works found for the full reading process and finally selected 8 more scientific works. Therefore, in Table 1 we will present the recommendations extracted from the articles selected to compose the corpus of research on pedagogical support and digital accessibility for ASD.

Table 1: articles selected for the “Corpus of Research"

<table>
<thead>
<tr>
<th>RECOMMENDATIONS/QUALITY CRITERIA</th>
<th>AUTHORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Treatment and Education for Autistic and Children with Communication Deficits (TEACCH) • PECs (Alternative Picture Exchange Communication System)</td>
<td>Reis, Arlene et al. (2020) and Castelo Branco, Karina et al. (2021).</td>
</tr>
<tr>
<td>• Universal design</td>
<td>Pletsch, MD, de Souza, IMDS, Rabelo, LCC, Moreira, SCPC, and de Assis, AR (2021) and Dias, Gisela (2022).</td>
</tr>
<tr>
<td>• Design Thinking</td>
<td>Pereira, Victoria (2021) and Barreto, Sara (2021).</td>
</tr>
</tbody>
</table>

Source: França et al. (2023).
Given the above, the schooling of people with ASD still generates reflections and adjustments in the areas of education, health and computer science in an interdisciplinary bias becomes relevant, so that studies in the area are important to bring contributions in this scenario to development of new teaching technologies. This reinforces the fact that students with ASD need specialized support to develop skills based on the design of educational applications that meet the singularities of ASD. Thus, with data surveys and analysis, we arrived at the functionalities and approaches to be taken to reach the objectives in a more efficient way for the teaching-learning process of reading for students in the first literacy cycle with ASD.

That said, the research contributed to the investigation and organization of learning routes according to the reality of the school and students with ASD, especially the development of game design, ensuring the structuring of teaching units, blocks of personalized words, collaborative planning and assessment of learning through evidence-based strategies. In view of this, the learning route was built from the word bank used to teach anagrams (syllabic units) with students with ASD attended at the SRM in the municipality of Paço do Lumiar. These data were used to base and compose the game “Cozinheiro Feiticeiro” as shown in Figure 1:

![Figure 1: Elaborate word blocks](source: França et al. (2023)).

We agree with Yamaura and Haydu (2021) when they emphasize that in the process of teaching reading “if control over minimum units is not acquired, the learner will only be able to read the set of words directly”. In this sense, we aim
to extend the intervention in teaching reading for ASD with the game “Witch Cook”, the student must generalize learning and learn the smaller units of the whole word studied, coming to recombine them in an interactive, intuitive and motivating way, with the educational app.

The learning route follows advances in teaching units, which are composed of three blocks of words recombined into smaller units. In this sense, each teaching block contains five words that were formed from recombinations between syllables from each previous block implemented from the set of eight syllable families. Keller (1972) implemented a teaching system called Personalized System of Instruction (PSI – Personalized Teaching System), which proposes that teaching be planned in small units, performance monitored individually and advanced as the student presents learning criteria in previous units.

Therefore, the learning routes started from the initial elaboration of the bank of words and images organized as an elementary basis for the decision and to achieve scalability of the teaching phases. It is through socio-historical and cultural appropriation, learning to discriminate more signs and use instruments, that changes mental functions and develops cognitively (Vygotsky, 2008). In such a way that the research brought reflections on the interpretation of data and information in its different meanings and values in order to understand the subjective aspects in the school reality in which students are inserted and how teachers understand and apply the reading process of these participants, favoring the construction of teaching and learning routes from the perspective of the stimulus equivalence model for reading this public served in SRM.

As a teaching model for the development of the game, it was based on the theoretical contribution of De Souza and Hubner (2010, p. 217) for teaching the emergence of stimulus equivalence relations, according to the procedure of matching the model by constructed response – CRMTS (Constructed Response Matching to Sample), which consists of the presentation of a model stimulus that can be a printed word or a spoken word or even a picture, and the comparison stimuli (letters or syllables of words that must be selected in the correct order).

Therefore, the game “Cozinheiro Feiticeiro” was divided into tasks with learning arrangements of two-syllable and three-syllable words composed into units
and teaching blocks for training anagrams with syllabic families through the CRMTS procedure. As stated by Calado et al. (2018, p.394) about teaching “to point out the corresponding letters/syllables in the correct order, thus composing a word”. The same can also be presented for the composition of sentences, where the selection of words in the correct order produces the sentence construction”.

The simultaneous CRMTS teaching module in the game makes use of the modeling strategy, where it generates auditory cues for words and syllables to minimize difficulties in discrimination through access by clicking on the megaphone icon. During teaching with the CRMTS procedure, there is a lower incidence of errors and frustrations (Alvarez, 2020). Thus, based on this procedure, the game uses reinforcement schemes and visual and auditory cues, which throughout the assertive interactions will gradually fade away for the acquisition of autonomous learning.

Planning for teaching recombinative reading to students with ASD carried out through Constructed Response Matching – To – Sample (CRMTS- Matching to the model by constructed response) was adapted to implement the teaching stages in the Game “O Cozinheiro Feiticeiro” as highlighted in Figure 2:

![Figure 2: teaching stages in the game “Wizard Cook”](source: França et al. (2023)).
This CRMTS teaching module in the game was planned in three stages, where the first presents the smaller units of the word for the user to recombine and assemble the word; the second generates tips for you to learn syllabic combinations through visual and sound support; and the third are reinforced with the release of an item from the wizard cook’s costume for every three correct answers given during interactions in the game.

Finally, with the help of the teaching strategy by pairing auditory and visual stimuli with the use of the educational game, other classes of equivalent stimuli will emerge that were not previously taught, assisting in their literacy process, providing users with predictive skills to perform global and recombinative writing and reading based on this teaching methodology.

The CRMTS procedure has proven to be very useful for teaching, as it requires specific behavior in relation to each letter of the word to be assembled. For D’Oliveira and Matos (1993), the fragmentation of words into smaller units and their recombination into new words can generate recombinative reading. Therefore, the steps to contemplate digital accessibility were subsidized by following the GAIA guidelines (Guide on Accessibility of Web Interfaces for Autism) using the principles of applied Behavior Analysis.

Therefore, with the completion of the application, we achieved the objectives and obtained the expected results, favoring the development of reading with understanding and digital accessibility, which highlights the importance of developing and using educational applications for the intervention and learning of people with this disorder of neurodevelopment, becoming of great importance in the areas of education, health and information technology, and especially for children with ASD.

Thus, “O Cozinheiro Feiticeiro” comes as a game to support the teaching of reading to students with ASD through the development of discrimination and recombination of the smaller units that make up words. The “Wizard Cook” Logo (Figure 3) was developed with elements that represent the wizard's hat in a simple layout, without letters, with adaptable colors and without contrasts for the user with ASD.
The development aspects of the images (objects) for plotting the game followed the digital accessibility criteria for people with autism. It is important to consider that after testing with users, adjustments were made to these colors and layout for adaptability when playing and remaining engaged during the teaching-learning process through digital resources.

To create the Educational Application, the content was decomposed into 4 Screens, with the main Menu access screen containing two icons to start the game and another to activate or deactivate the sound of the digital environment; the following screens correspond to the phases of CRMT teaching in game design, as described in Table 2:

**Table 2: Basic structure of the educational application “Cozinheiro Feiticeiro”**

<table>
<thead>
<tr>
<th>Screen 1</th>
<th>Screen 2</th>
<th>Screen 3</th>
<th>Screen 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home menu</strong></td>
<td><strong>Presentation of the corresponding syllable family</strong></td>
<td><strong>Presentation of the following syllable family</strong></td>
<td><strong>Syllabic family recombined without hints, conquering the elements</strong></td>
</tr>
<tr>
<td>1- Icon Play</td>
<td></td>
<td><strong>Level 1- immediate tip</strong></td>
<td><strong>Level 2- tip delay</strong></td>
</tr>
<tr>
<td>- Game Stages</td>
<td><strong>Level 3- no tip/help</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Achievements</td>
<td><strong>Each correct answer unlocks an item from the wizard cook’s costume.</strong></td>
<td></td>
<td><strong>Character conquered. New friends. Conquered monsters (you can choose who to play with when released)</strong></td>
</tr>
<tr>
<td>2- settings</td>
<td><strong>Sound/Music:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Mutate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>● volume</td>
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Source: França et al. (2023).

Figure 4 illustrates the initial screen designed in an objective and self-instructive manner, where the player can access the game steps and configure whether to activate or deactivate the sound.
When starting teaching in game design, the user will go directly to the gameplay screen, where they will have access to teaching the recombinations of words from each syllabic family, as each one is presented as a simultaneous visual cue, the user will recombine the smaller units in correct logical sequence as shown in the gameplay screen in Figure 5:

![Gameplay screen](source) Source: Ribeiro et al. (2023).

The Figure 6 shows the minimalist gameplay screen as a kitchen setting and with the arrangements of words and syllables at the ends as visual support, which makes it more objective and self-instructive, where the player can learn with the game in CRMTS format. Therefore, based on the CRMTS teaching procedure, the game uses reinforcement schemes and visual and auditory cues, which will gradually disappear throughout assertive interactions. In Figure 6, it
represents the positive reinforcement procedure for each correct answer made by the user, promoting engagement and stimuli to continue playing and learning within the game.

Figure 6: reinforcement screen

![Reinforcement Screen](source)

Source: Ribeiro et al. (2023).

After completing all the syllable families in the teaching unit, the user will complete the cook look, making him a complete wizard, according to Figure 7.

Figure 7: illustration of the wizard's steps in composing the complete costume

![Wizard Costume](source)

Source: Ribeiro et al. (2023).

With each assertive response through interaction in the game, a piece of costume is released, causing the cook to transform into a wizard. Upon completion of the phases, you receive recognition on the screen as social reinforcement as illustrated in Figure 8:
When finishing work on the character, it was essential to develop objects that complement the scenario, such as buttons, warnings and other accessories that will influence the child's gameplay, as shown in Figure 9:

The structured interface with elements that contribute to maintaining the student's attention when teaching through the game, also considered, in addition to these visual stimuli, the auditory stimuli that are presented in its gameplay, with the objective of the child learning and trying have fun to the fullest, highlighted in Figure 10:
Figure 10: Hearing support

Figure 10 shows the auditory support with approximately 50 audio tracks to support the user in the gaming experience, in addition to assisting in word pronunciation for the vocabulary repertoire learning process. After the testing phase with students with ASD from the first literacy cycle of SRM in the public network of the municipality of Paço do Lumiar-MA, it was deposited on the Google Play Store for free download available on the application platform through the link https://play.google.com/store/apps/details?id=br.com.ifma.cozinheirofeiticeiro. It is worth mentioning that the research project and testing of this application were approved on Plataforma Brasil in accordance with Consubstantiated Opinion No. 5,413,843 issued by the Research Ethics Committee of Hospital São Domingos (HSD).

Therefore, all stages of the game follow criteria that guarantee research eligibility and methodological and digital accessibility for ASD, in accordance with the GAIA guidelines (Web Interface Accessibility Guide for Autism) and the principles of Applied Behavior Analysis for teaching. Promoting studies, research and praxis to understand the reading and writing process of students with Autism Spectrum Disorders (ASD) based on auditory-visual and visual-visual pairing in game design.
3 CONCLUSION

This work conducted field research and literature review on teaching reading to students with ASD using ABA procedures, specifically CRMTS, especially with the development of learning with digital accessibility structured in the game as a pedagogical resource as object of study of equivalent stimulus organizations and teaching-learning routes for the recombinative reading process in students with Autism Spectrum Disorder.

In this way, it followed the criteria and recommendations for quality in the development of inclusive software for teaching reading for ASD based on bibliographical and field research carried out, especially with tests with users of the game, students with ASD attended in SEM a public school in the municipality of Paço do Lumiar. Where possible, make the necessary adjustments to the prototyping in view of the singularities of the public. The investigation made it possible to plan the word bank, select visual, auditory and textual stimuli for teaching reading and writing to students with ASD through the game. Proving that a digital environment accessible to different groups and people, comes to understand the pedagogical praxis of how to mediate the proposed teaching through appropriate procedures and techniques for each specificity. Therefore, the equivalence relationships systematized in the game contributed to supporting learning routes and supplementary teaching of reading and writing for students with ASD in a motivating and effective way based on scientifically proven evidence.
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