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UX Evaluation of Dyslexia App Based on Honeycomb Model

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ABSTRACT

Dyslexia is a learning disorder that affects literacy skills, creating challenges for children in traditional educational settings. This study evaluates the overall user experience (UX) of *Mari Membaca* app, which is designed to help dyslexic children improve their reading abilities. Using the UX Honeycomb model as a framework, the app was evaluated through usability testing tasks and teacher interviews. The findings show that the app supports letter recognition and reading comprehension while keeping children engaged with interactive features. However, there is room for improvement, such as using more dyslexia-friendly fonts, adding foundational modules, and expanding phonics content. This research highlights how user-centered design and structured feedback can enhance educational tools, making them more inclusive and effective. The study also emphasizes the potential of digital solutions like *Mari Membaca* to transform learning for dyslexic children and calls for their integration into educational policies to promote accessibility.

1. Introduction

Dyslexia, a neurodevelopmental disorder, impacts fundamental literacy skills such as spelling and reading. It affects a substantial portion of the population, especially children. According to the Ministry of Health portal (MyHealth), approximately 4 to 8% of school-aged children in Malaysia experience dyslexia [1]. In response to these challenges, various technological solutions have been created to assist dyslexic learners. This project focuses on the evaluation of a dyslexia app '*Mari Membaca*' designed to help children with dyslexia in improving their reading skills. It is specifically created and developed for the use of children with dyslexia. The conducted assessment of this app will determine its effectiveness in aiding dyslexic children and its reception among this user group.

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1.1 Background of The Problem

Children who have dyslexia encounter difficulties in processing information from traditional mediums such as books, lectures, and academic discussions. As we enhance special education and acknowledge the distinct needs of students with disabilities, like dyslexia, technology is emerging as a crucial tool to facilitate effective learning. However, certain dyslexia apps developed for educational purposes do not adhere to guidelines and instructional approaches. There is a deficiency in considering the unique requirements of children with dyslexia. Therefore, there is a need for systematic evaluation of these apps among children with dyslexia to evaluate their effectiveness and user-friendliness, ensuring that the apps adequately cater to their learning needs.

The main goal of this study is to include thorough evaluation of how well the '*Mari Membaca*' app functions and how dyslexic students experience using it. The aim is to understand what motivates these students to engage with the app and gather feedback to pinpoint its strengths, weaknesses, and areas needing improvement. The project focuses intensely on understanding the user experience, particularly for young dyslexic children. Challenges such as maintaining their engagement during task-based activities highlight the critical need for carefully designed methodologies.

Ultimately, the research strives to enhance educational tools tailored for dyslexic learners through meticulous evaluation and feedback collection. By contributing to the evolution of more inclusive and supportive educational technologies, the target is to enhance accessibility and ultimately improve learning outcomes for children struggling with dyslexia.

2. Related Works

2.1 Overview of Dyslexia

Dyslexia is a learning disability that affects a person's ability to learn to read and spell. It is a neurobiological and developmental condition that impacts the connection between spoken language and written words, specifically the phonological aspect of language. Difficulties in accurately decoding words and spelling can hinder reading comprehension, vocabulary development, and the production of written composition. It is important to note that dyslexia is not an indication of low intelligence, laziness, or poor vision and it can occur in individuals with various intellectual abilities. The challenges associated with dyslexia can lead to poor academic performance, low self-esteem, and a lack of motivation [2].

The term “Dyslexia” was coined by a German doctor in 1887, combining the Greek words “Dys”, meaning difficulty, and “Lexia”, referring to words. Dyslexia is a reading and learning disorder caused by a brain deficiency in processing graphic symbols, altering the brain’s approach to written materials. It is associated with abnormal structure and function in the left hemisphere of the brain, which governs reading and language networks. Dyslexic children have difficulties with word recognition, spelling, decoding, and reading comprehension, often resulting in an inferiority complex, particularly evident in poor handwriting [3].

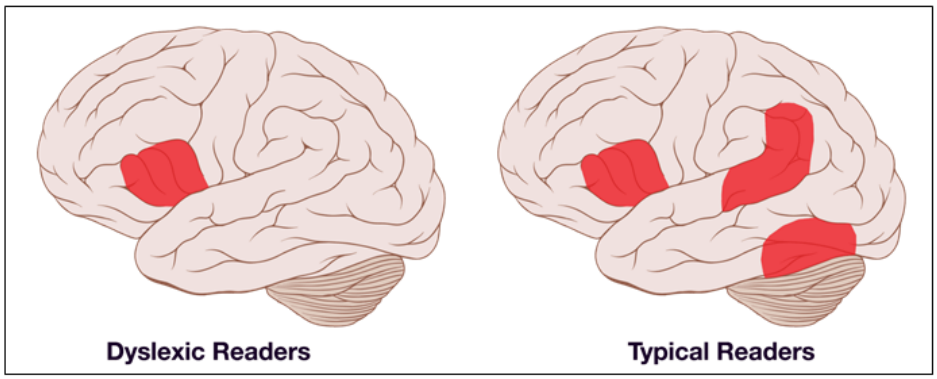

Fig. 1. Different Activation Patterns of Readers with and Without Dyslexia [4]

Other symptoms include learning difficulties, speech impediments, challenges in phonological processing, and reduced performance in phonological memory and vocabulary. Many countries are making efforts to diagnose and treat this disability, recognising the importance of supporting dyslexic individuals to foster success and empower the younger generations.

2.2 Prevalence of Dyslexia

According to the World Report on Disability, there is approximately 5% of the 9 million children aged 0-14 years old experience disabilities that impact their full participation in society, including learning disabilities. Individuals with dyslexia can be traced back to the 17th century due to the existence of documented cases [5]. Initially, acquired dyslexia cases primarily affected adults who had previously learned to read but lost that ability after a stroke or traumatic brain injury, even though their overall cognitive function remained intact. Later, developmental dyslexia cases were observed in children who struggled with reading despite having mathematical abilities and no apparent brain injury [6].

It is mentioned that in Malaysia, learning disabilities are one of the recognised categories of impairments for registering individuals with disabilities [1]. Registration allows people with disabilities to access government and government-linked services. Approximately 38.7% of registered persons with disabilities in Malaysia have learning challenges. However, accurate statistics regarding children with learning disabilities remain scarce due to a lack of up-to-date prevalence data.

As indicated by the Ministry of Health's MyHealth portal, it is estimated that between 4% and 8% of school-aged children in Malaysia are affected by dyslexia. However, there is roughly around 5 to 10% of its population is born with dyslexia symptoms [7]. To date, there is no precise statistics on the total number of children with dyslexia in Malaysia. A local newspaper reported that this country urgently needs a more comprehensive education system and increased awareness program for dyslexic children in order to prevent misdiagnosis with other health conditions. Additionally, the Dyslexia Malaysia Association notes that awareness and understanding of dyslexia among parents are still insufficient [1].

2.3 Overview of The Existing Application

From Table 1 overview of the existing applications, it can be concluded that the evaluation methods employed for the dyslexia apps have enabled the developers to achieve their desired results effectively. Most of the evaluations done covered the assessment of the apps' features, user engagement, and overall functionality. Most evaluations is to ensure the functions meet the specific

requirements by involving the end-users or experts. This kind of evaluations are part of system or app development life cycle and commonly used to refine app functionality and user interfaces. However, apart from the app's functional ability, these studies do not focus on the overall experience of the users including satisfaction, efficiency of completing tasks, ease of use and emotional response in the real world. There is remains room for improvement, particularly in implementing a holistic evaluation so developers can ensure that their apps not only meet the diverse needs of dyslexic users but also provide an optimized, intuitive and seamless user experience.

Table 1
Overview on different dyslexia apps

Study	Purpose	Evaluation Method	Model Used
Mobile Applications for Students with Dyslexia [8]	Systematic review of mobile apps improving learning for dyslexic students	Literature review, semi-structured interviews	Not specified
Dyslexia Baca [9]	Assist Malay dyslexic children in recognizing confusing letters	Heuristic evaluation by multimedia experts	ADDIE Model
ALEXZA [10]	Prototype app aiding real-life reading through AI/ML, OCR, and TTS	Testing with 5 dyslexic users and functionality assessments	AI-integrated UX
D-Lexis [11]	Interactive alphabet learning app using the Slingerland method	Observations, qualitative surveys, iterative design cycles	Rapid prototyping
Helpdys App [12]	Diagnose and treat dyslexia in rural areas with gamified learning tools	Prototyping and MARS evaluation	Spiral development model
EasyLexia [13]	Enhance fundamental skills like memory and math for dyslexic children	Laboratory and field studies, usability and performance metrics	Agile development
Assistive Mobile Apps for Dyslexia [14]	Develop and evaluate gamified learning app for Portuguese speaking dyslexics	Usability testing with 8 children	Gamification-enhanced UX

2.4 Overview of UX Model

The Honeycomb, Kano and UX Pyramid models are common frameworks used to understand and evaluate UX in product development. All models focus on user experience engagement and not just about functionality. The Kano model is useful for feature prioritization by understanding how each feature contributes to user satisfaction. The UX Pyramid helps in sequential building of UX elements , ensuring basic needs are met before moving on to more advanced elements. Thus, these two models are more suitable when to build the product functions systematically based on UX and satisfaction, starting from the basic needs to higher level of UX goals rather than assessing the overall UX. From the UX model comparison in Table 2, the Honeycomb Model is particularly well-suited and ideal for evaluating the overall user experience of a dyslexia reading app for children due to its comprehensive and multifaceted approach. By encompassing essential components such as usefulness, usability, desirability, findability, accessibility, credibility, and value, this model ensures that all critical aspects of the user experience are addressed. Each facet of the Honeycomb Model is instrumental in creating an engaging, effective, and inclusive app that meets the unique needs of dyslexic children. The focus on accessibility ensures that the app is usable for children with varying degrees of dyslexia, while the emphasis on usability and findability guarantees that young users can navigate the app with ease. Additionally, the components of desirability and value help in making the

learning process enjoyable and rewarding, thereby fostering a positive educational experience. Hence, the Honeycomb Model offers a robust framework that aligns perfectly with the goal of assessing real world usability and satisfaction.

Table 2
Comparison on UX models

Aspect	Honeycomb Model	Kano Model	UX Pyramid
Focus	User-centered design principles	Customer satisfaction and feature prioritization	Relationship and hierarchy of UX elements
Core components	Useful, Usable, Desirable, Findable, Accessible, Credible, Valuable	Must-be, One-dimensional, Attractive, Indifferent, Reverse	Functional, Reliable, Usable, Convenient, Pleasurable, Meaningful
Objective	Ensure a holistic user experience	Understand and categorize user needs and expectations	Improve UX design by understanding element relationships
Approach	Broad, covering multiple aspects of UX	Specific, categorizing features based onuser satisfaction	Hierarchical

3. Methodology

3.1 Research Workflow

A research workflow outlines the techniques and procedures utilized to identify and analyse information pertinent to a particular research topic [15]. It is the process through which researchers structure their study to meet their objectives using chosen research tools.

The research journey depicted in Figure 2 guides the enhancement of the '*Mari Membaca*' dyslexia app through four essential stages. It begins with a deep dive into literature, exploring dyslexia characteristics, technological aids for disabilities, existing dyslexia apps, and relevant UX models. This foundational phase sets the stage by identifying challenges and effective methodologies.

In Stage 2, the project defines its approach to evaluating the app, selecting The Honeycomb UX model for its comprehensive assessment of both practical and emotional aspects. This model shapes a task-oriented evaluation method tailored for dyslexic students, ensuring thorough insights into usability and emotional engagement.

Stage 3 focuses on qualitative methods, involving a small focus group of 3-5 young students guided by a teacher. Through the think-aloud technique, researchers observe and capture immediate reactions to assess usability and engagement levels. Teachers, armed with Honeycomb-based questions, further enrich the feedback process, aiming to deeply understand user needs and satisfaction. Additionally, participants will be given a structured list of tasks that is integrated with the UX Honeycomb criteria.

Stage 4 culminates in evaluation analysis, meticulously examining feedback gathered from the use of the think aloud strategy as well as interpretation from the interview to uncover what drives dyslexic students to use the app and identifying areas of strength and improvement. This thorough analysis aims to glean actionable insights that will guide future enhancements, ensuring the *Mari Membaca* app effectively supports the learning needs of dyslexic students.

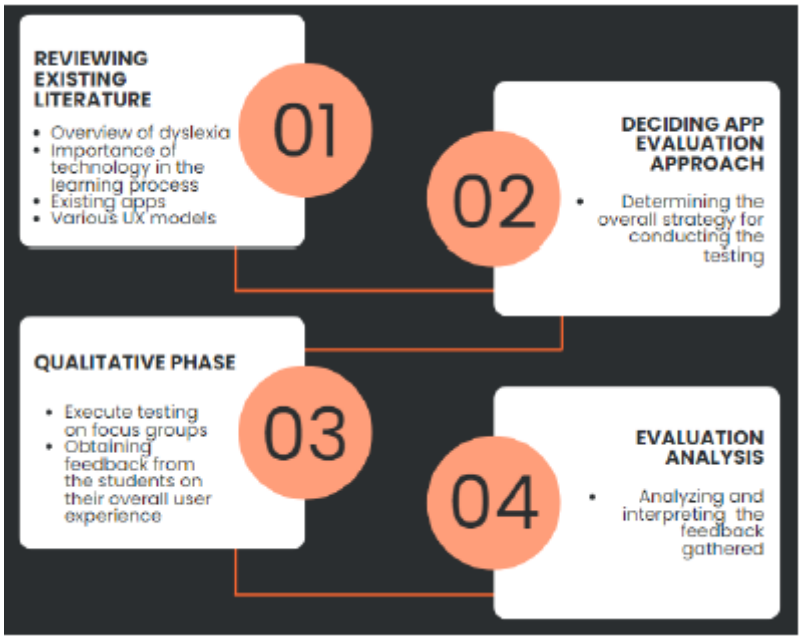

Fig. 2. Diagram of research workflow

3.2 Population and Sample

This study targets young dyslexic learners aged 5 to 7 years, who represent the primary audience for the *Mari Membaca* app. Participants will be selected from a dyslexia center to ensure alignment with the app's target demographic and research objectives. By focusing on this specific group, the study aims to evaluate the app's suitability for addressing their developmental and educational needs effectively.

The sampling method used is purposive sampling, which allows for the intentional selection of participants who meet specific criteria. This approach is well-suited for qualitative research, as it facilitates the collection of in-depth insights from a focused group. According to Hassan [16], purposive sampling not only ensures the efficient gathering of significant data but also saves time by targeting individuals most relevant to the study. The sample size of 3 to 5 students, along with the presence of a teacher to assist during the testing process, provides a manageable yet meaningful framework for detailed evaluation and analysis.

3.3 Data Collection Methods

The data collection methods for this study were selected to align with its qualitative nature and the goal of evaluating the *Mari Membaca* app using the UX Honeycomb model. These methods ensured a comprehensive assessment of the app's usability, accessibility, and overall user experience. To facilitate app testing, mobile devices with the *Mari Membaca* app pre-installed were provided, ensuring participants could engage with the app in a controlled environment free from external variables like device compatibility issues. A structured task list was created, guided by the five facets of the UX Honeycomb model: useful, usable, desirable, findable, and valuable. These tasks served as step-by-step guidelines for students and their teacher during the testing sessions, systematically evaluating the app's core objectives. Tables 3 and 4 detail the three tasks and their alignment with the Honeycomb criteria.

Table 3
Usability testing task

Task 1	Goal: To evaluate how useful and usable the Fonik category is in teaching letter sounds to dyslexic students.
Steps	• Open the *Mari Membaca* app and select the *Fonik* category. • Observe the alphabet letters displayed one by one. • Listen carefully to the verbal cues provided by the app. • Repeat the sounds or pronunciation as instructed.
Task 2	Goal: To assess how findable and engaging the Fonik dan Objek subcategory is for students
Steps	• Navigate back to the *Fonik* menu and select the *Fonik dan Objek* subcategory. • Look at the objects associated with the phonetic sounds. • Try to pronounce the letters and their corresponding objects and follow the on-screen cues from the app.
Task 3	Goal: To determine the value of the Membaca category in improving reading comprehension skills.
Steps	• Navigate to the *Membaca* category from the main menu. • For materials with 2 sentences, 4 sentences, and 6 sentences, select at least 5 objects. For materials with 8 sentences and 10 sentences, select at least 3 objects. • Read the text from the selected objects, following the instructions provided by the app.

Table 4
Honeycomb criteria implementation in the task

Task	Honeycomb Criteria
Task 1	Useful, usable
Task 2	Findable, Desirable
Task 3	Valuable

Additionally, interviews with the teacher at the dyslexia center provided valuable insights into the app's usability and effectiveness in educational settings. These interviews, guided by UX Honeycomb dimensions, covered areas such as accessibility, motivation, and potential improvements. The interviews were voice recorded for accuracy and detailed analysis, offering critical feedback to refine the app and enhance its utility for young dyslexic learners.

3.4 Data Analysis Method

The study used qualitative data analysis to evaluate the usability and experience of students with the *Mari Membaca* app. A think-aloud approach was applied, where students verbalized their thoughts while using the app. This method helps to understand how users think and solve problems, providing real-time identification of issues, as highlighted by Leighton [17]. This approach allows immediate observation of challenges, making it easier to pinpoint problem areas. Other methods, such as Exploratory Factor Analysis (EFA), reliability testing, and hypothesis testing, were also considered. These were compared to understand their purposes, strengths, weaknesses, and suitability for usability testing. A detailed comparison of these approaches is provided in Table 5.

Table 5
Comparison of different analysis approaches

Method	Purpose	Strength	Weaknesses	Typical Use
EFA [18]	Identifying underlying factors in a set of variables	Reveals hidden patterns, simplifies data, supports scale development	Requires large sample sizes, can be complex to interpret	Understanding key themes in feedback
Reliability Testing [19]	Ensure consistency of measurements	Provides dependable data, improves confidence in results	Time consuming, requires repeated measures	Validating the consistency of app feedback
Hypothesis Testing [20]	Analyze specific assumptions or theories	Clear decision-making process, statistically rigorous	Dependent on sample size, Requires assumptions about data distribution	Evaluating specific aspects of app performance
Think- aloud [21]	Understand user thoughts and experiences in real-time	In-depth insights, uncovers usability issues	Can be intrusive	Usability testing, identifying user pain points

4. Results and Discussion

4.1 Interpretation of Findings

The task given to the students of Dyslexia Genius Titiwangsa was designed to align with this model, providing a structured way to assess how the app meets the unique needs of dyslexic learners. The students were required to use certain features on the app which are the *Fonik*, *Fonik dan Objek* subcategory, and the *Membaca* category. These features were selected to assess whether they functioned as intended and effectively supported the students' learning experience.

4.2 Usability Testing Findings

The usability testing for the Mari Membaca app was conducted with dyslexic students from Dyslexia Genius Titiwangsa. The selection of participants was based on their availability during the testing period and their age group of 5 to 7 years old. A total of five students participated, aged between 6 and 7 years old, which is an appropriate sample size for a focus group in qualitative research in order to provide meaningful insights [22].

A teacher from the center was present throughout the session to observe the students and assist them as needed. Given the students' beginner-level reading proficiency, the teacher helped explain the tasks and occasionally read the instructions aloud. Prior to the testing, the teacher was briefed on the app's purpose and the intended outcomes of the session. Each student was provided with a mobile device pre-installed with the *Mari Membaca* app, and the think-aloud method was implemented to monitor their reactions and overall experience with the app.

4.3 Evaluating Useful and Usable Aspect

For the task aimed at evaluating the useful and usable aspect of the *Fonik* category, the students successfully opened the app and navigated to the *Fonik* section without difficulty. Once in the category, they were shown a list of alphabet letters and required to interact with each letter. They were then instructed to repeat the sounds or pronunciations heard by the verbal cues. Observations showed that the students were able to follow the verbal instructions accurately and pronounce the

letters without any confusion. This demonstrated the usability and the usefulness of the *Fonik* category in teaching letter sounds to dyslexic students.

4.4 Evaluating Findable and Desirable Aspect

To assess the findability and desirability of the *Fonik dan Objek* subcategory, the students were instructed to navigate back to the *Fonik* menu and select the *Fonik dan Objek* option. In this section, they interacted with letters and objects by dragging the letters to their corresponding objects as prompted by the app. While there was some initial hesitation when locating the subcategory, the students were eventually able to find it. Once engaged, they enjoyed the activity, particularly the interaction of dragging letters to their respective objects and pronouncing them afterward. This part of the app successfully captured the students' interest, fulfilling the findability and desirability criteria of the UX Honeycomb model.

4.5 Evaluating Valuable Aspect

For the final task, which aimed to evaluate the value of the *Membaca* category, the students were asked to navigate to the section from the main menu. They were presented with reading materials containing 2, 4, 6, 8 and 10 sentences, and they selected the materials they wished to read. Two of the 7-year-old students alternated between different materials, while the 6-year-old student chose the 2 sentences material, aligning with the participant's current reading level as informed by their teacher. During this task, the students were observed following the audio guide for each sentence and reading the text with relative ease. This demonstrated that the *Membaca* category successfully supports reading comprehension at various levels, providing both value and an engaging learning experience.

4.6 Interview Analysis

An interview with a teacher with three years of experience teaching dyslexic students was conducted to gather feedback on the *Mari Membaca* app's usability and effectiveness. The discussion, guided by the UX Honeycomb model, provided insights and improvement suggestions.

Key findings from this interview session are:

i. Useful: The Fonik and Membaca categories effectively address learning needs, though verbal cues were slightly fast. Students still managed to follow instructions with minimal difficulty.
ii. Usable: Students found the app easy to navigate and could complete tasks independently, reflecting its user-friendly design.
iii. Desirable: Students enjoyed the interactive Fonik dan Objek feature, particularly dragging letters to matching objects, which kept them engaged.
iv. Findable: While students could locate features, some needed help navigating sections like Fonik, highlighting the need for guidance for less advanced learners.
v. Accessible: The app caters well to dyslexic students but would benefit from a foundational module for teaching basic letter recognition before advancing further.
vi. Credible: The app's content aligns with the center's syllabus and established dyslexia teaching strategies, making it educationally reliable.
vii. Valuable: The teacher believes the app adds significant value to students' learning and highlighted the usefulness of the sound replay feature for instructions and pronunciation.

Improvement suggestions stated by the teacher:

i. Incorporate phonics sounds into the *Membaca* category to help students understand the content more effectively.
ii. Enlarge the size of letters displayed in the *Fonik* section to reduce confusion between similar-looking letters like 'b' and 'd.'
iii. Reduce the number of letter columns displayed per page in the *Fonik* category to avoid overwhelming students.
iv. Use dyslexia-friendly fonts, such as Comic Sans, with a size between 12 to 14 for better readability.
v. Add sentence-building and sentence-arranging activities in the *Aktiviti* section, such as providing an image of an object and letting students construct or rearrange sentences related to it.

The results show that *Mari Membaca* app is a good tool for dyslexic students to develop literacy skills, especially with *Fonik* and *Membaca* features that support letter recognition, phonics and reading comprehension. Practical suggestions such as using dyslexia friendly font, add more phonics content and add foundational module shows that it is vital to design user-friendly tool for dyslexic learners. This study also demonstrates how to integrate user experience principle and think aloud method can give valuable insights for educational app. On a bigger scale, it shows that there is a need to include digital tool like this in education policy to make learning more accessible and inclusive.

5. Conclusion

5.1 System Limitation

One limitation observed was that students and teachers at Dyslexia Genius Titiwangsa had no prior experience with educational apps like *Mari Membaca*, as the center mainly uses traditional teaching materials. This required students to take some time to adjust to the app. Additionally, a student-friendly feedback tool, such as a simple rating system, could have improved the collection of structured feedback. Lastly, the absence of a control group using traditional methods limited the ability to compare the app's effectiveness with existing teaching approaches, reducing the clarity of the study's conclusions about its impact.

5.2 Future Works

The app *Mari Membaca* could have the potential to become the new standard for aiding young learners with dyslexia in their educational journey. The usefulness of the app can be improved by applying the suggested improvements which could lead to the app reaching its full potential. Besides that, future studies could include integrating regular use of similar digital tools into the center's curriculum which could build comfort with educational technology. Additionally, a simple rating tool like a smiley-face scale could be used to allow students to express their opinions, which could help provide even more in-depth feedback. A control group for comparison between outcomes of app users and users with conventional materials could give clearer insights into the app's effectiveness. Lastly, future research could involve collaborating with additional centers or schools catering to dyslexic students in order to provide a larger and more diverse sample, strengthening the study's conclusions.

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