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Bloomy: Interactive System for Educational Support in Primary Education

Bloomy: Sistema Interativo No amparo Educacional Do Ensino Básico

Bloomy: Sistema Interactivo De Apoyo Educativo En Enseñanza Básica

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Abstract:
Bloomy is a project that seeks to provide educational support through engaging educational games, along with a tactile controller to assist elementary school students who have greater tactile aptitude. With games based on the common foundations of Portuguese Language, English, Science, and Mathematics, the project aims to engage students and increase their interest in learning, as well as test them to see how much they have learned through the lessons. A game platform built with React Native and JavaScript, and a controller built with an ESP32 microcontroller, the project was designed to aid in the education of children who have learning difficulties.

Resumo:
Bloomy é um projeto que busca um amparo educacional através de jogos educativos cativantes, junto de um controle tátil para auxiliar alunos do Fundamental I que possuem uma maior aptidão tátil. Com jogos baseados nas bases comuns das matérias de Língua Portuguesa, Inglês, Ciências e Matemática, o projeto busca engajar os estudantes a terem maior interesse no aprendizado, além de os testar para ver o quanto eles aprenderam com os jogos. Uma plataforma de jogos construída com React Native e JavaScript, e um controle construído com um microcontrolador ESP32, o projeto foi pensado para ser um auxílio ao ensino de crianças que possuem dificuldades em aprender.

Resumen:
Bloomy es un proyecto que busca brindar apoyo educativo mediante juegos didácticos interactivos, junto con un controlador táctil para ayudar a estudiantes de primaria con mayor aptitud táctil. Con juegos basados en los fundamentos comunes del portugués, el inglés, las ciencias y las matemáticas, el proyecto pretende motivar a los estudiantes y aumentar su interés por el aprendizaje, además de evaluar cuánto han aprendido a través del juego. Desarrollada con React Native y JavaScript, y con un controlador basado en un microcontrolador ESP32, el proyecto fue diseñado para apoyar la educación de niños con dificultades de aprendizaje.

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1. Introduction

School dropout is caused by numerous factors of diverse origins, including socioeconomic, psychological, and even ethnic factors (TENENTE, 2023). In 2023, approximately 400,000 young people between the ages of 6 and 14 stopped attending school—23.5% due to lack of interest—as reported by Camila da Silva (2024).

One fact regarding low academic performance discusses the relationship between the unwillingness to absorb the knowledge passed on by the educator, who does not support the unique experiences of the student, hindering the path to a liberating education (FREIRE, 1996). Disparities between the teaching methods applied and the specific aptitudes of students—specifically in digital-playful environments—can generate disinterest and demotivation with school in certain students.

Games that aim to teach, called serious games, are a promising bet today, given that it is an area of broad possibilities, considering that most scholars in this area are pedagogues, which makes the experiences less digital, according to Vasconcelos et al. (2017).

Bloomy was created with the objective of assisting the basic education system, through playful tools such as games and activities, to cultivate students' interest in the subjects taught in class, even those considered more difficult for the student, also with the use of sensory control so that the stimulus generated makes the learning experience more memorable.

For this, it is necessary to investigate and analyze the difficulties of elementary school students, and just as we must investigate flexible teaching methodologies to incorporate them into innovation; regarding development, it will be necessary to create user-friendly, intuitive and comfortable interfaces; also, to build hardware that communicates efficiently with the software; However, programming serious games that are still interesting for students, while remaining in sync with the control.

However, the application was developed based on qualitative research with concepts from the Unified Modeling Language (UML) and Design Thinking; For the constitution of the project, a mobile application was developed using React Native, a notable framework, a tactile IoT controller, and finally, serious games, developed with the Construct3 tool.

This prototype was developed to assist elementary school students residing in the East Zone of the capital of the state of São Paulo, specifically targeting students from municipal schools, since, in short, they have enrollments for this educational level.

Consequently, school dropout occurs for various reasons, considering the individual diversity of the student inside and outside the school. The inability to meet daily needs is one of the factors of school dropout, not necessarily due to the environment, but to the content and learning. Therefore, a one-dimensional solution is unlikely to meet such needs, although it is still able to help in one area.

Knowing this, how can a mobile platform for serious games lessen the effects of poor academic performance?

2. Theoretical Framework

This chapter will describe the theoretical foundations researched and used for the development of the project.

2.1. Educational Helplessness

Brazil received shocking results in the Progress in International Reading Literacy Study: approximately 38% of all Brazilian students lack basic reading skills, and only 13% were classified as proficient

(TENENTE, 2023). According to Samara de Sena et al., the changes of the 21st century make it evident that the educational approach must be reviewed, and epistemic games are a promising option (SENA, et al., 2016).

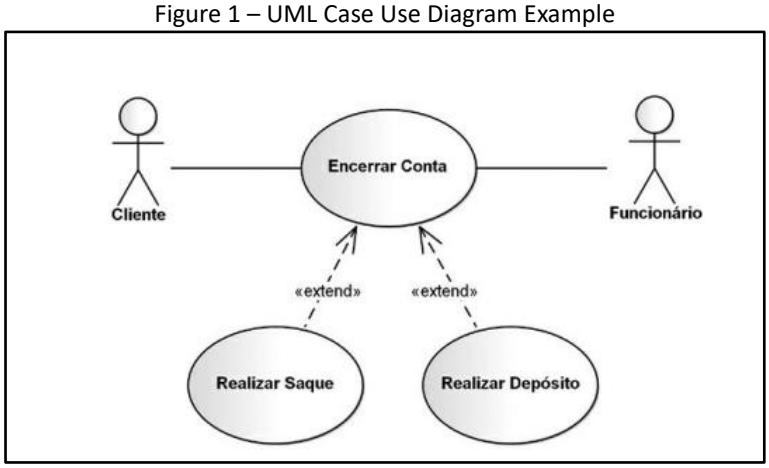
2.2. Serious Games

As stated by Vasconcelos et al. (2017), scholars have sought ways to link play with learning, called "serious games," where they plan to use playful tools to promote autonomous skills in students. According to Paula (2015), games create an immersive world—serving as a path to people's subconscious—and any message, for them, is susceptible to intimate reflections by the player, creating and developing critical thinking.

2.3. Unified Modeling Language (UML)

According to Guedes (2009), UML aims to assist software engineers in the construction, definition of dependencies, characterization, and detailing of the application, not being exclusive only to system interactions, but to all project dynamics.

Figure 1 – UML Case Use Diagram Example



Source: UML 2 – Uma Abordagem Prática (2018)

This is a simple use case diagram, which is one of the most widely used for structuring and diagramming systems.

UML, as described by Larman (2000), is a tool that offers patterns, which facilitates the visualization and arrangement of the project's structures and solutions, even without defining the step-by-step process of your project, it offers a description of structure and seriousness.

2.4. ESP32 Microcontroller

According to Pedro Bertoleti (2019), it is a board with a Central Processing Unit (CPU), memory, and wireless communication capabilities, offering significant processing power for its size.

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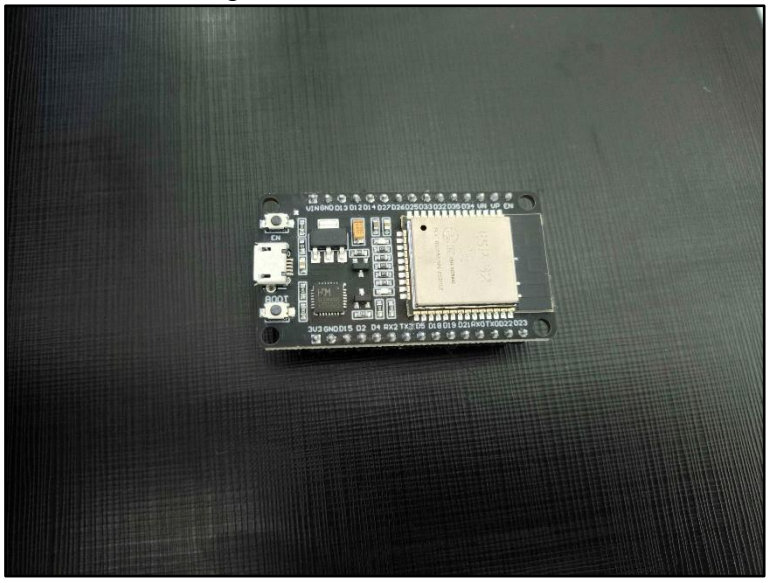
Figure 2 – ESP32 Microcontroller



Source: Own Authorship (2025)

According to Allyson Nascimento et al. (2023), the ESP32 microcontroller, especially ESPWROOM-32, has support for Wi-Fi, Bluetooth Low Energy (BLE), and Ethernet, in addition to having high energy efficiency.

2.5. React Native

React Native has similarities with React, but this does not rule out its differences. The language runs on JavaScript Core with a bridge to translate the code for rendering on any mobile operating system (SILVA; DE SOUZA, 2019).

According to Meta (2025), React Native was the repository with the most contributors on GitHub in 2018 and even today it has support from several companies, despite being an Open-Source project.

2.6. Construct 3

It is an intuitive platform for developing 2D games, using tools such as Event Sheets and Layout, as a more practical and dynamic means for projects in the field — ideal for laypeople (PIMENTEL, 2025).

The developer of Construct, Scirra (2025), describes Construct 3 as an evolution of Construct 2 to be able to run its games 100% within browsers, not depending on HTML5 or Flash exports.

2.7. Firebase

According to Machado (2021), it is a platform that enables querying and manipulating data in the cloud, with the added benefit of scalability, database security, authentication libraries, and even global-scale data management.

According to Doug Stevenson (2018), Firebase is a suite of tools and services for software developers, establishing robust, scalable frameworks that do not require the development of functions such as account authentication, databases, and data analysis.

3. Method

This chapter will describe all the steps that brought the project to fruition, from its initial conception and documentation to its development, based on the theoretical foundations of the authors previously presented in the theoretical framework.

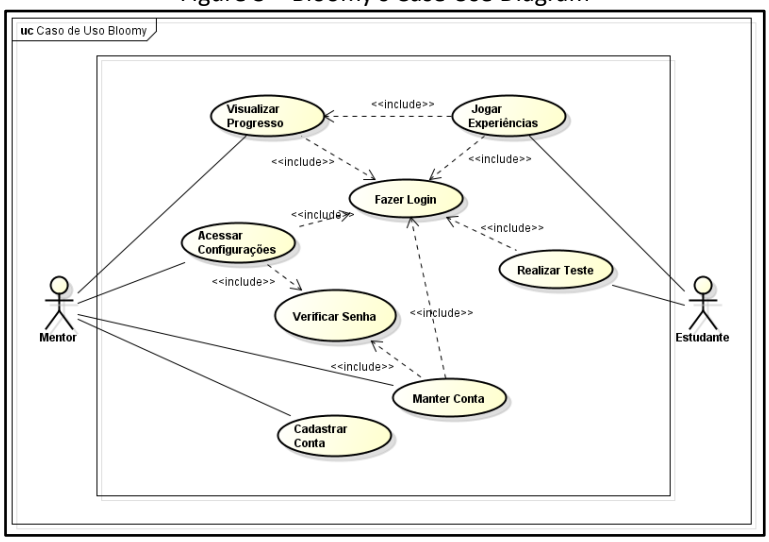
3.1. Development Methodology

The methodology used by Bloomy was qualitative, as described by Lakatos and Marconi (2003). Qualitative methodology focuses on the "why and how" of the results, with the aim of creating a base of information that can guide the project in a human way. This makes it possible to meet the broadest needs and address cases of disinterest in education.

3.2. Documentation

There are several steps prior to the completion of a project; one of these steps is defining all the requirements, functionalities, and rules of a system. To define how a system should function, one can use one of the simplest and most powerful UML diagrams, the use case diagram, which describes the interactions of the actors—who represent the role that a specific user performs in the system—and describes each function they can perform.

Figure 3 – Bloomy's Case Use Diagram



Source: Own Authorship (2025)

To describe system requirements, it's important to discuss functional requirements, the functions that interact directly with the user, represented by RF, a numbering system, and an intuitive name that reflects their behavior.

- RF01 – Register Profile;
- RF02 – Log In;
- RF03 – Edit Settings;
- RF04 – Edit Profile;
- RF05 – Validate Code;
- RF06 – Play Levels;
- RF07 – Check Progress;
- RF08 – Perform Test;
- RF09 – Update Progress;
- RF10 – Turn on Controller;
- RF11 – Pair Devices;
- RF12 – Connect to Device;

• RF13 – Send Motion Commands;

• RF14 – Activate Vibration;

• RF15 – Deactivate Vibration;

• RF16 – Turn Off Controller.

Furthermore, there are non-functional requirements, which represent functions not directly related to the user, and are represented by NFRs (non-functional requirements), numbering, and their name.

• RNF01 – Intuitiveness: Assumes the interface will be simple for students to understand, in an intuitive and comfortable way;

• RNF02 – Practicality: Indicates that the system should be agile in the execution of functions and in its navigability;

• RNF03 – Comfort: Bloomy will provide an interface with comfortable and relaxing colors;

• RNF04 – Synchronicity: The games and platform will have synchronous navigation with the controller commands;

• RNF05 – Customizable: Will allow customization of experience and preferences on the platform;

• RNF06 – Scalability and Performance: The system will be fully capable of supporting existing games and those that will be made available on the platform;

• RNF07 – Support: The application should provide information in case of doubts about general functionalities;

• RNF08 – Feedback: Should provide continuous progress feedback to the student on their study performance;

• RNF09 – Usability: Will allow navigation on the platform through the controller.

However, business rules define the rules and guidelines that the system imposes on its users to maintain the overall functioning of the system and good coexistence, which should be based on the functionalities, which are the needs related to its environment and its users.

- RN01 - It is only possible to follow the phases in ascending and progressive order;
- RN02 - It is necessary to complete one unit before moving on to the next;
- RN03 - It is necessary to enter the password before editing the settings and profile;
- RN04 - All manuals must be accessible, even after the first access to the platform;
- RN05 - It is feasible to activate and deactivate the controller vibration;
- RN06 - Every mentor must ensure possession of the account password, which grants access to restricted functions;
- RN07 - All account functions should only be accessed after password verification.

3.3. *Wireframes* and Design

Before programming a system, one of the most important steps is design, not only for aesthetics, but also to understand how well a new user can utilize the interface. One of the most sophisticated ways to define an app's design is by using wireframes, which are visual representations of how the interface can be applied, and may or may not undergo changes in its final application.

4. Results and Discussion

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This chapter refers to the results obtained from the development and discussions about its results, real-world applications, and potential improvements.

4.1. Mobile Platform

The first step in developing the platform was to define the platform's wireframes.

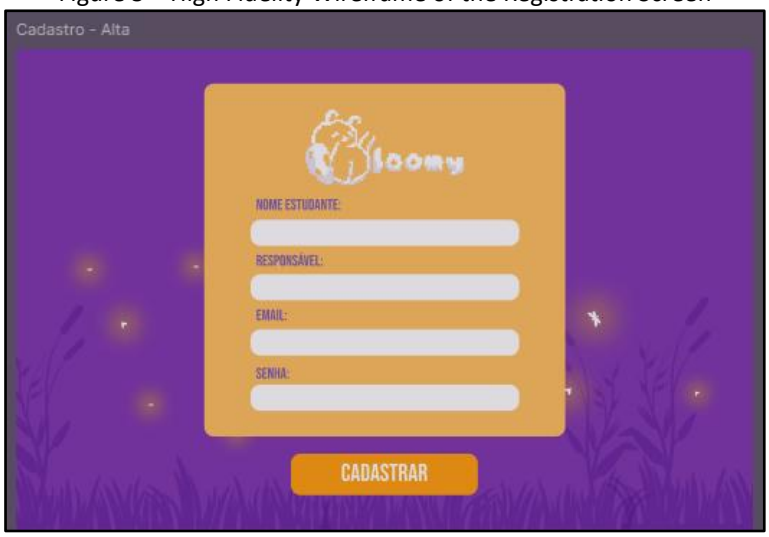
Figure 4 – High Fidelity Wireframe of the First Screen

Source: Own Authorship (2025)

This is a high-fidelity wireframe, created in the Figma interface design tool, of the first screen users should see when entering the system. This page serves as an intermediate step between the user entering the app and using it, helping to create greater harmony in its use and better defining the user flow.

This page should redirect to the registration screen when it identifies that the user does not have a logged-in account, which can be seen on the screen below.

Figure 5 – High Fidelity Wireframe of the Registration Screen



Source: Own Authorship (2025)

When registering, the system should retain your username, and the app's main screen should open. Similarly, when you log back into the app after your session, you should be redirected to the main screen after clicking the "log in" button on the home screen, which is shown below.

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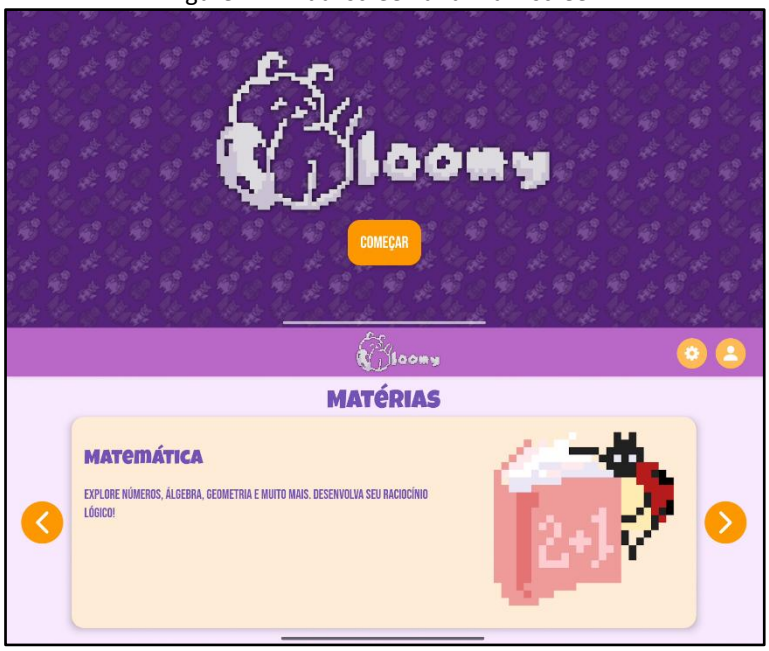
Figure 6 – High Fidelity Wireframe of the Main Screen

Source: Own Authorship (2025)

After defining the screens and their respective visual and interactive elements, they were developed and integrated with the database.

After defining the design using wireframes, the platform was developed in React Native.

Figure 7 – Initial screen and Main screen



Source: Own Authorship (2025)

These are some of the programmed screens, namely the home page and the main screen.

4.2. Game's Development

Eight games were developed using the Construct 3 platform, programming the mechanics and layout of each game, resulting in two games for each subject.

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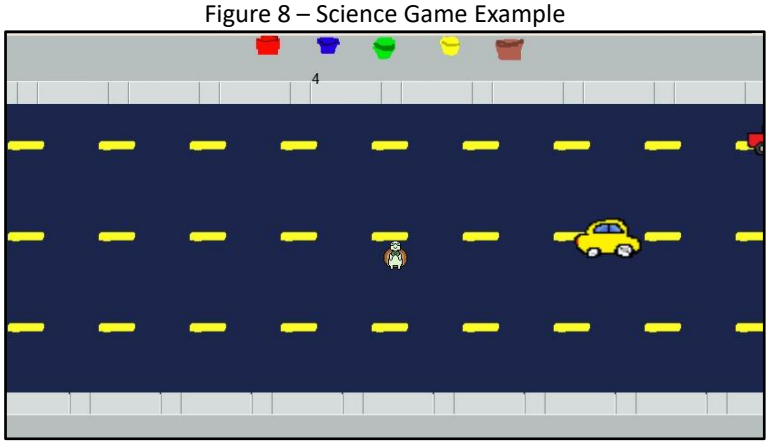
Consequently, the subjects for each pair of games are Portuguese, Mathematics, English, and Science—which are part of the Elementary I curriculum—with simple dynamics based on arcade classics like Space Invaders and Frogger, as well as isolated game rules like Omori, CatJumper, and Stardew Valley.

To captivate the audience, it is necessary to create characters in engaging situations that relate to the player throughout the experience. Therefore, Luke the turtle, Ruby the ladybug, Pipo the bat, and Vulpy the fox were created, each for a subject: Science, Portuguese, English, and Mathematics, respectively.

Figure 8 – Science Game Example



Source: Own Authorship (2025)

4.3. Controller Construction

For the use of the platform and tactile feedback, we created our own control system, which utilized various electronic components such as buttons, vibration motors, batteries, and the ESP32 to process the inputs and send them via Bluetooth to any device compatible with Bluetooth BLE keyboard inputs.

Figure 9 – Bloomy's controller 3D model

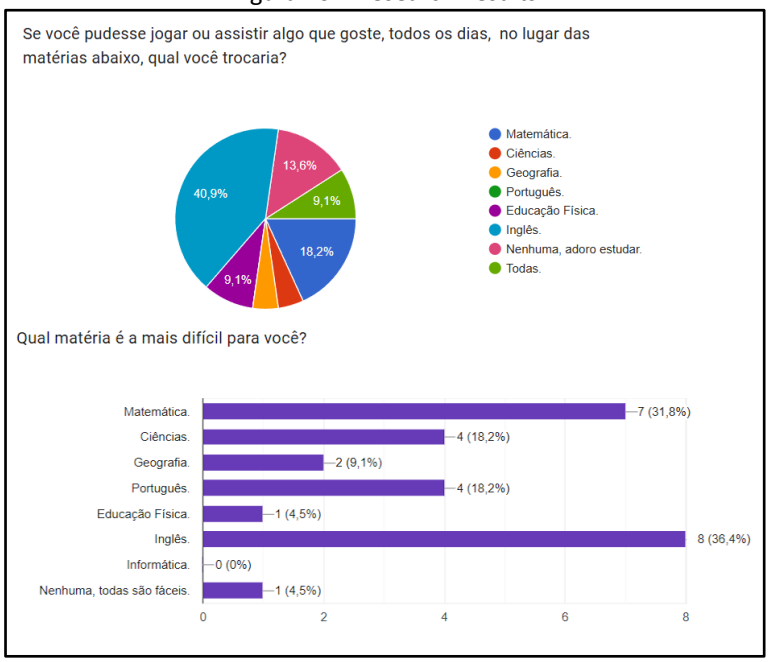
Source: Own Authorship (2025)

4.4. Qualitative Research

The research was conducted with 22 fifth-grade students from the Municipal Elementary School (EMEF) Prof. Virginia Lorisa Zeitounian Camargo, using a digital form, in order to obtain a clear view of the students' opinions on the subject.

However, the results indicate that the lack of interest in English is equivalent to the difficulty faced by the sample, being cited as the most difficult by 36.4% of the students, followed by mathematics with 31.8%. The equivalence is noted when there is a preference to exchange these subjects for some activity of interest, with 40.9% of students exchanging English, which is higher than its competitor mathematics with 18.2%. Furthermore, most students are interested in more engaging educational games to do their homework, with 95.5% in favor of using serious games for studying.

Figura 10 – Research Results



Source: Own Authorship (2025)

Above the graphs, you can see what questions were asked to the students; the segment graph above shows a single-answer question, and the one below was a multiple-choice question.

4.5. Results and Discussions

It was stipulated that disinterest caused dropout from the school environment, without mentioning other factors, when combined with difficulty in subjects, a factor that would consequently make schools unpleasant environments. With this, Bloomy was developed to assist elementary school children during their school journey, through reinforcement with exercises and sensory stimuli during games, to make the experience memorable and attractive, mitigating the consequences by offering a relatable possibility.

However, with the results of the qualitative research, it was possible to see that yes, the activities considered more difficult have less interest from the students. However, it is expressed in the sample that a minority of children dislike the school environment, despite it not being their favorite environment and having other interests, emphasizing that all stages of school dropout do not have a single cause.

5. Conclusion

However, it is considered that increased investment in learning is needed through initiatives like Bloomy. It is also understood that there are several factors that lead a student to stop studying, and not all of them will have the necessary support provided by software. In short, the interactive sensory

system is not an innovation; it is the use of technology in favor of current education, aiming to strengthen traditional teaching methods by offering an alternative that embraces the everyday interests of students.

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