GuessTheFlag: Development and Evaluation of a Low-Cost Web Game for Geography Education

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Abstract. Introduction*: The popularity of web-based games has surged alongside increased access to computers and smartphones. Beyond entertainment, these games serve as powerful educational tools by fostering critical thinking and research skills. Geography-themed games have gained significant prominence, largely driven by digital influencers and streamers. However, the prevalence of subscription-based business models in current platforms often creates accessibility barriers for many users.* ***Objective****: This work aims to address this gap by developing GuessTheFlag, a completely free, intuitive, and interactive web game designed for learning the flags of countries and territories.* ***Methodology****: The system was developed using standard web technologies (HTML, CSS, and JavaScript) and hosted via GitHub Pages to ensure global accessibility. An experimental study was conducted with 30 volunteers to evaluate usability and user experience through the SUS and UEQ-S instruments.* ***Results****: Data analysis over a 16-month period revealed significant organic traffic, primarily driven by search engines without advertising investment. The experimental results indicated high satisfaction and usability ratings. These findings demonstrate the game's effectiveness as a low-cost educational tool and provide a successful case study for independent web game development.*

Keywords *Educational Games, Geographic Education, Web Games, Human-Computer Interaction, Vexillology, Low-Cost Technology*

1. Introduction

Digital games have become one of the most relevant forms of entertainment and interactive learning in recent years, driven by the expansion of internet access and mobile devices [The Business Research Company 2024]. In this context, web-based games, especially those built with HTML, CSS, and JavaScript, stand out for eliminating installation barriers and enabling instant access from any connected device [Dutra et al. 2021]. This model has attracted both independent developers and

large companies, fostering diversity and innovation in casual and educational games [Nuci et al. 2021]. In this scenario, this work presents GuessTheFlag, a web game for flag recognition, describing its development and organic reach.

Developing a functional and accessible web game with a good user experience is technically challenging, particularly when aiming to reach a wide audience without server infrastructure or installation requirements [Krishnaraj 2017]. Choices such as lightweight technologies, cross-device compatibility, and intuitive interface design directly impact user engagement [Hoober 2020]. In GuessTheFlag, these challenges were addressed by developing the game entirely with HTML, CSS, and JavaScript, without a backend, hosted on GitHub Pages, and using an external SVG flag library resulting in a lightweight and scalable solution.

Among existing tools for learning flags and geography, platforms like GeoGuessr and Seterra stand out. GeoGuessr, launched in 2013, reached over 40 million users by 2022 [GeoGuessr AB 2024a], but its subscription model limits full access. Seterra, acquired by GeoGuessr in 2022, offers over 400 quizzes but is now part of a more complex ecosystem, with some content behind paywalls [GeoGuessr AB 2024b]. This reveals a gap for simpler, fully accessible solutions. GuessTheFlag addresses this by offering a lightweight, registration-free experience focused solely on flag recognition.

GuessTheFlag is a web game built with pure HTML, CSS, and JavaScript, hosted on GitHub Pages. It presents a random flag from over 240 countries and territories, challenging players to identify it among four options. The interface is simple, responsive, and requires no setup. A scoring system tracks performance, encouraging replay and progressive learning. This simplicity and accessibility contributed to its significant organic reach, discussed later.

This paper is organized as follows: Section 2 presents related work; Section 3 describes the architecture and development of the GuessTheFlag game, detailing its mechanics, technologies used, and development decisions; Section 4 presents the experiment conducted to evaluate the game; Section 5 presents the results and discussion, addressing usability and user experience evaluation as well as performance data and the game's organic reach; and Section 6 presents the final consideration.

2. Related Work

In recent years, independent digital game development has gained relevance in both industry and academia. [Jesus et al. 2024] analyzed the impact of indie games, highlighting their ability to introduce new mechanics and influence market trends with limited resources. Complementarily, [Nuci et al. 2021] showed, through an experiment with 257 students, that simple gamified quizzes significantly increase engagement and motivation, reinforcing the potential of lightweight web applications to reach large audiences.

In the context of SBGames, recent works have reported practical experiences in the development and publication of independent games. The work of [Lima et al. 2025] described the development of ReciclaQuest, a web game created in a Computer Graphics course using HTML and JavaScript, reporting technical decisions and initial applications, demonstrating the feasibility of lightweight web-based games to reach real audiences

without complex infrastructure. Similarly, [Corrêa et al. 2025] presented a pilot study evaluating the usability of a digital game using an adapted SUS questionnaire, obtaining an average score of 70.5 points, classified as "good", reinforcing the importance of validated instruments such as SUS in evaluating user experience in digital games.

Within SBGames, recent works have also explored the use of digital games for teaching geographic and cultural content. [Bastos et al. 2023] presented a game focused on teaching Brazilian biomes, demonstrating that playful approaches are effective in engaging students with geographic content that requires memorization. [Silva e Madeira 2024] proposed cartographic quests in an educational digital game to enhance geography teaching through spatial representation and motivating narratives. [Amarante et al. 2025] introduced Tata Adventure, a game addressing ethnic-racial relations and the history of South Africa, demonstrating the educational potential of games with international cultural content. Although these works focus on formal educational contexts, they reinforce that games centered on geographic and cultural themes have recognized engagement potential an aspect that GuessTheFlag also explores in a casual and accessible way.

The development and publication of games based on web technologies have also been addressed in SBGames. [Bahia 2023] provided a historical context of flash games, concluding that this ecosystem was fundamental in expanding the field of digital games and opening opportunities for independent developers to reach large audiences. [Ferreira e Junior 2023] analyzed postmortems of Brazilian games, highlighting that technical and scope-related decisions are decisive for independent projects to reach a publishable version. More recently, [Santos et al. 2025] presented the SWOT Game, an online browser-accessible game, demonstrating that lightweight web games remain a viable approach to reach users without installation barriers.

The analysis of related works indicates that, despite the existence of tools and studies on independent web games, gamified quizzes, and educational geography games, there is still a gap in solutions focused exclusively on flag recognition, built with lightweight web technologies, without registration requirements, and with unrestricted access. Platforms such as [GeoGuessr AB 2024a] and [GeoGuessr AB 2024b], although well-established, introduce access barriers through subscriptions or more complex ecosystems.

GuessTheFlag addresses this gap by combining technical simplicity, immediate browser accessibility, and a focused proposal that enables users to progressively learn the flags of more than 240 countries and territories. Together with its significant organic reach, these aspects position the game as a relevant case study in independent web game development for educational purposes.

3. GuessTheFlag: Design and Development

GuessTheFlag is a web-based game developed for the recognition of flags of countries and territories, accessible directly through the browser without the need for installation, registration, or any prior configuration. The central proposal of the game is to provide a simple and immediate experience, allowing users to test and expand their knowledge of the flags of 245 countries and territories. The following subsections detail the system

architecture, the technologies used in its development, the game mechanics, and usage instructions.

3.1. System Architecture

GuessTheFlag was designed with a *client-side* architecture, meaning that all operational logic is executed in the user's browser, without any server-side processing. Figure 1 illustrates the system architecture. The static HTML, CSS, and JavaScript files are served via GitHub Pages, a free hosting platform integrated with the project repository. The presentation layer is composed of HTML and CSS files, responsible for the structure and styling of the interface. The game logic is entirely implemented in JavaScript, which also triggers the browser's native Web Audio API for sound effects. The player's high score is stored locally in the browser using `localStorage`, eliminating the need for a database. The flag images are dynamically loaded from an external website [Kuchumov 2024].

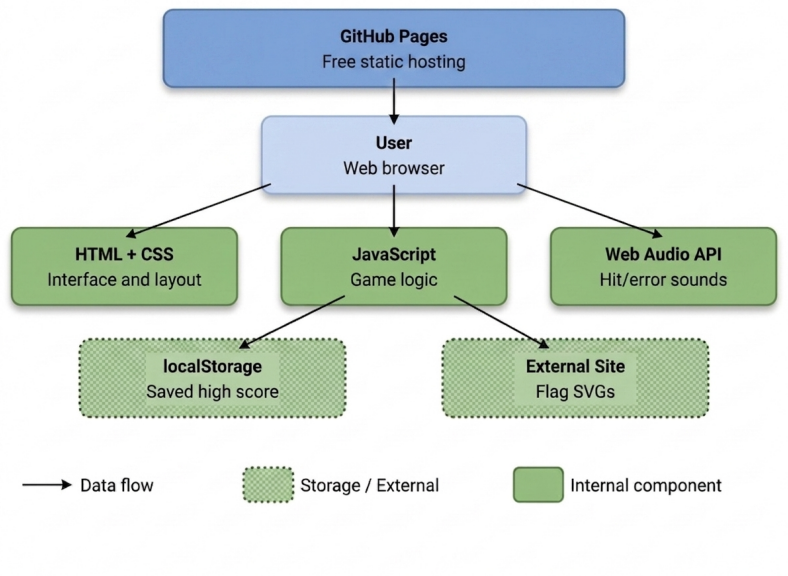

Figure 1. GuessTheFlag Architecture: client-side components, GitHub Pages hosting, and integration with an external flag website.

3.2. Development

The game was developed exclusively using HTML, CSS, and pure JavaScript, without the use of frameworks or external JavaScript libraries. The editors used during development were Visual Studio Code and Notepad. The code is organized into three main files: `index.html`, responsible for the page structure; the CSS file, which defines the visual style and interface responsiveness for both mobile and desktop devices; and `script.js`, which contains all the game logic. Random country selection, generation of the four answer options, score control, sound effect playback, and persistence of the high score via `localStorage` are all functions implemented directly in native JavaScript. The flag images were sourced from a public repository on GitHub [Kuchumov 2024], which provides icons in SVG format with a 3:2 aspect ratio. The project was hosted and published via GitHub Pages, making the deployment process automatic with each

repository update. Assistance from beta testers was also requested to make the game more intuitive and accessible.

3.3. Mechanics and Interface

The game interface displays four flags arranged in a 2x2 grid, each numbered from 1 to 4 and accompanied by a circular selection button. When the player clicks the **Play** button, the system randomly selects a country and displays its name, and the player must identify which of the four flags corresponds to the indicated country. Only one of the four options is correct; the others are randomly selected from the remaining available countries. If the player answers correctly, their score is incremented and a new country is automatically selected. In case of an incorrect answer, the current score is reset to zero, but the historical high score remains saved via `localStorage`, being updated only when the player surpasses their previous record. Distinct sound effects indicate correct and incorrect answers, providing immediate auditory feedback.

The game also supports keyboard shortcuts on desktop: the *Enter* key selects a new country, and the numeric keys 1, 2, 3, and 4 allow the player to choose the corresponding flag without using the mouse, streamlining the gameplay flow. It is possible to select a flag either by clicking the circular button next to it or directly on the flag image. The interface is responsive and compatible with both mobile devices and desktops. It is worth noting that not all available flags belong to sovereign countries; some correspond to territories and dependencies of other nations, which broadens the scope of the game without compromising its playability. Figure 2 illustrates the main interface of the game.

Figure 2. GuessTheFlag Main Interface: four flags are displayed and the player must identify the one corresponding to the indicated country.

4. Experiment

To evaluate the usability and user experience of GuessTheFlag, an experiment was conducted with 30 volunteer participants. The sample consisted mainly of technology students, aged between 18 and 42 years, with 80% from higher education and 20% from high school. The main objective was to analyze how users interacted with the game's

features, observing how the flag recognition mechanics and the web interface influenced usability perception and overall experience.

At the end of the session, participants answered two validated instruments: the System Usability Scale (SUS) [Brooke 1996], used to measure perceived usability, and the User Experience Questionnaire – Short Version (UEQ-S) [Schrepp et al. 2017], used to evaluate both pragmatic and hedonic aspects of user experience.

4.1. System Usability Scale (SUS)

The SUS provides a quantitative measure of perceived ease of use and learnability. The questionnaire consists of 10 items evaluated on a five-point Likert scale. The final score is calculated by normalizing the responses to a 0–100 scale, where values above 68 are generally considered indicative of above-average usability [Brooke 1996, Brooke 2013, Sauro e Lewis 2016]. Table 1 presents the questions applied, adapted to the context of interaction with GuessTheFlag.

Table 1. Usability questionnaire (SUS). Adapted from [Brooke 1996].

Q1.	I think I would like to use this system to learn about country flags in my daily life.	↑
Q2.	I find the system unnecessarily complex.	↓
Q3.	I found the system intuitive and easy to use.	↑
Q4.	I think I would need the help of a person with technical knowledge to use the tool.	↓
Q5.	I think the various functions of the system are well integrated.	↑
Q6.	I think the system exhibits a lot of inconsistency.	↓
Q7.	I imagine that people will learn to use this system quickly.	↑
Q8.	I found the system very complicated to use.	↓
Q9.	I felt confident using the system.	↑
Q10.	I needed to learn several things before using the system.	↓

(↑ Positive item, ↓ Negative item).

4.2. User Experience Questionnaire – Short Version (UEQ-S)

According to [Schrepp et al. 2017], the UEQ-S evaluates user experience through eight items divided into two categories: pragmatic quality, which measures efficiency and clarity, and hedonic quality, focused on stimulation and novelty. The evaluation is performed by participants using a seven-point scale defined by pairs of opposite adjectives. In this study, the UEQ-S aims to capture how the simple and accessible interface of GuessTheFlag, combined with its straightforward flag quiz mechanics, impacts user engagement and satisfaction. Table 2 presents the adjective pairs used.

4.3. Web Traffic Data

In addition to usability and user experience evaluation instruments, this study also analyzes the organic traffic data of GuessTheFlag collected through Google Analytics. The data covers a 16-month period and includes metrics such as number of users, sessions, and countries of access. This analysis complements the subjective evaluation of the

Table 2. UEQ-S items. Adapted from [Schrepp et al. 2017].

Pragmatic Quality	Hedonic Quality
I1. Obstructive / Supportive	I5. Boring / Exciting
I2. Complicated / Easy	I6. Not Interesting / Interesting
I3. Inefficient / Efficient	I7. Conventional / Inventive
I4. Confusing / Clear	I8. Usual / Leading Edge

questionnaires, providing an objective perspective on the game's reach and real user engagement.

5. Results and Discussion

The results of the usability and user experience evaluation were obtained through the SUS and UEQ-S instruments, applied to the 30 participants after their interaction with GuessTheFlag.

5.0.1. SUS Results

The SUS is a well-established metric for evaluating perceived usability. Reference studies indicate that the global average score is approximately 68 points [Sauro e Lewis 2016]. The evaluated system achieved a final score of 89.33. According to the adjective rating scale proposed by Bangor et al. [Bangor et al. 2009], whose ranges are detailed in Table 3, this score classifies the solution in the *"Excellent"* category, indicating usability well above average and excellent acceptance among participants.

Table 3. Descriptive Statistics of SUS Scores for Adjective Ratings. Adapted from [Bangor et al. 2009].

Adjective	Mean SUS Score
Worst Imaginable	12.5
Awful	20.3
Poor	35.7
OK	50.9
Good	71.4
Excellent	85.5
Best Imaginable	90.9

The detailed analysis of the SUS items, presented in Figure 3, shows strong performance across all evaluated dimensions. The highest score was recorded for Question 4 (9.75), indicating that users did not feel the need for technical support to use the game, demonstrating the intuitiveness of the interface. Questions 3 (9.58) and 6 (9.33) also achieved high scores, reinforcing that the system is perceived as intuitive, easy to use, and consistent. Questions 2 (9.25) and 10 (9.17) indicate that the game is not perceived as unnecessarily complex and that participants did not need to learn many things before starting to play. Question 1 obtained the lowest score in the set (7.92), although still quite positive, suggesting that some participants would not necessarily incorporate the game into their daily study routine, which is expected given the casual nature of the tool.

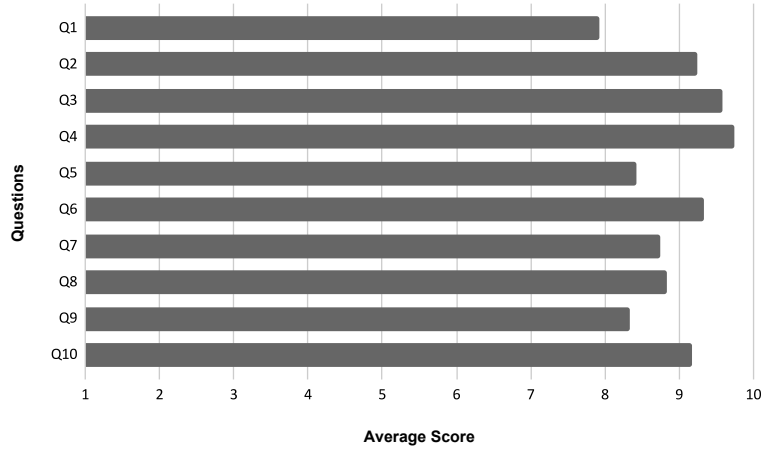

Figure 3. Average normalized SUS scores per item.

5.0.2. UEQ-S Results

User experience was analyzed using the UEQ-S, with results on a scale from -3 to $+3$. Values above $+0.8$ indicate a positive perception, while values above $+1.5$ are considered extremely positive [Schrepp et al. 2017].

The UEQ-S results were consistent and highly positive, as shown in Figure 4. In the Pragmatic Quality dimension (items I1 to I4), the system achieved an average of 2.367, with highlights on items I3 and I4 (both scoring 2.5), indicating that users perceive the game as efficient and clear for performing the proposed tasks. Item I1 (2.3) and item I2 (2.1) reinforce that the interface is seen as supportive and easy to operate, reflecting the technical simplicity of the solution.

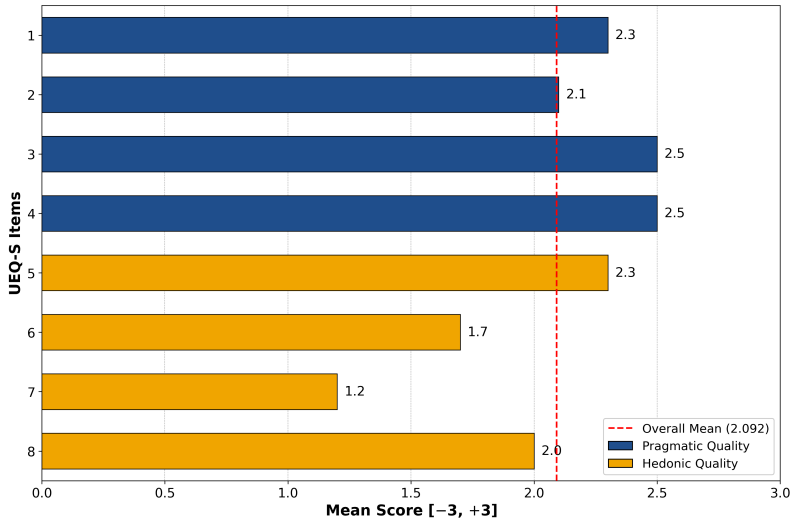

Figure 4. Average normalized UEQ-S item score.

Regarding Hedonic Quality (items I5 to I8), the average reached 1.817. Item I5 recorded the highest score in this dimension (2.3), showing that users consider the game stimulating and engaging. Item I8 (2.0) and item I6 (1.7) indicate that GuessTheFlag generates genuine interest and is perceived as a differentiated experience. Item I7 obtained

the lowest score in the study (1.2), suggesting that the interaction design is perceived as more conventional compared to the other dimensions, which is understandable given that the game adopts a straightforward and familiar quiz mechanic.

The overall system score was 2.092. When compared with the official UEQ-S benchmark [Schrepp et al. 2017], illustrated in Figure 5, Pragmatic Quality is classified as *Excellent* and Hedonic Quality as *Good*, with the overall score also falling within the *Excellent* range. These results indicate that GuessTheFlag provides a high-quality user experience, combining efficiency of use with genuine user engagement.

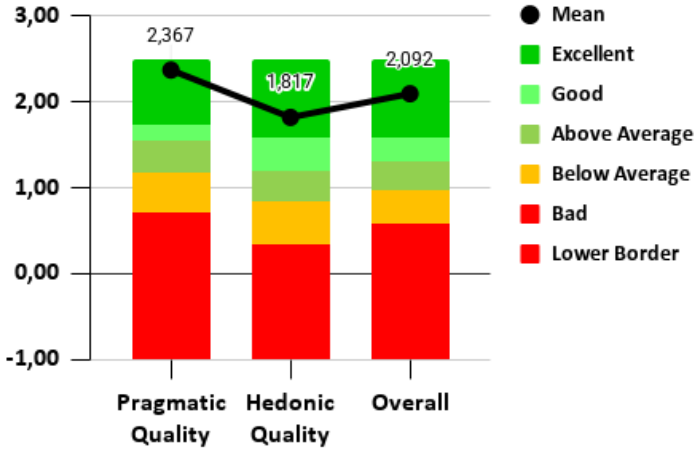

Figure 5. Comparison of UEQ-S scores with the benchmarks.

5.1. Usage Analytics

As shown in Figure 6, in the last 16 months the website had around 157,000 impressions – the number of times a user saw a link to the website –, and around 12,300 clicks – the number of times a user clicked on the website. Also, Table 4 shows the types of accesses to the website. The most interesting metric is the organic traffic (13,376 clicks), because it represents when the website was found in a search by the users themselves. Also it is possible to see a number of 1,141 returning users, showing that a part of the users wanted to visit the website again. It is worth mentioning that each of these results are calculated differently, the reason why the numbers are slightly distinct, but their proximity indicates that the data is reliable.

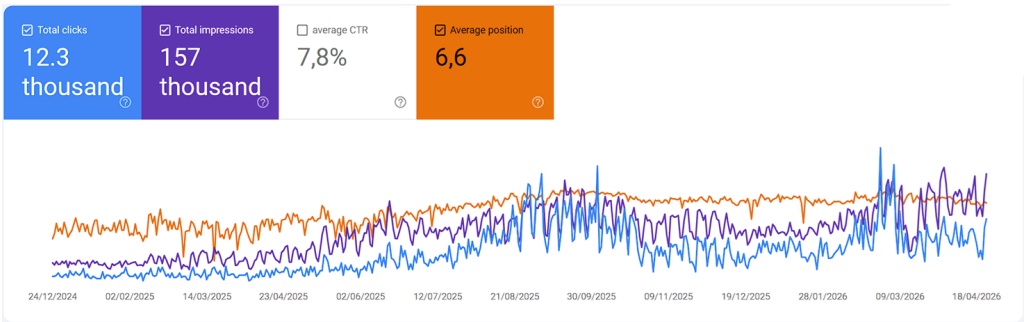

Figure 6. Accesses in the last 16 months

Table 4. Traffic acquisition channels.

Channel	Total Users	New	Recurrent	Average Time
Organic	13,376 (93.81%)	13,278 (93.8%)	1,141 (89.84%)	2min 03s
Referral	462 (3.24%)	459 (3.24%)	47 (3.7%)	1min 57s
Direct	422 (2.96%)	406 (2.87%)	80 (6.3%)	2min 05s
Social	11 (0.08%)	11 (0.08%)	1 (0.08%)	0s

6. Final Considerations

In this work, we presented the development of GuessTheFlag, a web-based game for the recognition of countries and territories, built using pure HTML, CSS, and JavaScript, hosted via GitHub Pages, and freely and unrestrictedly accessible through any browser. The proposal aimed to fill a gap identified in existing tools by offering a lightweight solution without registration requirements or access barriers, combining entertainment and geographic learning in a casual and progressive way.

The evaluation conducted with 30 participants demonstrated expressive results in both usability and user experience. The SUS score of 89.33, classified as *Excellent*, and the overall UEQ-S score of 2.092, also within the *Excellent* range, show that the game provides an intuitive, efficient, and engaging interface. The organic traffic data collected over 16 months further reinforces that the combination of technical simplicity and unrestricted access was decisive for achieving significant reach among users, without any investment in advertising. Additionally, the website had 13,376 users from organic search over the last 16 months, including 1,141 returning users.

From an educational perspective, learning flags goes beyond visual memorization, as it contextualizes countries, regions, and cultures, contributing to the development of geographical literacy. GuessTheFlag explores this potential by structuring the experience around trial, error, and immediate feedback, a dynamic that promotes information retention through repeated practice and progressive challenge. Unlike passive approaches, the interactive quiz format requires players to make decisions each round, fostering active engagement with the content. In this sense, the game functions as an informal learning environment, accessible to anyone with a browser, free of cost or registration barriers, characteristics that broaden its educational reach especially in resource-limited contexts.

As future work, it is intended to expand GuessTheFlag with new game modes, such as challenges in which players must identify the continent of a given country, or recognize landmarks, monuments, and cultural elements from images and associate them with their country of origin. Also, a way to make it easier for players to search about the territories would complement the experience. These expansions aim to broaden the educational scope of the game, making it a more complete platform for learning geography and world culture in a playful and accessible way.

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