Utilizing Games to Enhance the Learning of Students with Dyslexia: A Systematic Literature Review

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Abstract – **While discussions about the learning experiences of dyslexic students have been extensive, the exploration of interventions to address their learning obstacles using technology remains unresolved. This study aims to unpack the pattern use of games to enhance the learning of students with dyslexia using a systematic literature review of thirty-nine articles. The analysis findings reveal a notable increase in interest over the past decade in publications focusing on the utilization of games to enhance the learning experiences of students with dyslexia across various grade levels. The utilization is delineated in ways that exploring innovative approaches to enhance reading skills in dyslexic students through engaging and playful methods gives significant potential progress. The empirical results specifically indicate that employing playful strategies contributes to the enjoyment, motivation, and active participation of students with dyslexia. These can enhance reading skills by bolstering linguistic competence, improving working memory, and enhancing executive functions, thereby significantly supporting the learning process. The encouraging progress in utilizing games to enhance the learning of students with dyslexia underscores the need for research aimed at optimizing both cognitive and non-cognitive factors in their learning experiences.**

1. Introduction

In the ever-evolving era of education, the use of technology, especially games as learning tools has reached a significant level. Games are no longer merely a kind of amusement; they are a tool capable of combining education and enjoyment, stimulating critical thinking, and motivating students to participate actively in the learning process. Gamification exercises in the classroom can improve students' motivation and comprehension [1]. In this manner, learning has transformed into a dynamic process that employs many technology breakthroughs, rather than being constrained to typical monotonous techniques [2]. Recent studies have progressively proved that learning through the use of games is not only successful in general, but also gives unique solutions to the specific issues experienced by students with dyslexia [3], [4], [5], [6]. As a means to describe and assemble associated evidence, the systematics literature review technique provides a vital basis for investigating the role and impact of game use in learning, in particular the educational setting of dyslexic students.

The use of games in learning for children with dyslexia provides several major benefits. Firstly, games create an educational setting that motivates and interests students more intensively [3], [7], [8], [9]. Dyslexic students may feel more motivated to study if they are exposed to fascinating aspects, difficulties, and incentives. Games offer a dynamic and enjoyable learning experience, which has considerable benefits. Through direct action, investigation, and hands-on experience, dyslexic students may deepen their knowledge of topics and polish their abilities without the monotony that may emerge in conventional learning techniques [3], [7].

The usage of games emphasizes the need for individualized learning. Games may be adapted to each student's learning needs, allowing them to study in an atmosphere that meets their learning methods and rhythms [3]. In broadly, the modest use of games in the learning of children with special needs can help the work of speech and language therapy [10]. Furthermore, educational games give possibilities for practice and solidification of certain abilities, such as reading, spelling, and writing, which are critical emphasis areas for dyslexic students [3], [7], [11], [12], [13], [14]. The ability to repeat things without boredom enables students to continuously enhance their abilities.

Furthermore, the educational advantages, of the use of games in learning might eliminate the stigma that children with dyslexia can encounter [15]. The use of games has a favorable influence on the achievement of dyslexic students [16]. In an inclusive setting that provides an enjoyable educational environment, students might feel more confident and motivated to get past their learning difficulties [9]. Games can also improve metacognitive abilities, such as planning, self-monitoring, and assessment, which help people discover effective learning methods [3], [17].

Lastly, games combine visual and auditory features, allowing students with dyslexia to learn using several methods. It takes an integrated method of learning, assisting individuals with visual or auditory learning preferences to make better use of their abilities [7], [8], [13], [14]. Thus, integrating games in dyslexic classrooms has numerous advantages, including accessible learning opportunities, academic skill improvement, and increased student motivation and confidence.

Dyslexia, a neurological disorder that impairs the ability to read, spell, and write, can offer a significant hurdle in the learning process [18]. In this situation, technology for games is developing as an attractive and practical choice. Using a systematic literature review method, this article seeks to give a complete and structured evaluation of the current scientific evidence on the function and usefulness of games in promoting dyslexic student learning.

The significance of addressing this problem systematically from our capacity to detect patterns, knowledge gaps, and practical implications of previous research findings. The article will not only explore the good contributions that have been discovered but also the problems that remain to be conquered and future research directions in incorporating gaming into the classroom settings of dyslexic students. This study, using a systematic literature review method, is designed to offer an adequate basis for deeper knowledge of the use of games in learning, particularly to benefit dyslexic students. Thus, this contribution is intended to serve as the foundation for the creation of more inclusive and successful educational practices for this specific learning group.

This article explores the extent of game roles in changing the current paradigm of learning. In recent years, many studies have developed games for dyslexic students [5], [8], [16], [19]. A lot of studies have learned about dyslexic students' phonological awareness [4], [20], spelling skills [12], attention [21], writing skills [3], language comprehension [8], and learning process [22]. However, most of the studies focus on developing games or applications to assess and improve dyslexic students' reading skills [5], [6], [23], [24], [25], [26].

The importance of results-oriented education makes this innovative approach even more relevant. By utilizing game technology, teachers can create an adaptive learning environment and support a variety of learning styles [2]. Games also provide individualized learning, allowing each student to learn at their own pace and behavior while remaining involved and motivated [27], [28]. Furthermore, the advancement of games in terms of visuals, artificial intelligence, and other technology creates the potential to offer instructional information appealingly and realistically. Games, for example, may imitate complicated scientific settings, allow students to perform virtual experiments, and help them come up with innovative solutions in real-world scenarios.

This study differs from other research on the topic of game use and learning in many ways. First, all publications published between 2014 and 2023 that were included in journals that Scopus indexed were the subject of this study. To be useful as a foundation for future research, the second goal of this study is to examine several publications about the use of games for dyslexic pupils. Third, content analysis is based on several factors.

2.   Methodology

This section explains the procedures for searching and selecting data sources, and their analysis.

2.1. Search and Selection Procedures

Search and selection procedures consists of two stages as follows.

2.1.1. Initial Search

The initial stage in this procedure is to define the inclusion criteria.

The criteria for inclusion are: the literature must be about games, the literature must be about dyslexia, the literature must suggest at least one type of initial skills, the literature must have been published in journal articles, conference proceedings, or book chapters that have previously gone through a peer process-review, the year the article was published is 2014-2023, and the articles allowed are in English. The researchers used SCOPUS database sources to obtain articles. The initial search contains the phrase "game" AND "dyslexia". The overall search yielded 300 articles from the database.

2.1.2. Article Selection and Coding

Researchers assessed the relevance of 300 articles based on certain criteria. First, all articles published more than the last ten years were removed (n = 60 removed). Second, all duplicates in the initial search were removed (n = 0 removed). Third, articles must be written in English (n = 10 removed). Fourth, articles restricted that published as journal articles (not book chapters, proceedings, etc.) (n = 131 removed). Fifth, the selected articles discussed games and dyslexia which were screened from the title and abstract (n = 45 removed). Finally, the article must be available in full paper (n = 15 removed). After applying the above inclusion criteria, we retained 39 articles. This article selection process is shown in Figure 1.
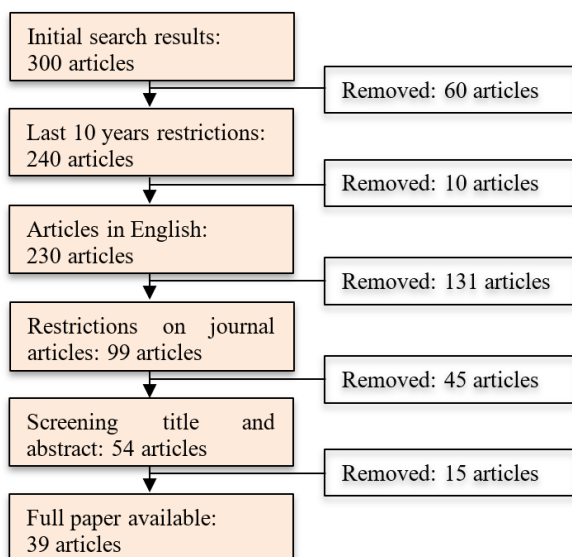

Figure 1. Articles selection process

2.2. Analysis

At the analysis stage, categorical analysis and synthesis of findings and discussion are explained.

2.2.1. Categorical Analysis

The next step is to classify the 39 articles that match the criteria. The coding technique was conducted using a Google Forms file that contained information on the study's authors, year of publication, research paradigm, research aspect, authors' country, variables measure, and source title.

2.2.2. Synthesizing the Findings and Discussions

To provide a structured summary of the research that has been conducted, a map was developed regarding measured abilities in research on the use of games with dyslexic students. This can be used to identify research gaps for research consideration. Next, the synthesis of this research results is summarized to be presented in the discussion. Finally, potential limitations of the findings that have been made are also discussed to make recommendations for further research.

3. Results

The initial search for relevant literature on games to enhance dyslexic abilities yielded 300 linked articles. The literature includes a variety of materials such as articles, conference papers, reviews, conference reviews, book chapters, book, editorials, data papers, notes, and short surveys. Table 1 shows the different sorts of papers, their frequencies, and percentages.

Table 1. Document types obtained based on the original search

Document Type	Documents	Percentage
Article	139	46,33%
Conference Paper	101	33,67%
Review	20	6,67%
Conference Review	19	6,33%
Book Chapter	10	3,33%
Book	4	1,33%
Editorial	4	1,33%
Data Paper	1	0,33%
Note	1	0,33%
Short Survey	1	0,33%

The data collected is mostly presented in academic journal papers, as Table 1 illustrates. Among the other notable details discovered from the first set of search results are pertinent articles that are dominated by computer science areas, followed by social science areas (Figure 2). This demonstrates that studies on games, dyslexia, and their effect on students' fundamental skills have been conducted in the disciplines of technology and social sciences, including education.
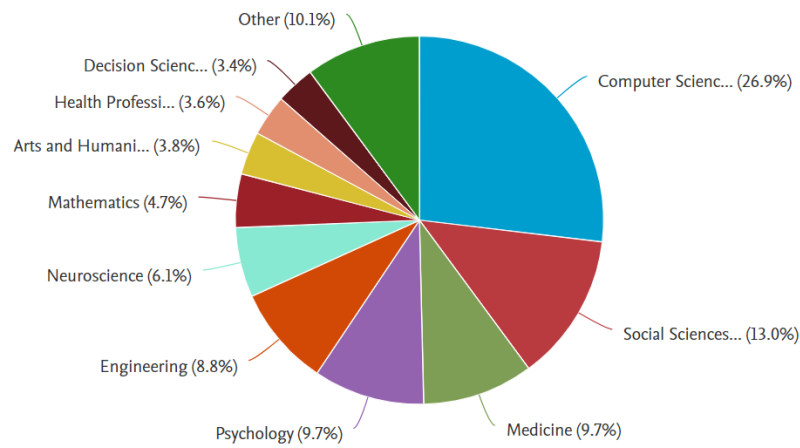
Figure 2. Documents by subject area
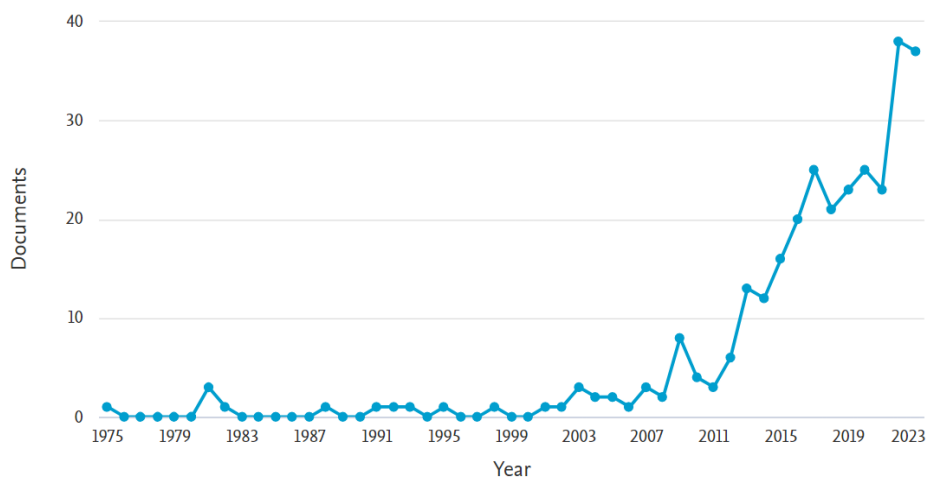
Figure 3. Trends in related research publications

From the first search results data, VOSviewer analysis revealed that out of 576 words in the titles field, 45 of them met the criterion. Next, the relevance score is computed for each of the 45 words.

The words with the greatest relevance will be chosen based on these ratings. 60% of the most relevant keywords are chosen by default by VOSviewer. 27 terms were chosen as meeting the requirements based on the analysis's findings.

Figure 4. Terms analysis by VOSviewer

Terms that match the criteria are split into six clusters, each represented by a distinct color (Figure 4). Of the six clusters, four are big clusters. The first cluster is red, and it describes the link between 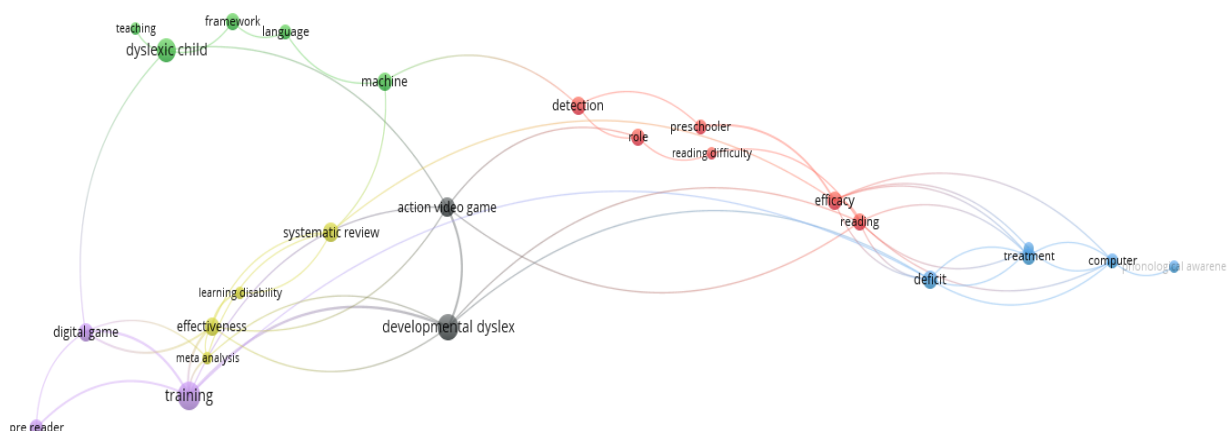fundamental abilities and study topics, including detection, efficacy, preschoolers, reading, reading difficulty, and role. The second cluster is green, and it describes the link between standard words based on the unit of research and analysis topics, namely dyslexic children, framework, language, machine, and teaching. The third cluster is blue, which describes the link between treatment and result phrases namely computer, deficit, feasibility, phonological awareness, and treatment. The fourth cluster is yellow, which describes the form of research analysis used, namely effectiveness, learning disability, meta-analysis, and systematic review. The fifth cluster is purple, which describes the relationship between the forms of games and research subjects, namely digital games, pre-readers, and training. The sixth cluster is purple, which describes the relationship between the forms of games and the unit of analysis, namely action video games, and developmental dyslexia.

Table 2. Article results of final data extraction based on the PRISMA 2020 criteria

No	Author(s)	Year	Educational Target	Country	Source Title
1	[20] Romero, et al.	2023	4-5 years	Spain	International Journal of Child-Computer Interaction
2	[6] Rodríguez-Ferrer, et al.	2023	Students with a mean age of 14.22 years	Spain	Research in Developmental Disabilities
3	[12] Holz, et al.	2023	Second- to fourth-grade children	Germany	Learning and Instruction
4	[21] Kress, et al.	2023	Adult learner	Canada	Acta Psychologica
5	[29] Villaverde, et al.	2023	10 – 15 years	España	Pixel-Bit, Revista de Medios y Educacion
6	[30] Junttila, et al.	2023	7 - 11 years	Finland	Frontiers in Human Neuroscience
7	[3] Brennan, et al.	2022	9 and 12 years	Ireland	Transactions on Learning Technologies
8	[4] Khaleghi, et al.	2022	6–8 years	Iran	Entertainment Computing
9	[31] Franceschini, et al.	2022	Children (with no specific mention)	Italy	Journal of Cognitive Enhancement
10	[32] Minoofam, et al.	2022	Primary School	Iran	Multimedia Tools and Applications
11	[11] Rauschenberger, et al.	2022	Children (with no specific mention)	Spain and German	Frontiers in Computer Science
12	[5] Ruiz, P.A.	2022	8 years	Spain	Texto Livre
13	[8] Bempt, et al.	2022	Kindergarten	Belgium	JMIR Serious Games
14	[19] Peters, et al.	2021	8-13 years	Australia	Scientific Reports
15	[16] Malliakas, et al.	2021	Secondary students	Greece	Social Sciences
16	[25] Bempt, et al.	2021	Kindergarten students	Jerman	Frontiers in Psychology
17	[26] Larco, et al.	2021	7-10 years	Ecuador	Sustainability (Switzerland)
18	[33] Yildirim & Surer	2021	7-11 years	Turkey	JMIR Serious Games
19	[34] Jaramillo-Alcázar, et al.	2021	The level is not explained	Ecuador	Sustainability (Switzerland)

No	Author(s)	Year	Educational Target	Country	Source Title
20	[13] Bertoni, et al.	2021	Primary school students	Italy	Brain Sciences
21	[35] Rello, et al.	2020	Secondary students	Spanish	PLoS ONE
22	[23] Mehringer, et al.	2020	Preschool	Swiss	Research and Practice in Technology Enhanced Learning
23	[9]Ahmed, et al.	2020	Primary school students	UK	Frontiers in Education
24	[14] Cancer, et al.	2020	8-14 years	Italy	Frontiers in Psychology
25	[36] Coskun & Mitrani	2020	Adult learner	Turkey	Cypriot Journal of Educational Sciences
26	[24] Ebrahimi, et al.	2019	9–11 years	Iran	Scientific Reports
27	[37] Dymora & Niemiec	2019	Children (with no specific mention)	Poland	Informatics
28	[22] Sulaiman & Ban	2019	8-11 years	Malaysia	International Journal of Advanced Trends in Computer Science and Engineering
29	[38] Łuniewska, et al.	2018	9.0–13.2 years	Poland	Scientific Reports
30	[7] Aljojo, et al.	2018	4-7 years	Saudi Arabia	International Journal of Interactive Mobile Technologies
31	[17] Antzaka, et al.	2017	18–45 years	French	Scientific Reports
32	[39] Franceschini, et al.	2017	7.8 –14.3 years	Italy	Scientific Reports
33	[40] Vasalou, et al.	2017	11-12 years	England	Computers and Education
34	[41] Alt, et al.	2017	7–9 years	USA	Journal of Speech, Language, and Hearing Research (JSLHR)
35	[42] Pedroli, et al.	2017	9-12 years	Italy	Computational and Mathematical Methods in Medicine
36	[43] Drigas & Elektra	2016	Kindergarten	Greece	Emerging Technologies in Learning (iJET)
37	[44] Franceschini, et al.	2015	Children (with no specific mention)	Italy	Curr Dev Disord Rep
38	[45] Gabay & Holt	2015	Adults	USA	Cortex
39	[46] Ludovico, et al.	2015	7-9 years	Italy	Emerging Technologies in Learning (iJET)

Based on Table 2, articles about the use of games for children with dyslexia are dominated by countries in the Southern European region, namely Italy and Spain.

This was followed by countries from other regions such as Germany, Iran, Greece, Ecuador, Turkey, Poland, and the USA.

Meanwhile, fewer were written from Canada, Finland, Ireland, Malaysia, Belgium, Australia, Switzerland, UK, Saudi Arabia, France and England. Meanwhile, in terms of age, research subjects were mostly carried out on children aged 7-14 years.

There are several variables associated with research that relate to the use of gaming applications for dyslexia. Below are presented the variables in question obtained from the identification of 39 articles that have been carried out as presented in Table 3 below.

Table 3. Variables related to the use of gaming applications for dyslexia

Variables measured	Sources	Frequency
Reading skills	[3], [5], [6], [7], [11], [12], [14], [17], [21], [24], [25], [26], [31], [32], [33], [34], [35], [38], [39], [42], [46]	21
Attention	[13], [19], [21], [42], [44]	5
Perception	[5], [8], [49], [50], [44]	5
Spelling skills	[3], [9], [12], [37]	4
Academic performance	[6], [11], [16]	3
Phonological awareness	[4], [20], [43]	3
Writing skills	[3], [11], [33]	3
Learning process	[22], [29], [40]	3
Language comprehension	[8], [39]	2
Spoken	[30]	1
Visual perception	[31]	1
Decoding skills	[9]	1
Problems in vocabulary acquisition	[36]	1
Speech	[45]	1
Verbal memory	[20]	1
Alphabetic awareness	[20]	1
Receptive language	[20]	1
Print awareness	[20]	1
Word learning	[41]	1
Number-based information and math	[33]	1

Based on Table 3, reading skill is the most dominant variable studied in research involving games for dyslexic children. So far, research on reading skills shows that the use of games among students improves their reading skills significantly [6], [14], [23], [24], [25], [38], [44].

4. Discussion

Basic reading skills are one form of reading difficulty experienced by students with dyslexia. Not only basic reading skills, reading difficulties also include reading fluency and reading comprehension [47]. Farris [47] also explained that to measure students' reading abilities, a word reading skills and decoding test is needed where students are asked to read words ranging from simple ones to increasing difficulty. Students' decoding abilities can be measured by providing several words with almost the same spelling. Pedroli [42] developed an application to help students improve their decoding and spelling skills through various learning activities and exercises in games.

Spelling is a student skill that supports students' reading abilities. Meanwhile, spelling abilities themselves can be supported by students' abilities in alphabetic awareness and print awareness. Therefore, students' alphabetic and print awareness is one of the abilities that also needs to be considered. In this case, it was able to overcome dyslexia students' difficulties in alphabetic and print awareness through a game that was created [3]. So students can improve their reading skills. Several researchers have studied the use of games in measuring and/or improving students' spelling skills [5], [8], [42], [44]. Dymora and Niemiec developed a game to improve students' spelling skills, which includes a menu for practicing spelling, playing games, and doing practice questions [37].

Furthermore, Rodriguez-Ferrer [6] explained that the use of games also affects their academic performance . Academic performance in this case is related to several skills such as reading, writing, calculating, and solving problems.

Improving the academic performance of students with dyslexia goes hand in hand with improving students' reading skills so that students no longer have difficulty participating in learning. In addition, Brennan [3] explained that the use of the game had a positive impact on students' phonological awareness skills. Phonological awareness is related to students' oral language skills. Several researchers studied the phonological awareness of dyslexic students using games [3], [14], [37]. The research results show that the use of games designed to measure students' phonological awareness improves students' learning abilities, especially in overcoming their difficulties in recognizing letters [4]. This can happen because indirectly, students can control their attention when playing the game. The ability to control attention is also one of the variables most studied after reading. Games developed to improve students' skills in controlling attention are designed with conditions as similar as possible to students' real-life experiences [42]. So that students do not feel unfamiliar with the situations or conditions displayed in the game and can train students' problem solving which can also indirectly train students' writing skills and learning skills. Apart from several general skills related to reading, attention, spelling, academic performance, and learning processes, game development for dyslexia students is also widely carried out to measure other specific skills such as language comprehension, spoken word, visual perception, etc. as in Table 3. This means that it is known that the development of games specifically related to students' numeracy skills is very rare. Yildirim and Surer [33] specifically developed a game to measure number-based information and math skills. Meanwhile, other research focuses more on students' language skills and memory skills.

5. Conclusion

In conclusion, there is a tendency to select certain abilities that are enhanced with the use of games. Also obtained are the trends in the use of the subjects studied and where the researchers come from. More general and specific distribution patterns have also been revealed. The results show that most of the abilities improved by dyslexic children are reading abilities, followed by attention, perception, and spelling skills. Other abilities that are measured in smaller numbers are academic performance, phonological awareness, writing skills, learning process, and language comprehension. Meanwhile, abilities that are rarely revealed along with the use of games for children with dyslexia are spoken word, visual perception, decoding skills, problems in vocabulary acquisition, speech, verbal memory, alphabetic awareness, receptive language, print

awareness, word learning, and number-based information and mathematics. Of course, this can be a consideration for further research to develop their research and show the novelty of the research they have. However, it does not rule out the possibility that many researchers prefer abilities that have been widely researched by other people.

In future research, it is necessary to consider the implementation of research aimed at optimizing cognitive and non-cognitive factors in their learning experience. This is based on the fact that optimizing children's intelligence requires a two-sided approach, not just one.

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