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Examining the Role of Gamification in Enhancing Students' Interest and Engagement in the Science Classroom in Cross River State, Nigeria

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Abstract

The study examined the role of gamification in enhancing students' interest and engagement in science classrooms in Cross River State. Specifically, the study identified the types of gamification to be integrated into teaching science subjects in secondary schools; and the roles of gamification in enhancing secondary school students' interest and engagement in science classroom. The research questions in line with the specific objectives guided the study. The study used a descriptive survey research. It was carried out in Cross River State, Nigeria. The population for the study was 250 science teachers selected from 25 public secondary schools in Cross River State. Structured questionnaire consisting of 33 items were used for data collection. The instrument was face validated by three experts. Cronbach alpha reliability method was used to determine the internal consistency of the instrument and it yielded a reliability coefficient of 0.82. Data collection was done by the researcher and three trained research assistants. Data analysis was carried using mean and standard deviation. The results identified ten (10) types of gamification to be integrated into teaching science subjects in secondary schools, which include: use of simulation games, use of points system for completing tasks or answering questions correctly, role-playing activities in scenarios to solve real-world problems; use of digital badges for mastering specific science concepts or skills among others. The findings further revealed twenty (20) roles of gamification in enhancing secondary school students' interest and engagement in science classroom to include: stimulating intrinsic motivation through engaging narratives and rewards, encouraging teamwork and collaborative problem-solving among students, helping students identify strengths and areas for improvement, enhancing students critical thinking and problem solving abilities, boosting overall class participation and enthusiasm among others. Based on the findings, the study concluded that gamification is not a luxury but a necessity in modern science classrooms. It was therefore recommended among others that science teachers should be encouraged to incorporate gamifications in teaching and learning science subjects in secondary schools in Cross River State.

Keywords: Gamification, Enhancing, Students Interest, Engagement, Science Classroom, Secondary Schools.

Introduction

In Nigeria, the teaching and learning of science subjects often face challenges, including student disengagement and traditional pedagogical approaches that do not cater to diverse learning needs (Osakwe, 2021). These challenges necessitate the exploration of pedagogical innovations such as the use of gamification. Gamification, the integration of game-design elements in non-game contexts, has gained significant attention in educational settings, particularly in enhancing student interest and engagement. Gamification has been posited as a viable strategy to address these challenges by fostering a more interactive and motivational learning environment (Dichev & Dicheva, 2020). Research demonstrates that the use of gamification can significantly boost student interest and engagement by making learning experiences more enjoyable, thereby promoting deeper involvement in science classroom (Kapp, 2019).

A science classroom is a student-centered learning environment where students actively engage in scientific inquiry and develop critical thinking, problem-solving skills, and high-level cognitive skills (National Science Teachers Association, 2021). This emphasizes the importance of a classroom that

encourages active student participation rather than passive absorption of information. In a student-centered environment, students take an active role in their learning, often through hands-on experiments and collaborative projects that build critical thinking skills essential for future scientific endeavors. A science classroom can also be defined as a space where students construct their understanding of science concepts through hands-on experiments, collaborative discussions, and reflective practices (Kuhlthau, 2020). This is deeply rooted in constructivist principles, which posit that learners construct their own understanding based on experiences and reflections. According to Slotta and Chi (2018), a science classroom can be described as a community of learners where students learn through investigation, experimentation, and collaboration to apply scientific concepts and practices. This positions the science classroom as a community where learning is facilitated through investigation and experimentation. A science classroom is characterized as an environment that supports students in engaging with content through inquiry-based learning, integrating science with real-world applications. When the learning is learner centred and applicable to real life issues, the students become more interested in learning.

Interest is as a psychological state that is characterized by the focus of attention and the investment of cognitive resources toward a particular topic or subject area (Hidi & Renninger, 2020). It emphasizes the dynamic nature of interest, suggesting that it is not a static trait but rather a state that can fluctuate based on situational factors. When students find a subject appealing, they are more likely to engage deeply and dedicate cognitive resources to learning As stated by Schiefele et al. (2021), interest can also be viewed as a relatively stable personal trait that reflects individuals' preferences, tendencies, and motivations to engage with certain content or activities. This trait-based definition implies that students possess stable interests that guide their choices and behaviors over time. These interests can influence not just academic performance but also career paths and lifelong learning pursuits. Understanding individual interests is crucial for educators as they can tailor learning experiences to align with students' predispositions, thus fostering greater engagement and commitment (Schiefele et al. 2021). According to Raufelder et al. (2020), student interest is a significant predictor of academic engagement, suggesting that students who express higher interest in their studies tend to demonstrate greater involvement and participation in learning activities. When students display an active interest in a subject, they are more likely to collaborate with peers and engage meaningfully.

Student engagement is the degree of attention, curiosity, interest, and passion that students show when they are learning, and how it transcends into their experiences in the educational environment (López et al., 2021). This emphasizes the multifaceted nature of student engagement, which extends beyond mere participation in classroom activities. It involves emotional, cognitive, and behavioral dimensions. When students are engaged, they are not only present physically but are also invested emotionally and intellectually in what they are learning. Student engagement is defined as the active participation of students in their learning process, which includes behavioral, emotional, and cognitive involvement in academic activities (Fredricks et al., 2020). The authors break down engagement into three components: behavioral (participation in activities), emotional (students' feelings towards their learning), and cognitive (the extent to which students are invested intellectually). Student engagement refers to how students connect with their educational environment, signifying a dynamic interaction between student characteristics, curriculum, and pedagogical practices (Kahu, 2020). It involves a complex interplay between student attributes (such as motivation, resilience, and demographics), the curriculum (what is being taught), and pedagogical practices (how it is taught). This perspective acknowledges that engagement can vary significantly across different students and learning contexts, emphasizing the need for tailored educational strategies such as the integration of gamification in the teaching and learning processes to boost engagement levels.

Gamification is the use of game design elements in non-game contexts to engage users and solve problems (Werbach & Hunter, 2020). This emphasizes applying game mechanics like points, badges, levels, or leaderboards outside of traditional games such as in education or the workplace. The goal is to increase user motivation, enhance focus, and improve engagement. Gamification can also be referred to as

the application of game-design elements such as points, leaderboards, challenges, rewards, and competition in non-game settings like education to improve learner motivation and engagement (Mavridis & Tsiatsos, 2022). Unlike traditional instruction, gamification taps into students' intrinsic and extrinsic motivators, making learning more interactive, enjoyable, and goal-oriented. According to Landers (2022), gamification refers to the strategic use of game mechanics and dynamics to solve problems in non-game contexts. This brings attention to the strategic application of game features to address specific challenges within various fields such as education. In education, gamification can be seen as the strategic integration of game-like elements into classroom teaching and learning for enhanced students' participation and learning.

Gamification in education, particularly in science classrooms, has been recognized for its potential to enhance students' interest and engagement. According to Hamari et al (2020), gamification has been shown to significantly boost students' motivation to participate in science learning activities. By incorporating game-like elements such as points, leaderboards, and rewards, students feel compelled to engage and strive for better performance. Also, Chen & Chang (2021) stated that gamification often incorporates team-based challenges, fostering collaboration among students. This peer interaction can improve problem-solving skills and encourage knowledge sharing in science topics. Furthermore, the application of gamification techniques as noted by Bodnar and Kahn (2020) can lead to increased retention of knowledge, as game mechanics often promote active learning and repeated exposure to content, which is critical in complex subjects like science. In the science classroom, gamification can be used to reinforce difficult concepts, foster teamwork, and promote sustained attention especially among students with short attention spans or negative attitudes toward science. The use of games in classroom teaching and learning often provide immediate feedback on student performance, allowing learners to understand their mistakes promptly and learn from them (Kapp, 2020). This aspect is crucial in science education, where concepts can be complex and nuanced.

Several studies have illustrated the effectiveness of gamified learning environments in enhancing academic performance and fostering positive attitudes toward learning (Hamari et al., 2016). Particularly, the use of game mechanics, such as point scoring, leadership boards, role playing and challenges, has been linked to improved engagement levels, suggesting that incorporating these elements into science classroom could transform students' educational experiences (Liu et al., 2021). Furthermore, understanding the cultural context is crucial when implementing gamification strategies in Nigerian classrooms. Gamified learning approaches should be culturally responsive to ensure they resonate with local students, helping to maintain interest and engagement in science subjects (Aguti & Haruna, 2021). Engaging educators, policymakers, and researchers in this conversation is vital, as it aligns with broader educational goals within Nigeria. Also, it promotes STEM education and prepares students for a competitive global workforce especially in regions like Cross River State, where educational outcomes need improvement (Ekanem et al., 2021).

In Cross River State, where many students are in under-resourced schools and teachers rely heavily on teacher-centered methods (Okon & Essien, 2022), gamification offers a cost-effective and scalable way to reinvigorate science learning. According to Yusuf & Afolabi (2023), one of the critical factors affecting student learning in science is the lack of engaging instructional strategies. Traditional methods such as lecture and rote memorization dominate science instruction, failing to cater to diverse learning needs or stimulate student interest. This outdated pedagogy has contributed to consistently poor performance of some students in science subjects in national examinations. However, despite its potential, there is limited empirical data on the systematic use of gamification in science education across the state especially in science classroom. Also, most schools lack structured implementation models, and many teachers have little or no training on how to integrate gamification into existing curricula (Aramide, 2020). Therefore, this study sought to examine the role of gamification in enhancing students' interest and engagement in science classrooms within Cross River State.

Statement of the Problem

The integration of gamification in educational contexts has been increasingly recognized as a vital tool for enhancing student engagement and interest, particularly in subjects that may be perceived as challenging, such as science. In Cross River State, Nigeria, the traditional teaching methodologies often fall short of stimulating students' interest in science subjects, leading to low engagement levels and poor academic performance. Recent studies indicate that a significant number of students in Nigeria exhibit a lack of motivation towards science learning, which is evident in the dismal performance recorded in national examinations (Aramide, 2020; Uddin & Uba, 2022). Furthermore, with the rapid technological advancements and the shift towards digital learning environments, there is a pressing need to explore innovative strategies that harness the potential of game-based learning. Gamification, characterized by the application of game-design elements in non-game contexts, has shown promise in transforming learning experiences and fostering greater engagement among students (Olaniyi et al., 2021).

Despite the pronounced potential of gamification in education, its empirical application and efficacy in enhancing student interest and engagement in the science classroom remain underexplored in Cross River State. There exists a knowledge gap specific to the implementation of gamification strategies in science education within the Nigerian context, particularly in Cross River State, where educational resources and infrastructure may differ significantly from urban centers like Lagos or Abuja (Eze, 2023). Therefore, examining this phenomenon is crucial as it could potentially inform teaching practices and educational policies aimed at improving the overall academic enthusiasm and outcomes of students in science subjects. Hence, this study field aimed at examining the role of gamification in enhancing students' interest and engagement in science classrooms within Cross River State.

Research Objectives

The main objective of this study is to examine the role of gamification in enhancing students' interest and engagement in science classrooms within Cross River State. Specifically, the study examined the:

1. types of gamification to be integrated into teaching science subjects in secondary schools in Cross River State; and
2. roles of gamification in enhancing secondary school students' interest and engagement in science classroom

Research Questions

The following research questions guided the study:

1. What are the types of gamification to be integrated into teaching science subjects in secondary schools in Cross River State?
2. What are the roles of gamification in enhancing secondary school students' interest and engagement in science classroom?

Research Methodology

The study used a descriptive survey research. It was carried out in Cross River State, Nigeria. The population for the study was 250 science teachers selected from 25 public secondary schools in Cross River State. The secondary schools selected for the study cut across the five educational zones in Cross River State. The educational zones are: Calabar, Ikom, Ogoja, Obudu and Ugep; and five (5) public secondary schools were selected in each of the education zone in the state. Also, the science teachers selected include: Biology teachers, Chemistry teachers, Physics Teachers and Basic Science teachers. A total of ten (10) teachers were selected from each of the secondary schools, making it fifty (50) science teachers from one education zone. There was no sampling because the entire population was size and manageable.

Structured questionnaire consisting of 33 items were used for data collection. The questionnaire was divided into two parts. Part 1 sought personal information about the respondents while Part 2 was further divided into two sections A and B, with each section soliciting responses on a particular research question. The instrument was structured into four-point response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with assigned weights of 4, 3, 2, and 1 respectively.

The structured questionnaire was face validated by three experts in the Department of Biology Education, University of Calabar, Cross River State. Further, the reliability of the questionnaire was determined using Cronbach Alpha method. Thirty (30) copies of the validated questionnaire were trial tested by administering to secondary school science teachers Akwa-Ibom State. The completed instruments were collected and analyzed, and it yielded a reliability coefficient of 0.82, which showed that the questionnaire was reliable and can be used to collect the desired data from the respondents.

Data collection was done by the researcher and three trained research assistants. A total of 250 copies of the questionnaire were administered to the secondary school science teachers in the study area. At the end, only 235 of the instruments were retrieved and used for data analysis. Data analysis was carried using mean and standard deviation. Mean was used to answer the three research questions; while standard deviation was used to determine how close or far the respondents were to the mean and to one another. The cut-off point of 2.50 was used for decision-making regarding the mean. The decision rule was that any item with a mean rating of 2.50 and above was accepted while any item with mean value less than 2.50 was rejected. All the data analyses were carried out with the use of statistical package for Social Sciences (SPSS) 25.0 version.

Presentation of Results

Table 1: Mean Responses and Standard Deviation Analysis on the types of gamification to be integrated into teaching science subjects in secondary schools in Cross River State

S/N	Items on the types of gamification to be integrated into teaching science subjects in secondary schools include:	$\bar{X}$	SD	Rmks
1	Simulation games (use digital or board games to simulate scientific processes for experiential learning	2.84	0.81	Agreed
2	Use of points system (for rewarding students with points for completing tasks or answering questions correctly)	2.69	0.90	Agreed
3	Role-playing activities (allowing students to take on roles in scenarios to solve real-world problems	3.11	0.66	Agreed
4	Team-based competitions (organizing science challenges between groups to foster collaboration while learning)	3.02	0.52	Agreed
5	Use of digital badges (awarding badges for mastering specific science concepts or skills, which students can showcase)	3.00	0.89	Agreed
6	Puzzles and escape rooms game (designing science-themed puzzles and escape rooms that require teamwork and problem-solving skills)	2.83	0.91	Agreed
7	Science fair competitions (hosting gamified science fairs where students present their projects and earn awards	3.20	0.46	Agreed
8	Time-based challenges (implementing timed quizzes or experiments to encourage quick thinking and application of knowledge)	2.88	0.60	Agreed
9	Peer teaching projects (creating opportunities for students to teach each other science topics through fun games or activities)	3.03	0.79	Agreed
10		2.45	0.76	Disagreed
11	Use of rewards systems (implementing a system where students earn points for participation, collaboration, or successful completion of tasks)	2.98	0.99	Agreed
12	Card games (designing educational card games centred around scientific principles)	2.40	0.80	Disagreed
13	Spin-the-wheel quizzes (random question generation for enhancing students engagement)	3.12	0.86	Disagreed

Key: $\bar{X}$ = Mean; SD = Standard Deviation, Total Population = 235

Table 1 result showed the mean responses and standard deviation of the different types of gamifications to be integrated into teaching science subjects in secondary schools in Cross River State. The result revealed that 10 items (items 1, 2, 3, 4, 5, 6, 7, 8, 9, and 11) out of the 13 items recorded mean values above 2.50 cut of

mark, which implied that the respondents agreed that the 10 items are the types of gamification to be integrated into teaching science subjects in secondary schools in Cross River State. However, 3 items (items 10, 12, and 13) obtained mean values below cut of point of 2.50, indicating that the respondents disagreed that the three items are not the types of gamifications to be integrated into teaching science subjects in secondary schools in Cross River State. Furthermore, the corresponding standard deviation to each of the items ranged from 0.46 to 0.99, implying that the opinions of the respondents were not far from each other.

Table 2: Mean Responses and Standard Deviation Analysis on the roles of gamification in enhancing secondary school students' interest and engagement in science classroom in Cross River State

S/N	Roles of gamification in enhancing secondary school students' interest and engagement in science classroom include gamifications:	$\bar{x}$	SD	Rmks
1	stimulate intrinsic motivation through engaging narratives and rewards	3.12	0.90	Agreed
2	encourage teamwork and collaborative problem-solving among students	3.01	0.60	Agreed
3	help students identify strengths and areas for improvement.	3.20	0.67	Agreed
4	enhance students critical thinking and problem solving abilities	3.06	0.90	Agreed
5	boost overall class participation and enthusiasm	3.09	0.77	Agreed
6	enhance various skills, including communication, leadership, and scientific inquiry.	3.14	0.77	Agreed
7	link classroom learning to real-world applications of science	2.60	0.85	Agreed
8	encourage students to persevere through challenges in a fun way, fostering grit	3.20	0.67	Agreed
9	demonstrate that failure is part of the learning process, making it less intimidating	3.11	0.97	Agreed
10	drive excited involvement in learning activities.	3.10	0.98	Agreed
11	often lead to better retention of scientific concepts and principles	2.78	0.87	Agreed
12	encourage students to become more adept at using technology for learning	3.44	1.10	Agreed
13	transform the learning process into a fun experience thereby instilling passion for science	2.99	0.67	Agreed
14	lead to varied instructional strategies, keeping the classroom environment dynamic.	2.98	0.51	Agreed
15	build a sense of community through collaborative games and challenges	3.00	0.68	Agreed
16	encourage teachers to adapt and refine teaching strategies based on student performance and engagement	3.20	0.87	Agreed
17	boost motivation through rewards and recognition	2.76	0.80	Agreed
18	promote active participation during lessons	3.14	0.66	Agreed
19	increase academic performance in science	3.28	0.83	Agreed
20	build teamwork and communication skills	3.03	1.09	Agreed

Key: $\bar{X}$ = Mean; SD = Standard Deviation, Total Population = 235

The data presented in Table 2 on the mean responses and standard deviation of the roles of gamification in enhancing secondary school students' interest and engagement in science classroom in Cross River State indicated that all the 20 items obtained mean responses ranging from 2.60 to 3.28, which is above 2.50 cut of point. This implied that the respondents agreed that all the items are the roles of gamification in enhancing secondary school students' interest and engagement in science classroom in Cross River State. In addition, the corresponding standard deviation for all the items ranged from 0.51 to 1.10, indicating that the respondents were very close to the mean and not far from one another in their responses.

Discussion of Findings

The results presented in Table 1 identified ten (10) types of gamification to be integrated into teaching science subjects in secondary schools in Cross River State, Nigeria. The gamifications identified are: use of simulation games to simulate scientific processes for experiential learning; use of points system for completing tasks or answering questions correctly; role-playing activities in scenarios to solve real-world problems; team-based competitions between groups to foster collaboration while learning; use of digital badges for mastering specific science concepts or skills, which students can showcase; puzzles and escape rooms game that require teamwork and problem-solving skills; science fair competitions where students present their projects and earn awards; time-based challenges to encourage quick thinking and application of knowledge; peer teaching projects for students to teach each other science topics through fun games or activities; and use of rewards systems where students earn points for participation, collaboration, or successful completion of tasks.

The findings on the use of points system for completing tasks or answering questions correctly aligns and the use of digital badges for mastering specific science concepts or skills align with Seaborn and Fels (2020), who stated that awarding points and badges for completing tasks, experiments, or quizzes can create a sense of achievement and motivate students to participate actively. According to Kapp (2020), students earn digital badges for mastering specific skills or completing projects, which not only provides recognition but also encourages continuous learning and achievement. For example, students in Cross River State could earn badges for mastering topics like the periodic table or completing a physics experiment successfully. This fosters a competitive but enjoyable learning environment. Also, the finding on the use of simulation games to simulate scientific processes for experiential learning conforms with Rojas-Drummond and Patiño (2021), who opined that the use computer simulations to create immersive experiences where students can conduct virtual experiments allows for exploration and learning in a controlled environment. Assigning points for completing tasks in these simulations makes learning engaging while reinforcing complex topics like electricity or molecular interactions. Furthermore, the result on the role-playing activities in scenarios to solve real-world problems is in line with Hamari et al. (2020), who buttressed that the use of role playing help in creating scenarios where students assume roles related to scientific concepts. Students can assume the roles of scientists or researchers to solve real-world problems. For instance, a biology lesson could involve students acting as ecologists working to restore a damaged ecosystem. This encourages them to engage creatively and collaboratively with the subject matter.

The data presented in Table 2 revealed twenty (20) roles of gamification in enhancing secondary school students' interest and engagement in science classroom. The roles revealed are that gamification: stimulate intrinsic motivation through engaging narratives and rewards; encourage teamwork and collaborative problem-solving among students; help students identify strengths and areas for improvement; enhance students critical thinking and problem solving abilities; boost overall class participation and enthusiasm; enhance various skills, including communication, leadership, and scientific inquiry; link classroom learning to real-world applications of science; encourage students to persevere through challenges in a fun way, fostering grit; demonstrate that failure is part of the learning process, making it less intimidating; drive excited involvement in learning activities.; often lead to better retention of scientific concepts and principles; encourage students to become more adept at using technology for learning; transform the learning process into a fun experience thereby instilling passion for science; lead to varied instructional strategies, keeping the classroom environment dynamic; build a sense of community through collaborative games and challenges; encourage teachers to adapt and refine teaching strategies based on student performance and engagement; boost motivation through rewards and recognition; promote active participation during lessons; increase academic performance in science; and build teamwork and communication skills.

The result on gamification encourage teamwork and collaborative problem-solving among students is in support of Chen & Chang (2021), who maintained that gamification often incorporates team-based challenges, which helps in fostering students' collaborative learning. The authors further stated gamification cam also help improve problem-solving skills and encourage knowledge sharing in science topics. According to Balaskas (2023), gamified activities in science classrooms promote critical thinking

and problem-solving by presenting challenges that require analytical reasoning. For instance, gamified quizzes and puzzles can help students understand complex scientific concepts like genetics or chemical reactions. In addition, the finding on gamification often lead to better retention of scientific concepts and principles is in accordance with Bodnar and Kahn (2020), who stressed that the application of gamification techniques can lead to increased retention of knowledge, as game mechanics often promote active learning and repeated exposure to content, which is critical in complex subjects like science. Zhao et al (2021), noted that the use of gamification such as interactive simulations improve the retention of scientific concepts by linking them to memorable experiences. For example, a game about the water cycle could help students remember its stages more vividly. Furthermore, the finding on gamifications enhance students critical thinking and problem solving abilities strengthens Zainuddin and Perera, (2021), who pointed out that the use of gamification in teaching and learning processes encourages strategic thinking and problem-solving abilities among students in the sciences. According to Balaskas (2023), gamified activities in science classrooms promote critical thinking and problem-solving by presenting challenges that require analytical reasoning. For instance, gamified quizzes and puzzles can help students understand complex scientific concepts like genetics or chemical reactions. By engaging in game scenarios that require analysis and decision-making, students can develop these skills in a supportive environment.

Conclusion

Gamification offers a practical, innovative approach to addressing persistent challenges in science education, particularly low student interest and engagement. Through mechanisms such as point systems, digital badges, quizzes, and interactive games, students are encouraged to actively participate, collaborate, and retain information more effectively. The study highlights the potential of gamification to enhance student interest and engagement in science classrooms in Cross River State, Nigeria. The findings suggest that gamification can increase student motivation, participation, and academic performance in science subjects. This study further recognizes that while gamification is not yet widely adopted in the region, its application can significantly transform the science learning experience when properly implemented.

However, for this potential to be realized, teachers must be equipped with both the skills and support systems needed to adopt gamification tools. Policy makers and stakeholders must also commit to providing the resources and infrastructure necessary to facilitate digital learning strategies. In conclusion, gamification is not a luxury but a necessity in modern science classrooms. Its consistent and context-appropriate application can help bridge the gap between student disinterest and meaningful engagement, ultimately contributing to improved science learning outcomes in Cross River State. Overall, the implications of this research extend beyond the immediate classroom, influencing the broader educational landscape and potentially shaping the future of science education in Cross River State and Nigeria at large.

Recommendations

Based on the findings, the study recommended the following:

1. The Ministry of Education in Cross River State through curriculum planners should develop science curricula that include gamified elements, ensuring they are engaging and relevant to students' interests.
2. Science teachers should be encouraged to incorporate gamifications in teaching and learning science subjects in secondary schools in Cross River State.
3. There is need for Cross River State government through her State Ministry of Education to conduct professional development programs for teachers on effective integration of gamification techniques in teaching and learning of science subjects.
4. Students should be adequately involved in the selection and design of gamified elements to cultivate a sense of ownership and relevance in their learning process.

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