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Can Game-Based Learning Help to Increase the Awareness of Water Management in Uganda? A Case Study for Primary and Secondary Schools

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Abstract: In the Ugandan curriculum, theoretical teaching predominates in conveying water-related topics due to its efficiency and low resource requirements. However, this teacher-centred approach limits student interaction and collaborative learning. Conversely, game-based learning can enhance social skills, critical thinking, and engagement, yet it remains underutilised in Ugandan education. To address this gap, this study developed three educational games: Water Conservation Snakes and Ladders (WCSL), Water Awareness Quartet Cards (WAQC), and Water Pollution Puzzle (WPP). These games were implemented in four schools—three primary and one secondary—where students engaged in competitive, team-based play. The impact of these games on learning outcomes was assessed through pre- and post-test questionnaires. Descriptive and thematic analysis indicated a significant positive effect, with WAQC showing a 25% greater influence on performance than WCSL (18%) and WPP (14%). The findings also underscored the importance of age in determining game acceptability and enjoyment. To enhance education on water-related issues, it is recommended that these topics be integrated into both Science and Social Studies curricula and taught consistently across academic terms. Ultimately, the Ugandan government should consider incorporating game-based learning strategies into schools to improve student engagement and learning in water resource management.

Keywords: game-based learning; water management; board game; card game; Ugandan curriculum; science learning; social studies learning

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1. Introduction

The growing urbanisation in Uganda has contributed to the increased demand for the country's freshwater resources [1,2]. The rising demand for water has had an impact on the levels of existing freshwater resources. For example, from 1993 to 2016, the water level in Lake Victoria declined by 0.005 m each year, for a total reduction of 0.115 m [3]. As a result of this reduction, the lake's area and volume were reduced by 100 km^2 and 5 km^3, respectively [3]. This emphasises the necessity for sustainable water management methods and investment in water-saving measures. Environmental Education (EE) for sustainable development is emerging as a key approach to motivate students to conserve and protect water resources [4]. EE involves topics such as water sources, water access at homes and community level, water pollution, water demand and supply. All are among the important topics that are taught under the theme of water in the Ugandan curriculum [5,6]. Theoretical training is the approach commonly used when teaching water-related topics in Ugandan schools [7]. It offers the ability to disseminate large amounts of information in a short period of time [8], and this approach further helps students absorb more content about conserving water resources by reading textbooks and listening to their teachers [9]. However, this kind of teaching lends itself better to short-term learning, with Riyad et al. [8] suggesting that students retain such knowledge on average for 1–2 months. Furthermore, theoretical education is recognised as a teacher-centred method, whereby teachers provide the required information, and the students passively receive it [10]. When this strategy is adopted, the learning experience is controlled by the teachers, and students tend to have fewer opportunities to interact with others and share their opinions [11]. On the other hand, game-based learning is a student-centred approach that helps the learner to obtain usable knowledge while developing a wider range of skills [12,13]. Particularly, this approach enables students to develop social skills, engage in critical thinking, and nurture attention and concentration, culminating in the building of long-term memories through providing continuous and personalised feedback and developing emotional skills [14,15]. Game-based learning provides students with the opportunity to be participants rather than passive observers [16], as they learn via participating in game activities, forging their problem-solving and decision-making skills. Game-based learning can enable students an opportunity to repeat failed tasks and correct previous mistakes [17,18] allowing the initial negative experience to be transformed into a final success [18]. There are no fundamental guidelines with which games can designed because everything depends on the goal and knowledge that teachers would like students to achieve in their specific topic [19,20].

Although game-based learning has several advantages, as previously described, it also has some flaws. Games require time and effort when participating in them [21,22] and also when designing, testing and implementing them [23]. Ballou and Deterding [24] suggest that planning sessions when using game-based learning is challenging because the nature of the approach means that activities can vary in length. This may affect the capacity to adequately cover curriculum content, as well as lead to frustration among students when they are unable to complete games in class. The nature of gaming as a form of entertainment can lead to challenges for some students in attaining knowledge because they may not take the game seriously as a learning tool [25].

Board and card games are among the most popular non-digital games, and they are played by people of all age groups [16,26]. Success in educational games is based more on ability and knowledge than on competitiveness. They can be used in game-based learning to develop academic knowledge [27–29]. Previous studies have already confirmed this in various subjects such as Environment Sciences, Chemistry, English Language, Health Science and Engineering [30,31]. Board and card games have produced excellent results at the Undergraduate and Master's levels [32] when used alongside a more varied and traditional curriculum approach. Gutierrez's [29] study on the development of an educational card game as Supplementary Material for comprehending selected themes in biology revealed that students found the game to be very pleasant and successful in boosting learning and improving concept recall. Additionally, a study by Kurisu et al. [33] on the development of a board game to encourage life cycle thinking among university students in Japan in relation to their daily behaviours revealed that their Life Cycle Thinking (LCT) knowledge increased significantly after playing the game, and the participants rated the game positively in terms of satisfaction and relevance to daily life.

Thus, considering their benefits, they could be adopted to help students better understand how to manage freshwater resources in Uganda, supporting government and private industrial efforts in targeting a more sustainable world and more efficient use of water resources. To date, board and card games that focus on water resources have been used and tested at different levels in education settings. For example, the Wash Quartet card game promotes water recycling and hygienic practices at schools in Ethiopia [34], the Water Ark board game simulates the use and allocation of water resources [14,35], and the Crazy Water board game simulates residents' water habits in their daily lives [14]. However, there are limited studies about game-based learning on increasing the awareness of the students on water resource management in Uganda. To fill this gap, this study would like to design and use both board and card games to achieve this goal in Uganda, filling the space left out by theoretical teaching being the main method used to inform and educate about water-related topics in the Ugandan education system. To fill this void, three games (WCSL), (WAQC) and (WPP) were designed with the specific purpose of increasing student awareness of freshwater resource management in Uganda, and they have been tested in various schools, at both primary and secondary levels, to identify the impact they can have on learning linked with this topic.

2. Materials and Methods

2.1. Data Collection

To conduct this study, research was undertaken with primary and secondary students. A mixed methodological approach was used in the study, integrating both quantitative and qualitative techniques to collect data from the students. As shown in Figure 1, four schools were visited in Uganda for data collection in July–August 2023.

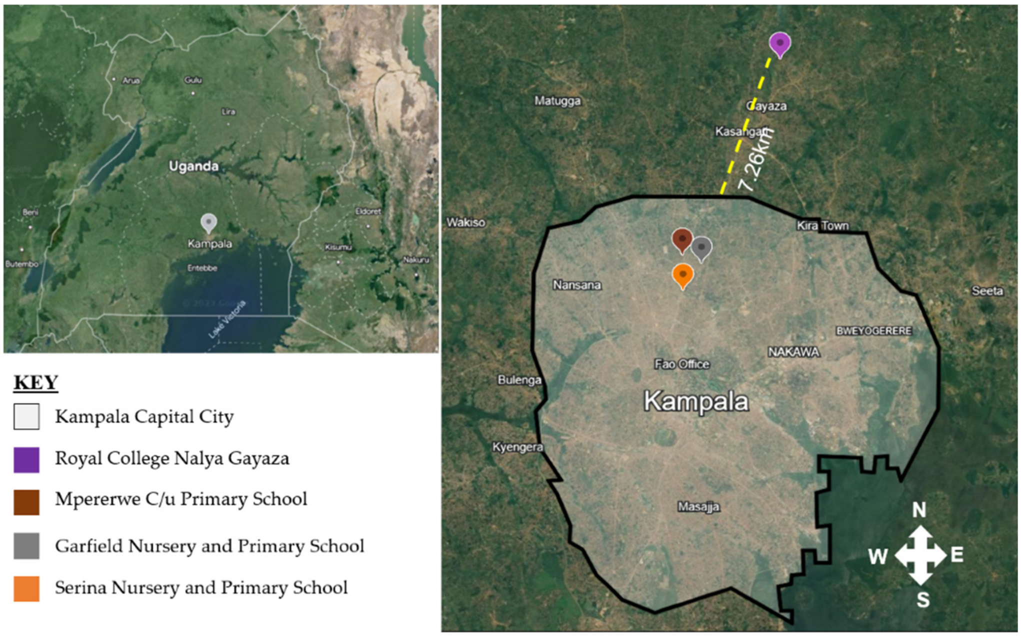

Figure 1. Map of Kampala showing the location of the schools where datasets were collected in July–August 2023.

The schools included were (i) the Royal College Nalya Gayaza, (ii) the Mperewe C/u Primary School, (iii) the Garfield Nursery and (iv) the Primary School and Serina Nursery and Primary School. These four schools were considered after an initial consideration because they were the only ones that agreed to provide the required time (1 and a half hours to 2 h) to conduct the research discussed, implement the games, and secure the answers from the students with pre and post questionnaires. All 165 students accessed within the schools chose to participate in the research, with a breakdown of 52:48 per cent, female to male students. These figures indicate that the study was well represented in terms of both genders participating almost equally. The participants' average age is 12 years old, which reflects the average age of students in Uganda in these classrooms.

2.2. Game Design and Educational Objectives

The Water Conservation Snakes and Ladders (WCSL), Water Awareness Quiz Cards (WAQC), and Water Pollution Puzzle (WPP) games were developed by the authors with explicit educational objectives aimed at imparting knowledge related to water conservation, pollution, and management. The primary objective was to create interactive and engaging educational tools that facilitate learning through play, thereby enabling students to grasp and retain complex environmental concepts more effectively. Each game was meticulously aligned with specific learning outcomes: WCSL emphasised the implications of both positive and negative water-related behaviours (e.g., conservation versus waste), WAQC fostered comprehensive knowledge of various water-related topics, and WPP introduced participants to sources of water pollution through a puzzle format. Each game was designed to strike a careful balance between enjoyment and educational content, promoting a positive disposition toward water-related subjects. This dual focus was intended to render the educational material more accessible and memorable for students.

2.2.1. Testing of the Games with Students

To assess the effectiveness of the game designs and identify areas for improvement, the authors conducted an initial round of testing with a sample group of 10 students. This cohort comprised six primary-level students (ages 10–13) and four secondary-level students (ages 13–15), all selected from their homes. The mixed-age composition facilitated feedback from students across different developmental stages, which was critical for ensuring the games' appropriateness for a diverse range of learners. During the testing phase, the authors observed the students' interactions with the games, focusing on key metrics such as engagement levels, comprehension of the rules, and retention of the educational content throughout gameplay. Furthermore, students were encouraged to provide feedback on their experiences, particularly regarding the clarity of the rules, overall enjoyment of the games, and perceived effectiveness in learning about water-related topics.

2.2.2. Identified Challenges and Adjustments

Throughout the testing process, the authors identified several areas requiring modification to enhance the educational effectiveness of the games. One significant issue arose with the Water Conservation Snakes and Ladders (WCSL) game. In its original iteration, players could reach the final box and win the game without answering any questions, undermining the educational value and failing to reinforce the learning objectives associated with water conservation consistently. In response to this concern, the authors revised the game rules so that any player who reached the finishing box was required to correctly answer a water-related question before being declared the winner. This adjustment ensured that success in the game necessitated knowledge rather than mere luck, thereby maintaining the educational focus while preserving an engaging gameplay experience.

Similarly, the Water Awareness Quiz Cards (WAQC) game initially allowed participants to request specific cards needed to complete a quartet by merely stating the title of the card desired from the opposing team. This approach inadvertently shifted participants' focus solely toward forming quartets, detracting from engagement with the educational content presented on the cards. To rectify this, the rules were modified so that when a team requested a card, they were required to accurately recite all the activities listed on that card before it could be handed over by the opposing team. Failure to do so resulted in the opposing team retaining the card and gaining the opportunity to request a card themselves. This change was implemented to ensure full engagement with the educational content while maintaining the competitive nature of the game and enhancing interactivity among participants.

The Water Pollution Puzzle (WPP) also underwent revisions following observations made during initial gameplay. Initially, students were allotted 15 min to locate pollutant-related words hidden within the puzzle. However, this duration proved excessive, as all participants easily found the words within the given timeframe, thereby diminishing the sense of competition and engagement. To address this issue and increase the game's challenge, the time limit was reduced to 7 min, with participants now required to identify pollutant words based on provided definitions within this condensed timeframe. This adjustment significantly heightened the game's competitiveness and engagement levels, compelling students to think and act more swiftly. Furthermore, the reduced time limit aligned with the practical constraints of the study, particularly the limited time available during classroom sessions. By streamlining the game in this manner, not only was the learning experience enhanced, but it was also a better fit within the structured time allocated for educational activities.

2.3. Materials and Instructions

Each game had different instructions (see Supplementary Material Document S1 for WCSL, Document S3 for WAQC and Document S4 for WPP) that students had to follow when playing. Once visiting the schools, during the first 20 minutes, a short demonstration was given to the students to familiarise them with the game and to explain the goals and the actions they could take. Students then could choose to participate in the games, and those who did began to play the games in the teams they had formed. This was important to ensure that students understood their rights as research participants, especially necessary in an institutional setting under the 'adult gaze' [36,37] of teaching staff. The detailed instructions for each game are explained in the next sections. A very small minority of students chose to withdraw from the research before the end of the activities, reinforcing the fact that they felt comfortable and understood their rights within the research process.

2.3.1. Water Conservation Snakes and Ladders

WCSL (see Supplementary Material Figure S1) was an adaptation of the traditional board game Snakes and Ladders [38]. Snakes and Ladders is a game normally played by children for entertainment purposes, and it is a tool to increase students' knowledge. Research by Nurhayati and Widodo [39] saw an increase in children's knowledge of dental and oral hygiene when using Snakes and Ladders. This benefits teachers and students as both can act as co-producers of knowledge in some sessions. Moreover, it promotes creativity among teachers as they design the game to be used, encouraging them to use more practical approaches rather than learning [40].

WCSL follows the traditional Snakes and Ladders format, where players move across the board by rolling a die. However, in this version, progress depends not only on the die roll but also on the player's knowledge of water conservation. When a player lands on a square at the base of a ladder, they must answer questions related to water-saving practices, pollution, and sustainable water management (see Supplementary Material Document S2). Correct answers allow the player to climb the ladder, symbolising positive actions like conserving water and reinforcing the idea that good water practices lead to rewards and progress. If a player provides an incorrect answer, they remain on the same square and are unable to advance up the ladder. Certain squares represent negative water behaviours, such as wasting water or contributing to pollution, marked by a snake. When a player lands on one of these squares, they must slide down the snake to the square at its tail. This setback highlights the consequences of poor water management and wasteful habits, reinforcing the importance of making responsible environmental choices.

2.3.2. Water Awareness Quartet Cards

Studies have shown that the use of quartet cards can increase the activeness of students in learning, hence improving students' learning outcomes [41,42]. Furthermore, WAQC (Supplementary Material Figure S2) have an impact beyond the classroom environment; for example, Wash Quartet Cards were employed to raise sanitation awareness at a refugee camp in Northern Uganda [43]. In terms of teaching materials, Ayriza et al. [44] found that quartet cards provide a fun experience, relaxation, and a level of challenge, which promotes students' internal learning motivation, resulting in a more engaging learning environment. The game provides pictures and words that are engaging and practical for learning water-related activities. WAQC are effective across all age groups, from young children to adolescents, making them a versatile learning tool in educational settings [45]. Quartet cards have also been effective in the evaluation of learning economics in high school [46].

Players aim to collect complete sets of four cards, known as a quartet, from their opponents. Each card within a set represents a specific water-related theme, such as water conservation techniques, pollution control measures, or organisations responsible for water management. During a player's turn, they ask a specific opponent for a card that fits within a water-related topic of their choice. For example, a player might request a card related to "organisations in charge of water" or "methods for reducing water pollution". If the opponent holds the requested card, they must hand it over; if not, the turn passes to the next player. The goal is to strategically collect all four cards in a set, reinforcing the player's knowledge of various water conservation topics along the way.

2.3.3. Water Pollution Puzzle

WPP (see Supplementary Material Figure S3) has been reported to increase the motivation of students towards lessons [47,48]. According to Kalkan's study [48], students stated that solving puzzles increases their motivation for improvement and influences them to remember the information they have learned. The board game has been an effective learning tool for mastering English vocabulary in schools [47,49], and word search puzzles can be effective as a teaching technique in nursing education [48]. WPP consisted of water pollutant words like Pesticides, Domestic waste, and Clinical waste hidden within a grid of letters. The pollutants were considered because the studies conducted by Nantaba et al. [50] and Mdegela et al. [51] showed that Lake Victoria is the main recipient of domestic, industrial, hospital and agricultural waste from Uganda.

Players were divided into two teams that competed against each other to correctly pair as many water pollution terms and definitions as possible within the allocated time of 7 min. Terms included pollutants like "domestic waste", "industrial waste", or "plastic", while their definitions explained the sources of these pollutants in water ecosystems (see Supplementary Material Document S5). At the end of the time limit, the team with the most correct matches were declared the winner. The game not only added a competitive edge to learning but also encouraged collaboration and discussion among team members as they worked together to identify correct matches. As the puzzle progressed, players gained a deeper understanding of the various sources of water pollution.

2.4. Distribution of the Games

The games were distributed to students according to their class levels. In primary schools, lower primary students and upper primary students were grouped differently to participate in the games, as shown in Figure 2. In Uganda, primary four is a transition year from lower to upper primary [52]; however, in this study, primary four students were considered in the lower primary level. This is because they are just transforming from lower primary to upper primary, meaning that they have more knowledge about lower primary teaching than upper primary. Upper primary students (primary five-seven) were also grouped together, and they had to participate in the games according to the groups they had formed.

2.5. Assessment of the Games Using Questionnaire

The effectiveness of the games as an educational tool was evaluated using pre and post-test questionnaires (see Supplementary Material Document S6–S11). This method has been adopted by previous studies (i.e., [53–57]) to evaluate the efficiency of their research. In addition, a questionnaire (see Supplementary Material Document S12) was employed to glean student feedback on the games in which they participated. Here are some examples of the questions used to obtain their responses (the rest can be found in Supplementary Material Document S12).

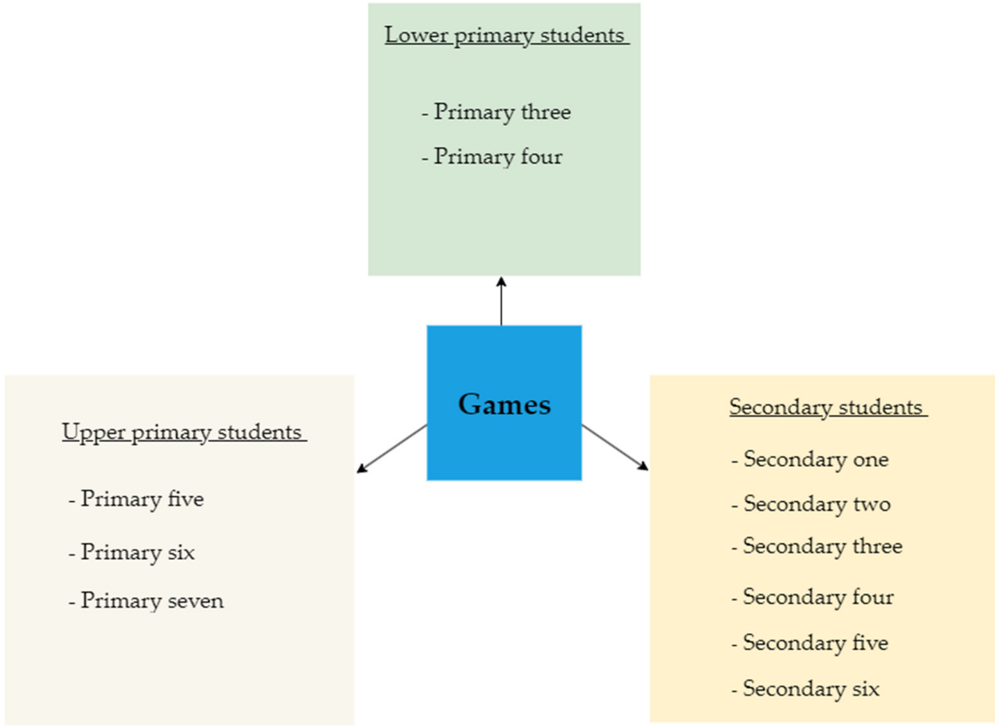

Figure 2. Grouping of students according to class levels to participate in the game activities.

5. Rank the game you enjoyed most. (1—Most enjoyed and 3—Least enjoyed).

a. 1. ____________________
   2. ____________________
   3. ____________________

10. Rank the games according to which one helped you most to learn about the activities

a. (1—Most helped and 3—Least helped)
   1. ____________________
   2. ____________________
   3. ____________________

2.6. Questionnaire Design

Each game had a pre-test and post-test questionnaire specifically designed based on the activities that were targeted. Both the pre-test and post-test consisted of 10 questions, with the first three questions in the tests always about the students' demographics (age, gender, and class level), and the remaining seven questions focused on the activities of a particular game. Some questions in the post-test were rephrased on purpose to avoid students memorising the answers.

2.6.1. Testing of the Questionnaires

As stated in Section 2.2.1, 10 students participated in the games, and the same group was used to test the questionnaires. Initially, we asked the students to rank the games using a Likert scale ranging from strongly agree to strongly disagree, focusing on which game helped them learn about water-related topics and which they enjoyed most. However, some students marked "strongly agree" for all the games, making it difficult to determine their preferences.

To improve the validity of the questionnaire and better capture the differences in the games' impact on students' learning and enjoyment, we amended the questionnaire by adding a ranking question. In this revised version, students were asked to rank the games from 1 (most enjoyable) to 3 (least enjoyable), ensuring a clearer understanding of their preferences. This adjustment also improved the reliability of the results, as it provided a more consistent and interpretable measure of student preferences across participants.

2.6.2. Distribution of Questionnaires

The pre-test and post-test questionnaires distributed to participants were the same across all class levels. After completing each game, such as WCSL, students were immediately given the corresponding post-test questionnaire before proceeding to the next game. Once they had participated in all the games and completed both the pre-test and post-test questionnaires, they were given a final opinion questionnaire designed to gather their feedback on the three games.

2.7. Ethical Considerations

Throughout the data collection process, ethical guidelines were observed. It is necessary for any study to obtain permission and consent from the participants [58]. The study was conducted in accordance with the Declaration of Helsinki, and all participants gave their informed consent for inclusion before participating in the study. The study also gained ethics approval from Coventry University, as shown in Supplementary Material Figure S4.

2.8. Data Analysis

The data obtained from the pre-test and post-test questionnaires were analysed using a descriptive statistical tool [59] in the IBM Statistical Package for Social Science (SPSS), version 28. Descriptive analysis was used to measure the frequency of the data, for example, the number of correct answers for each number in the pre-test and post-test. Cross-tabulation [60] is another tool under descriptive statistics that was used to examine the relationships within the data that were not obvious by just looking at the total responses from the study. For example, the tool was used to examine the relationship between the materials used in the games and their impact on the students' learning based on their age. To analyse the qualitative data from the questionnaire, a thematic analysis was used as an approach to identify the main messages with the text because this has been demonstrated to be a useful method across a range of research methodologies [61]. NVIVO (Release 14.23.2, Build 46) is a qualitative data analysis software [62] that was used to conduct thematic analysis.

3. Results

3.1. Effects of Games on Students' Learning

As mentioned, students were given a pre-test and post-test to complete to determine whether the games impacted their knowledge. The percentage of the correct answers per question in the pre-test and post-test for each game is presented in Table 1. To obtain the percentage of the correct answers, the formula below was used.

$$\% = \frac{x}{n} \times 100 \quad (1)$$

where x is the total number of correct answers, and n is the total number of the participants.

Table 1. Descriptive frequency of correct answers in the pre-test and post-test for the games.

	WAQC		WCSL		WPP	
Questions	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**
Q4	74%	65% ↓	62%	83% ↑	74%	90% ↑
Q5	18%	72% ↑	70%	83% ↑	83%	85% ↑
Q6	22%	68% ↑	61%	91% ↑	86%	94% ↑
Q7	47%	87% ↑	82%	82% →	56%	56% →
Q8	57%	75% ↑	39%	79% ↑	81%	91% ↑
Q9	72%	90% ↑	44%	61% ↑	77%	81% ↑
Q10	38%	44% ↑	26%	32% ↑	26%	82% ↑

Symbols meaning: ↓ Decrease in performance. ↑ Increase in performance. → Neither increase nor decrease in performance.

For each game, the mean for pre-test and post-test scores and the difference between the mean and the Probability value (*p*-value) appear in Table 2.

Table 2. Mean and *p*-value of pre-test and post-test scores for the three games.

	Mean Pre-Test Score	**Mean Post-Test Score**	**Difference (Post-Test–Pre-Test)**	***p*-Value**	**Interpretation**
WAQC	3.38	4.79	1.41	<0.001	Significant difference
WCSL	3.12	4.18	1.06	<0.001	Significant difference
WPP	4.83	5.60	0.77	<0.001	Significant difference

If the *p*-value is greater than (>) 0.05, then there is no significant difference between the test scores; however, If the *p*-value is less than or equal to (≤) 0.05, then there is a statistically significant difference between the test scores.

- Formula for Mean:

$$\overline{x} = \frac{\sum x}{n} \quad (2)$$

where $\overline{x}$ is Mean; $\sum x$ is *the* sum of all the correct answers; and n is the Total number of participants.

- Formula for Mean difference:

$$d = X_2 - X_1 \quad (3)$$

where d is Difference, X_2 is Post-test scores, and X_1 is Pre-test scores.

Wilcoxon paired test [63] was used to measure the *p*-value of the pre-test scores and the post-test scores for the games. Wilcoxon paired test was used because it is a non-parametric statistical test used to compare paired samples such as pre-test and post-test measurements, and it assesses whether the ranks of the two related groups are different [64]. The significance level of (0.05) is used to define the strength of evidence to reject the null hypothesis. For this test, the null hypothesis is that there is no significant difference between the test scores.

The *p*-value of the pre-test scores and post-test scores for all the games indicates that there is a statistically significant difference between the two scores. This means that the games impacted the students' learning.

3.2. Game-Based Learning Material That Most Improved Student Performance in the Pre-Test and Post-Test

Based on the data collected, the average score for correct responses in WAQC, WCSL and WPP pre-tests was 57 per cent, but there was an improvement in the post-tests, with the average score for correct responses increasing to 76 per cent. WAQC's average score increased by 25 per cent between the pre-test and post-test, and it was the highest average score compared to 18 per cent in WCSL and 14 per cent in WPP, as shown in Figure 3. This indicates that WAQC had the highest impact on the students' learning. The content being tested differed between games, and this could have influenced the students' performance. When students were asked to provide an opinion on the games they participated in, 70 per cent of the students strongly agreed that WCSL helped them to learn about water activities, compared to 67 per cent for WAQC and 62 per cent for WPP, who strongly agreed that these game materials helped them. A lack of similarity between game results and student opinion can arise due to misunderstanding of game processes [65].

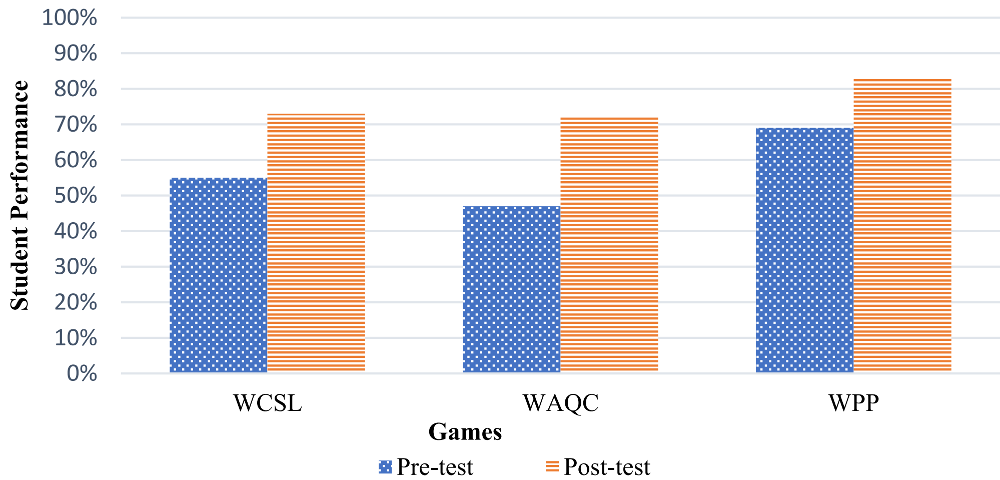

Figure 3. Impact of game materials on student's correct responses in the tests.

Therefore, improving the final design of the games and providing guidance on how to understand the game content can help students form more informed opinions [55]. When asked to define each game using three words in an open-ended question, students described WCSL, WAQC, and WPP as "Educative" resources. According to the students' opinion in (see Supplementary Material Document S12, Question 11), the word Educative appeared 94 times (57 per cent) while characterising the games, indicating positive results, which is because the games were designed to educate students about water activities.

In addition, the other most frequent positive words that were used to describe the games were Good, Interesting and Fun, as shown in Table 3. The positive words are used to showcase that the games can attract potential players and create a sense of optimism and excitement. However, students expressed some negative feedback on the games, such as Annoying, Bad, Confusing, and Boring. Negative feedback on game-based learning can be associated with factors like the lack of clear instructions, the dependence on luck in a game and the social dynamics involved in playing the games. The lack of clear instructions on how to play the game might contribute to a negative experience, as students may struggle to understand the rules and techniques of a particular game, resulting in confusion and disengagement of an individual [22]. Ensuring clear and comprehensive explanations, along with visual aids, can help mitigate this confusion and help players understand the components and their roles in the game [66]. Games like WCSL, where players have limited control over the outcomes due to excessive reliance on dice rolls, can lead to frustration and reduced enjoyment of the game [67]. However, the presence of luck in a game can serve to balance the influence of skills, adding an element of unpredictability that prevents the same player from winning every time [68]. This can contribute to increased replay value and prevent the game from getting boring or predictable. Furthermore, the competitive nature of the games can lead to bad social behaviours among students, like cheating [69,70], as they may become overly focused on winning, potentially leading to social tension and conflict. It is important to note that the negative feedback on the games can be associated with the mentioned factors, although individual preferences can vary on a certain game. Additionally, understanding and addressing the factors can help WCSL, WAQC, and WPP be more enjoyable, improving the overall quality and reception of the game, and this will be taken into consideration for future studies.

Table 3. Students frequently used these words to characterise the games in which they participated.

Feedback	Words	Frequency (Times)	Percentage of Frequent Words Used
Positive	Good	135	82
	Interesting	120	73
	Fun	97	59
	Educative	94	57
	Happy	57	36
	Awesome	48	29
Negative	Annoying	29	18
	Bad	18	11
	Confusing	11	7
	Boring	8	5
	Hard	8	5
	Unenjoyable	3	2

3.3. Impact of Each Game on the Students' Awareness of Water Resources Management According to Their Age Group

3.3.1. WCSL

The average score for primary-level students' performance between the pre-test and post-test improved by 15 per cent compared to 4 per cent for secondary-level students. This indicates that WCSL impacted more on the students' awareness of water resources management for students in primary schools compared to those in secondary schools, as shown in Figure 4. This could be influenced by the different age groups' preferences for game-based learning [71,72]. According to the data collected, 14 per cent of the students aged 8 years most enjoyed playing WCSL, compared to 4 per cent of 19-year-old students. Furthermore, 17 per cent of 10-year-old students rated WCSL as the most beneficial game for learning about water activities, compared to 3 per cent of 18-year-old students.

The pre-test results revealed that secondary students had greater knowledge about water conservation compared to primary students. The average pre-test result for secondary students was 72 per cent, compared to 54 per cent for primary students. Furthermore, a secondary three student indicated that WCSL was her second favourite game, and she stated, "*It is because I knew all the answers, they asked me in snakes and ladders*". However, the average pre-test performance for students aged 14 and 15 years was 79 per cent, compared to 67 per cent for students aged 16 and 17 years. Water conservation themes are taught inconsistently at the secondary level, with some secondary classes missing them in specific academic terms. According to Nalumenya et al. [5], Geography has the highest occurrence (44.4 per cent) of water-related topics in the secondary school curriculum. However, water conservation topics only appear in secondary Three Term II under a topic called The Relief Regions and Drainage of Africa [73].

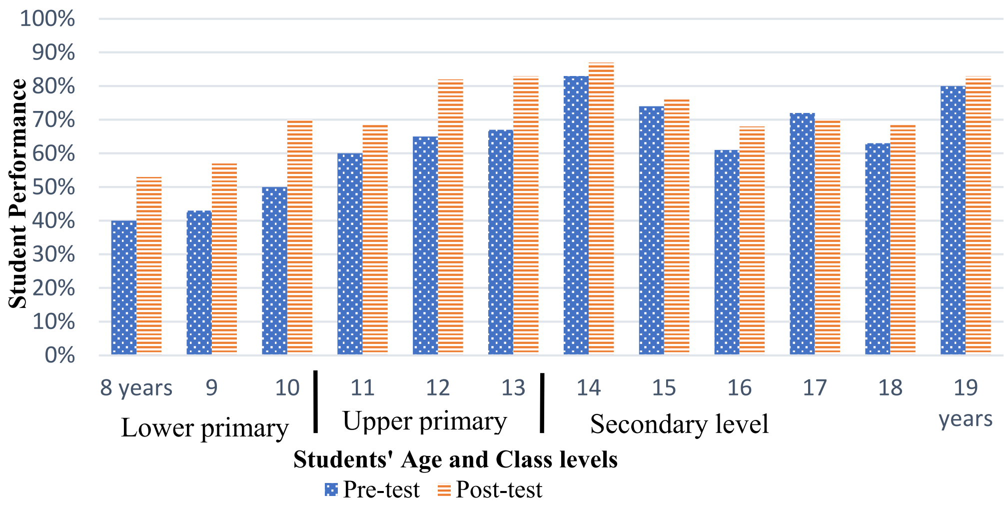

Figure 4. Impact of WCSL on students' performance according to their age in the tests.

3.3.2. WAQC

According to the findings of the pre-test and post-test, secondary students had the greatest gain in average scores between the two exams compared to primary students, as indicated in Figure 5. The average score for secondary students increased by 18 per cent between the pre-test and the post-test, while it increased by 12 per cent for primary students. At the primary level, the average score for lower primary level students increased by 2 per cent between the pre-test and the post-test compared to 23 per cent in the upper primary score increase. This indicates that WAQC had less impact on lower primary students because they scored the lowest average score increase between the pre-test and the post-test. According to the observation made when students were participating in WAQC, students in the lower primary were aiming at winning the game rather than reading the content on the cards. For example, a team of four students won by creating two quartets, namely water and environment organisation and causes of water stress. However, the four students were unable to recall all the activities listed on each of the quartet cards they had created.

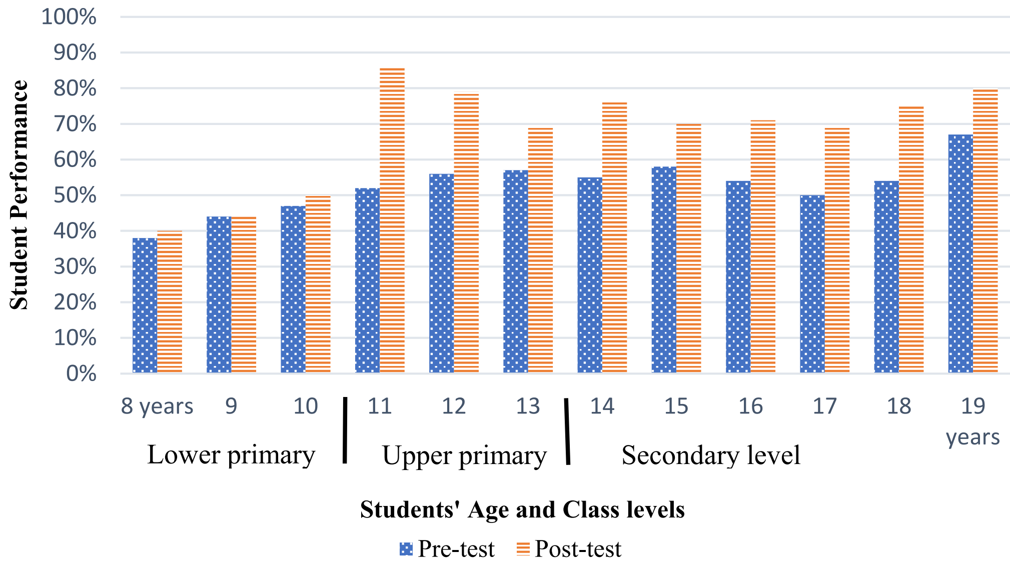

Figure 5. Impact of WAQC on students' performance according to their age in the tests.

3.3.3. WPP

As illustrated in Figure 6, WPP had an impact on the students' learning of water pollutants. According to the data collected, a primary six student ranked WPP as the most enjoyable game, and he stated, "*Pollution puzzle helped me to learn about pollutants I did not know*". Furthermore, the average score for primary students increased by 22 per cent between pre-test and post-test performance, while it increased by 10 per cent for upper primary students and 6 per cent for secondary students.

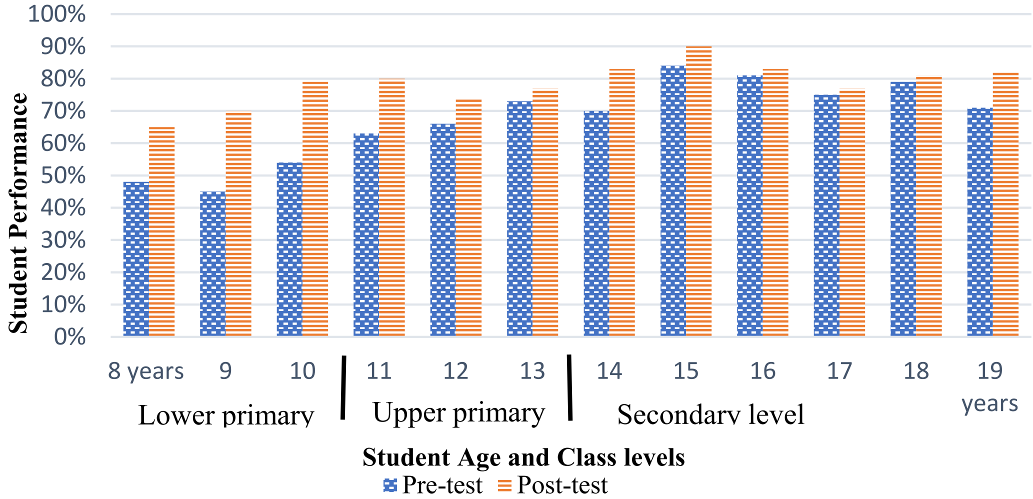

Figure 6. Impact of WPP on students' performance according to their age in the tests.

However, the data gathered also revealed that students in lower primary received the lowest average mark in their pre-test compared to students in upper primary and secondary. Lower primary students scored 49 per cent on average, upper primary students scored 67 per cent, and secondary students scored 77 per cent. The performance of students in lower primary schools indicates that water pollution topics are missing in the teaching of lower primary classes. In lower primary, inadequate water pollutant lessons (Sustainable Development Goals 6 Target 6.3 [74]) are taught; for example, in primary three, under the Sub Theme Water, urinating and putting rubbish in water sources are the only ways of contaminating water sources taught. This leaves students in lower primary ignorant about other water pollutants like climate-related, clinical, and industrial waste.

3.4. Science and Social Study Questions About Water-Related Topics Before and After the Games

The pre-test and the post-test questionnaires involved Science and Social study questions, as shown in Table 4. In the pre-test questionnaires, students scored a higher mark of 69 per cent in the Science questions compared to 52 per cent in Social study questions, as shown in Figure 7. According to the study conducted by Nalumenya et al. [5], 66 per cent of water-related lessons are in Science subjects, compared to 34 per cent in Social Studies. This higher frequency in Science helps students better understand and retain information, leading to improved learning outcomes [75]. After engaging in the games, however, students' performance improved in both the Science and Social Studies topics, with the average score for student performance increasing by 14 per cent in both tests. This indicates that the games had an impact on the student learning in both the Science and Social Studies questions.

Table 4. Science and Social Studies questions were used in the pre and post-questionnaire.

Pre and Post Questionnaire	Science Question	Social Studies Question	Supplementary Material
WCSL	Q4	Q6	Document S8 & S9
	Q5	Q7	
	Q10	Q9	
WAQC	-	Q4	Document S6 & S7
	-	Q5	
	-	Q9	
WPP	Q4	-	Document S10 & S11
	Q5	-	
	Q6	-	

Note: Q4 to Q10 refer to Questions 4 to 10 from the questionnaires as explained in Section 2.6.

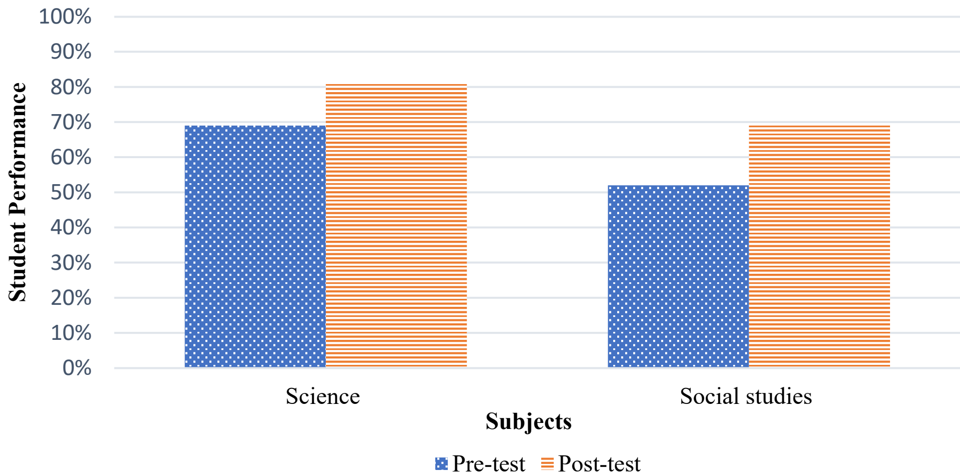

Figure 7. Students' performance in the Science and Social Studies questions.

3.4.1. Social and Scientific Questions About Water-Related Topics Before and After the Games Basing on the Students' Age

Science Questions

In the academic Term II, students participated in a pre-test for Science questions. At the primary level, students aged 12 years and 13 years performed better than other age groups, as shown in Figure 8. The analysed data indicates that 73 per cent of the students aged 13 years were in primary seven, and 27 per cent were aged 12 years. Furthermore, research by Berti [76] and Davidson et al. [77] reveals that children between the ages of 12 and 13 have substantial mental development, including the ability to understand and recall more complicated concepts, think critically, and engage in academic learning such as water resource management. Primary school in Uganda lasts seven years and is generally for children between 6 and 13 years old [78]. According to the study conducted by Nalumenya et al. [5], in the academic Term II, water-related topics in the Science subject only appeared in primary seven. This enabled the students aged 12 years and 13 years to perform better than the age group at the primary level. Students often have a fresh memory of materials that are currently being taught or previously taught [79,80]. In Primary Three, Four and Five, the water-related topics only appeared in Term I and Primary Six in Term III [5]. An individual can easily forget the material that is not sufficiently practised and reviewed [81]. Some studies have suggested that students can forget 80 per cent of the materials they have learnt within the first 24 h (i.e., [82]).

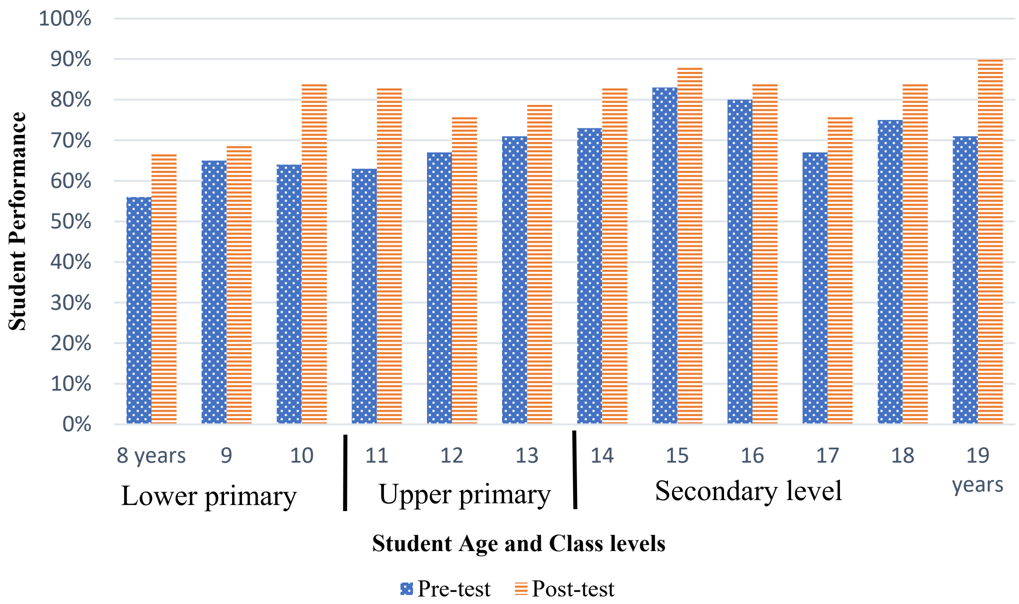

Figure 8. Students' performance in the Science questions according to their age.

Social Studies

The pre-test questionnaires contained Social Studies questions; lower primary students scored the lowest average performance (46 per cent) in the questions compared to the 50 per cent average score for upper primary students and 55 per cent for secondary students, as shown in Figure 9. Water-related topics in Social Studies appear to be 31 per cent in lower primary and 69 per cent in upper primary [5]. In Social studies, water-related topics taught in the lower primary are aligned with SDG 6 Target 6.1—Safe and affordable drinking water, and SDG 13 Target 13.3—Build knowledge and capacity to meet climate change [74]. However, lessons like water conservation, water scarcity and water demand under Target 6.4—Improve water quality by reducing pollution under Target 6.3, are among the missing lessons in the subject. This leaves students in lower primary school with knowledge of access to safe and affordable drinking water but limited knowledge of how to manage water resources for future use in Social Studies.

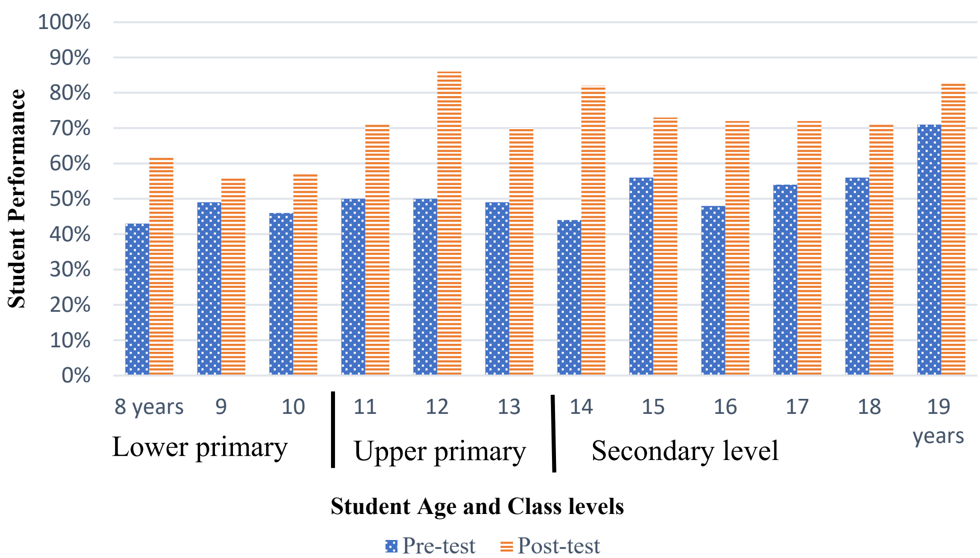

Figure 9. Students' performance in the Social Studies questions is determined according to their age.

4. Discussion

The pre-test and post-test methods used to measure students' performance have limitations that should be considered when evaluating their effectiveness. One major limitation is the potential influence of short-term memory on post-test performance [83,84]. When students take a pre-test, they are exposed to the content or questions they may not have previously encountered. The learning activities like WCSL, WAQC and WPP that follow can help reinforce this material, but even if the activity is ineffective, students might still perform better on the post-test simply because the questions are familiar from the pre-test. This effect of short-term memory retention can lead to inflated performance improvements [85–87], making it difficult to determine whether genuine learning or the mere recall of information is responsible for the apparent progress. Another limitation is the lack of long-term evaluation [88]. Pre-test and post-test designs often assess immediate or short-term outcomes, but they fail to measure whether the knowledge gained is retained over time [84]. This short-term focus can provide a misleading picture of the intervention's effectiveness if improvements seen on the post-test quickly fade. Additionally, pre-test and post-test methods may not fully capture conceptual understanding [89]. Students might improve their scores by memorising facts without truly comprehending the underlying concepts. This can give a false sense of success if the goal of the activity is to develop deeper critical thinking or problem-solving skills. However, despite these limitations, the pre-test and post-test approach is useful for measuring immediate outcomes, as it allows researchers or educators to quantify changes and assess the impact of an activity or program within a short period of time [90]. This approach provides a clear comparison of participants' knowledge or skills before and after the intervention [91], offering insight into the effectiveness of the educational or training initiative [91]. While it provides valuable insights into the effectiveness of educational activities, it should be used alongside other methods, such as follow-up assessments [92], to capture a more comprehensive view of learning and long-term retention.

Students' preferences for game-based learning can be strongly influenced by their age [71,93], as it was observed in the statistical results of Section 3.3.1. When choosing games to increase students' awareness of water resource management, the appropriateness of a game for a specific age category is an essential factor in determining the suitability and enjoyment of the game for students [94]. Worldwide, games are categorised into different age groups, such as Early Childhood (EC), Everyone (E), Everyone over 10 (E10+), Teens (T), and Adults Only (AO) [95]. These strict categorisations are necessary to distinguish what is appropriate for each group. When choosing age-appropriate games for children, recognising the intended audience's age group is important in shaping procedures, subject and complexity to ensure that it is acceptable and interesting for the specified age range [80,96]. Whilst age may play a significant role in shaping students' preference for games, the relationship is arguably influenced by various factors like game design and type, and they can differ across different age groups. Teachers can run surveys to acquire data on students' game preferences, such as the types of games they enjoy, the frequency with which they play, and their preferred gaming devices. By collecting this information, teachers can gain insights into students' gaming experience and preferences, which can be used to guide the creation of game-based learning activities based on the specific preferences and habits of the student population. Therefore, types of games and the design of game-based learning experiences may need to be created to suit the students' age and developmental stage [72,97]. For example, games aimed at younger students (aged from 4 to 12 years) should include practices that encourage interaction, collaboration, and easy decision-making [98], but games aimed at adults (teenagers) may require mechanisms that involve strategic thinking, risk assessment, and competitive play [99]. Furthermore, if a game is regarded as 'too easy', students may become disengaged due to a perceived lack of challenge in what they are doing [71]. Therefore, while age can play a role in determining students' love for game-based learning, game type and game design also contribute to students' game preferences.

Water-related topics should equally appear in both the Science and Social Studies subjects since this can provide a deeper understanding and promote the application of knowledge in diverse contexts and relevant educational experience to students, as was observed in the post-test results of Section 3.4. Students have subject preferences [100], which might influence the students' ability to understand water-related topics in Science rather than in Social Studies and vice versa. Students not only differ in their general level of school engagement but also in the degree to which they like and value specific subjects [101]. Students are expected to prefer subjects that allow them to best use their abilities, such as reasoning, problem-solving, thinking, understanding challenging ideas, and learning quickly [102]. Students demonstrating a preference for specific subjects has important consequences; for example, having an interest in a specific subject has been shown to predict educational and career choices [103]. A study conducted by Lavruijsen et al. [100] revealed that characteristic interests and mental abilities are unique predictors of subject preference. Investing time to examine and understand the students' feelings towards a subject can enable educators to gain insights into various factors like personal, social or emotional issues that contribute to disengagement in the subject. This assists teachers in gaining valuable insights into the root cause of the disengagement and developing effective strategies to re-engage students in the subject's learning process. However, teachers appear to have an impact on students' interest in their subject [104–107]. Teachers who are unpleasant or disrespectful might reduce students' pleasure in a subject, whereas those who make classes enjoyable and are polite and passionate about teaching can increase students' interest. According to Lavruijsen et al. [100], teachers who combined a passion for their subject with the ability to connect it to students' lives promoted subject liking. Although teachers are enthusiastic about the subject, it could be argued that liking the subject can only be promoted to students who prefer the subject [108]. Therefore, when these water-related topics are equally taught in both subjects, it would impact the students' learning based on their subject preferences. It will even be more advantageous for the student's learning when the student is comfortable with both subjects.

Consistent teaching of water-related themes in areas such as Science throughout all academic terms is essential for students' understanding and retention of the materials they are taught. According to Patra and Chakraborti [109], brains are designed to forget in order to optimise decision-making in rapidly changing environments, as well as to filter out irrelevant information so that people can focus on what is important. Students may forget a significant portion of what they learn if diligent efforts are not made to reinforce water-related lessons in all three academic terms in the Ugandan education system [110], as was evident in the statistical results that were obtained in Section "Science Questions". An academic year for primary and secondary education in Uganda starts in January and ends in December. It is divided into three academic terms [5]. Term I runs from January to April, Term II runs from May to August, and Term III runs from September to December [5]. Therefore, teaching water-related topics in a specific subject over the course of three academic terms may eventually help students understand and recall the material they have learned about water resource management. Consistency in teaching water-related themes not only benefits students but also allows teachers to learn more about the topic by creating a steady and predictable learning environment. When teachers deliver instruction consistently, they can deepen their understanding of the subject matter through repeated presentation and exploration of essential concepts. In addition, this can provide opportunities for teachers to do research and improve their teaching strategies, resulting in a better understanding of the water-related topics they teach. Approaches like maintaining a consistent approach to instruction [111] and employing a variety of teaching strategies while remaining consistent [112] are also important for students to understand and retain the materials taught about water resource management. However, the inconsistencies in teaching philosophies [113] may hinder students' ability to grasp and remember the content taught about water resource management. Therefore, the significance of consistency in teaching approaches is evident in the positive impact it has on student understanding and academic performance [114].

5. Conclusions

5.1. Implications

Students participated in activities that involved WCSL, WAQC, and WPP, and the effectiveness of each game was evaluated using pre- and post-test questionnaires. The results show that the games positively impacted students' learning and awareness of water resource management. WAQC improved student performance by 25 per cent, compared to 18 per cent for WCSL and 14 per cent for WPP, making WAQC the most effective game. The games also enhanced students' performance in both Science and Social Studies related to water topics. Therefore, these games could complement traditional education in Uganda to improve students' awareness of water resource management.

The main key outcomes obtained from the study can be summarised as follows:

- Student age can influence game-based learning choices, making age-appropriate games crucial for understanding water resource management and ensuring engagement;
- Subject preferences may affect students' ability to understand water-related topics in Science rather than Social Studies, and vice versa, highlighting the need for balanced inclusion of water-related topics in both subjects;
- Regular teaching of water-related themes across all academic terms is critical for student comprehension and retention of taught materials.

The study recommends that the Ugandan government integrate game-based learning into the education system. This approach can significantly improve students' awareness of water management and can also be an effective tool for educating the wider community.

5.2. Limitations

Despite the positive findings, this study faced limitations. First, the sample size may not be fully representative of the broader student population in Uganda, limiting the generalizability of the results. Additionally, the study only measured short-term improvements in learning, and it remains unclear whether the positive effects of game-based learning are sustained over time. The focus on only three specific games also limits the scope of the findings, as other game types or educational tools might yield different results.

5.3. Future Works

Future research should address these limitations by expanding the sample size and including a more diverse demographic to validate the generalizability of the findings. Longitudinal studies should be conducted to assess the long-term impact of game-based learning on water resource management education. Additionally, exploring a broader range of game types and digital learning tools could provide a more comprehensive understanding of which methods are most effective across various contexts.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/world5040050/s1, Figure S1. Water Conservation Snakes and Ladders; Figure S2. Water Awareness Quartet Cards; Figure S3. Water Pollution Puzzle; Figure S4. Certificate of Ethical Approval; Document S1. Rules and regulations for Water Conservation Snakes and Ladders; Document S2. Questions and Answers used in Water Conversation Snakes and Ladders; Document S3. Rules and regulations for Water Awareness Quartet Cards; Document S4. Rules and regulations for Water Pollution Puzzle; Document S5. Water pollutant terms to find in Water Pollution Puzzle; Document S6. Pres-test for Water Awareness Quartet Cards; Document S7. Post-test for Water Awareness Quartet Cards; Document S8. Pre-test for Water Conservation Snakes and Ladders; Document S9. Post-test for Water Conservation Snakes and Ladders; Document S10. Pre-test Water

Pollution Puzzle; Document S11. Post-test Water Pollution Puzzle; Document S12. QUESTIONNAIRE ABOUT THE GAMES.

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References

1. Chitonge, H. Urbanisation and the water challenge in Africa: Mapping out orders of water scarcity. *Afr. Stud.* **2020**, *79*, 192–211. [CrossRef]
2. Nalumeya, B.; Rubinato, M.; Kennedy, M.; Catterson, J.; Bakamwesiga, H.; Blackett, M. Water Management Education in the East African Region: A Review of the Challenges to Be Addressed. *Sustainability* **2023**, *15*, 11597. [CrossRef]
3. Sichangi, A.; Makokha, G. Monitoring water depth, surface area and volume changes in Lake Victoria: Integrating the bathymetry map and remote sensing data during 1993–2016. *Model. Earth Syst. Environ.* **2017**, *3*, 533–538. [CrossRef]
4. Sukma, E.; Ramadhan, S.; Indriyan, V. Integration of environmental education in elementary schools. *J. Phys. Conf. Ser.* **2020**, *1481*, 012136. [CrossRef]
5. Nalumenya, B.; Rubinato, M.; Kennedy, M.; Catterson, J.; Bakamwesiga, H. Identifying Gaps within the Education System in Uganda to Prepare Students for More Sustainable Water Management in the Future. *Educ. Sci.* **2023**, *13*, 597. [CrossRef]
6. Uganda Primary School Notes (P.1–P.7). Available online: https://teacher.ac/uganda-primary-schools-resources/ (accessed on 4 April 2023).
7. Otaala, J.; Maani, S.J.; Bakaira, G.G. Effectiveness of University Teacher Education Curriculum on the Secondary School Teacher Performance in Uganda: The Case of Kyambogo University. *J. Int. Coop. Educ.* **2013**, *15*, 95–112.
8. Riyad, M.; Pramana, C.; Maseleno, A.; Munakib, A. Theoretical Education vs Practical Education. *Test Eng. Manag.* **2020**, *82*, 5074–5081.
9. Dhond, P.; Dalvi, M.A. Game-based learning to raise awareness about water sustainability. *Homi Bhabha Cent. Sci. Educ.* **2022**, 235–242.
10. Jalani, H.N.; Sern, C.L. Efficiency Comparisons between Example-Problem-Based Learning and Teacher-Centred Learning in the Teaching of Circuit Theory. *Procedia-Soc. Behav. Sci.* **2015**, *204*, 153–163. [CrossRef]
11. Fischer, E.; Hänze, M. Back from "guide on the side" to "sage on the stage"? *Effects of teacher-guided and student-activating teaching methods on student learning in higher education. Int. J. Educ. Res.* **2019**, *95*, 26–35. [CrossRef]
12. Platz, L. Learning with serious games in economics education a systematic review of the effectiveness of game-based learning in upper secondary and higher education. *Int. J. Educ. Res.* **2022**, *115*, 102031. [CrossRef]
13. Dobrescu, I.L.; Greiner, B.; Motta, A. Learning economics concepts through game-play: An experiment. *Int. J. Educ. Res.* **2015**, *69*, 23–37. [CrossRef]
14. Tsai, C.J.; Liu, S.C.; Chang, C.Y.; Chen, S.Y. Using a Board Game to Teach about Sustainable Development. *Sustainability* **2021**, *13*, 4942. [CrossRef]
15. Jääskä, E.; Aaltonen, K.; Kujala, J. Game-Based Learning in Project Sustainability Management Education. *Sustainability* **2021**, *13*, 8204. [CrossRef]
16. Arboleya-Garcia, E.; Miralles, L. The Game of the Sea: An Interdisciplinary Educational Board Game on the Marine Environment and Ocean Awareness for Primary and Secondary Students. *Educ. Sci.* **2022**, *12*, 57. [CrossRef]
17. Adipat, S.; Laksana, K.; Busayanon, K.; Asawasowan, A.; Adipat, B. Engaging students in the learning process with game-based learning: The fundamental concepts. *Int. J. Technol. Educ.* **2021**, *4*, 542–552. [CrossRef]

18. Hakak, S.; Noor, F.M.N.; Ayub, N.M.; Affal, H.; Hussin, N.; Imran, M. Cloud-assisted gamification for education and learning–Recent advances and challenges. *Comput. Electr. Eng.* **2019**, *74*, 22–34. [CrossRef]
19. Syakur, A.M. The use of board game in teaching speaking to young learners. *J. Engl. Teach. Res.* **2020**, *5*, 149–155. [CrossRef]
20. Akcaoglu, M.; Kale, U. Teaching to Teach (with) Game Design: Game Design and Learning Workshops for Preservice Teachers. *Contemp. Issues Technol. Teach. Educ.* **2016**, *16*, 60–81.
21. Cardinot, A.; Fairfield, J.A. Game-based learning to engage students with physics and astronomy using a board game. *Int. J. Game-Based Learn.* **2019**, *9*, 42–57. [CrossRef]
22. Jääskä, E.; Aaltonen, K. Teachers' experiences of using game-based learning methods in project management higher education. *Proj. Leadersh. Soc.* **2022**, *3*, 2–12. [CrossRef]
23. Cojocariu, V.M.; Boghian, I. Teaching the Relevance of Game-Based Learning to Preschool and Primary Teachers. *Procedia-Soc. Behav. Sci.* **2014**, *142*, 640–646. [CrossRef]
24. Ballou, N.; Deterding, S. I Just Wanted to Get It Over and Done With: A Grounded Theory of Psychological Need Frustration in Video Games. *Proc. ACM Hum.-Comput. Interact.* **2023**, *7*, 217–236. [CrossRef]
25. Garneli, V.; Giannakos, M.; Chorianopoulos, K. Serious games as a malleable learning medium: The effects ofnarrative, gameplay, and making on students' performance and attitudes. *Br. J. Educ. Technol.* **2017**, *48*, 842–859. [CrossRef]
26. Hamden Hamid, S.; Zulkiply, N.; Mohamad, S.F. The Effects of Non-Digital Game-Based Learning and Cognitive Level of Questions on Isometric Transformations. *Asian J. Univ. Educ.* **2022**, *18*, 34–50. [CrossRef]
27. Bochennek, K.; Wittekindt, B.; Zimmermann, Y.S.; Klingebiel, T. More than mere games: A review of card and board games for medical education. *Med. Teach.* **2007**, *29*, 941–948. [CrossRef]
28. Mercier, M.; Lubart, T. The effects of board games on creative potential. *J. Creat. Behav.* **2021**, *55*, 875–885. [CrossRef]
29. Gutierrez, F.A. Development and Effectiveness of an Educational Card Game as Supplementary Material in Understanding Selected Topics in Biology. *CBE-Life Sci. Educ.* **2014**, *13*, 76–82. [CrossRef]
30. Rajkovic, I.A.; Ruzic, S.M.; Bojan, L. Board Games as Educational Media: Creating and Playing Board Games for Acquiring Knowledge of History. *Int. Assoc. Res. Textb. Educ. Media* **2021**, *11*, 1–21. [CrossRef]
31. Tsai, C.J.; Liu, S.C.; Chang, C.Y.; Chen, S.Y. Element Enterprise Tycoon: Playing Board Games to Learn Chemistry in Daily Life. *Educ. Sci.* **2020**, *10*, 48. [CrossRef]
32. Parrondo, M.; Rayon-Viña, F.; Borrell, J.Y.; Miralles, L. Sustainable Sea: A board game for engaging students in sustainable fisheries management. *Appl. Environ. Educ. Commun.* **2021**, *20*, 406–421. [CrossRef]
33. Kurisu, K.; Okabe, H.; Nakatan, J.; Moriguchi, Y. Development of board game to encourage life cycle thinking, and trial with university students in Japan. *Clean. Responsible Consum.* **2021**, *3*, 100033. [CrossRef]
34. Kok, D.K.; Bisschops, I.; Knoop, L.; Tulu, L.; Kujawa-Roeleved, K.; Masresha, N.; Houtkamp, J. Game over or play again? Deploying games for promoting water recycling and hygienic practices at schools in Ethiopia. *Environ. Sci. Policy* **2020**, *111*, 83–90. [CrossRef]
35. Cheng, H.P.; Yeh, K.T.; Tsai, C.J.; Lin, R.C.; and Chang, Y.C. Development of an Issue-Situation-Based Board Game: A Systemic Learning Environment for Water Resource Adaptation *Education. Sustain.* **2019**, *11*, 1341. [CrossRef]
36. Mathews, B. Adolescent capacity to consent to participate in research: A review and analysis informed by law, human rights, ethics, and developmental science. *Laws* **2022**, *12*, 2. [CrossRef]
37. Matthew, H.; Limb, M. Defining an agenda for the geography of children: Review and prospect. *Prog. Hum. Geogr.* **1999**, *23*, 61–90. [CrossRef]
38. Topsfield, A. Snakes and Ladders in India: Some Further Discoveries. *Artibus Asiae* **2006**, *66*, 143–179. [CrossRef]
39. Nurhayati, M.; Widodo, Y. The use of Educational Media Snakes and Ladders Dental Health in Improving Dental and Oral Health Knowledge of Students of Class 3 Madrasah Ibtidaiyah IICity of Palembang. *East Asian J. Multidiscip. Res.* **2022**, *1*, 1951–1956. [CrossRef]
40. Taka, D.S. Teaching Speaking by using snake and ladder board game. *J. Lang. Teach. Learn. Linguist. Lit.* **2019**, *7*, 72–86. [CrossRef]
41. Lestari, O.; Priscylio, G.; Copriady, J.; Holiwan, B. The use of quartet card game on hydrocarbon to improve learning outcomes ten-grade students. *J. Phys. Conf. Ser.* **2020**, *1567*, 032096. [CrossRef]
42. Harahap, B.P. The Use of Quartet Card Learning Media in Social Studies Subjects in Elementary School: Systematic Literature Review. *J. Gen. Educ. Sci.* **2024**, *8*, 250–255.
43. Wash Quartet Game//Training Manual. Available online: https://www.susana.org/_resources/documents/default/3-4953-7-1648825044.pdf (accessed on 27 January 2024).
44. Ayriza, Y.; Setiawati, A.F.; Triyanto, A.; Gunawan, E.N.; Anwar, K.M.; Budiarti, D.N.; Fadhilah, R.A. The effectiveness of quartet card game in increasing career knowledge in lower grade elementary school students. *Curr. Psychol.* **2021**, *42*, 3498–3509. [CrossRef]
45. Ong, J.D. The development of food mission: A nutrition based card game for grade 6 students. *E3S Web Conf.* **2021**, *244*, 1–7. [CrossRef]
46. Hakim, L.; Subroto, T.W.; Kurniawan, Y.R. Developing an Quartet Card Game as an Evaluation of Economics Learning for Senior High School. *Int. J. Control Theory Appl.* **2015**, *8*, 1645–1655.
47. Fitria, N.T. The Effectiveness of Word Search Puzzles Game in Improving Students Vocabulary. *Pioneer J. Lang. Lit.* **2023**, *15*, 50–67. [CrossRef]

48. Kalkan, N.; Güler, S.; Bulut, H.; Ay, A. Views of students on the use of crossword and word search puzzle as a teaching technique in nursing education: A mixed-method study. *Nurse Educ. Today* **2022**, *119*, 105542. [CrossRef]
49. Vini, Y.M.; Hampp, P.; Andries, A.F. The effectiveness of word search puzzle medium in vocabulary mastery. *J. Teach. Engl. Linguist. Lit.* **2023**, *2*, 1278–1288.
50. Nantaba, F.; Palm, W.U.; Wasswa, J.; Bouwman, H.; Kylin, H.; Kummerer, K. Temporal dynamics and ecotoxicological risk assessment of personal care products, phthalate ester plasticizers, and organophosphorus flame retardants in water from Lake Victoria, Uganda. *Chemosphere* **2021**, *262*, 127716. [CrossRef]
51. Nantaba, F.; Wasswa, J.; Kylin, H.; Bouwman, H.; Palm, W.U.; Kummerer, K. Spatial trends and ecotoxic risk assessment of selected pharmaceuticals in sediments from Lake Victoria, Uganda. *East Afr. Sci. Total Environ.* **2024**, *906*, 167348. [CrossRef]
52. Atuhurra, J.; Kaffenberger, M. System (in) Coherence: Quantifying the Alignment of Primary Education Curriculum Standards, Examinations, and Instruction in Two East African Countries. *Res. Improv. Syst. Educ.* **2020**, 1–50. [CrossRef]
53. Ezezika, O.; Fusaro, M.; Rebello, J.; Aslemand, A. The Pedagogical Impact of Board Games in Public Health Biology Education: The Bioracer Board Game. *J. Biol. Educ.* **2023**, *57*, 331–342. [CrossRef]
54. Haddeland, K.; Slettebø, A.; Svensson, E.; Tosterud, B.R.; Wangensteen, S.; Fossum, M. The Effects of Using High-Fidelity Simulation in Undergraduate Nursing Education: A Multicenter Randomized Controlled Trial with a Process Evaluation. *Int. J. Educ. Res.* **2021**, *109*, 101813. [CrossRef]
55. Alt, D.; Raichel, N. Enhancing perceived digital literacy skills and creative self-concept through gamified learning environments: Insights from a longitudinal study. *Int. J. Educ. Res.* **2020**, *101*, 101561. [CrossRef]
56. Wulanyani, M.S.N.; Pratama, S.Y.; Swastika, K.; Sudarmaja, M.I.; Wandra, T.; Yoshida, T.; Budke, C.; Ito, A. A preliminary study to assess the use of a "Snakes and Ladders" board game in improving the knowledge of elementary school children about taeniasis. *Acta Trop.* **2019**, *199*, 105117. [CrossRef] [PubMed]
57. Karbownik, S.M.; Wiktorowska-Owczarek, A.; Kowalczyk, E.; Kwarta, P.; Mokros, L.; Pietras, T. Board game versus lecture-based seminar in the teaching of pharmacology of antimicrobial drugs—A randomized controlled trial. *FEMS Microbiol. Lett.* **2016**, *363*, fnw045. [CrossRef]
58. Manti, S.; Licari, A. How to obtain informed consent for research. *Breathe* **2018**, *14*, 145–152. [CrossRef]
59. Kaur, P.; Stoltzfus, J.; Yellapu, V. Descriptive statistics. *Int. J. Acad. Med.* **2018**, *4*, 60–63. [CrossRef]
60. Andrews, P. Mathematics teacher typologies or nationally located patterns of behaviour? *Int. J. Educ. Res.* **2007**, *46*, 306–318. [CrossRef]
61. Nowell, S.L.; Norris, M.J.; White, E.D.; Moules, J.N. Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *Int. J. Qual. Methods* **2017**, *16*, 1–13. [CrossRef]
62. Castleberry, A.; Nolen, A. Thematic analysis of qualitative research data: Is it as easy as it sounds? *Curr. Pharm. Teach. Learn.* **2018**, *10*, 807–815. [CrossRef]
63. Divine, G.; Norton, H.J.; Hunt, R.; Dienemann, J. A Review of Analysis and Sample Size Calculation Considerations for Wilcoxon Tests. *Anesth. Analg.* **2013**, *117*, 699–710. [CrossRef] [PubMed]
64. Sinha, S.; Sankhala, G.; Lal, P.S. Effectiveness of ICT based Mobile App in Knowledge Gain apropos 'Environment-Friendly Dairy Farming Practices': Paired 't' and Wilcoxon Signed paired Rank test Analogy. *J. Community Mobilization Sustain. Dev.* **2018**, *13*, 561–566.
65. Antequera-Barroso, J.A.; Revuelta-Domínguez, F.I.; Guerra Antequera, J. Similarities in procedures used to solve mathematical problems and video games. *Educ. Sci.* **2022**, *12*, 172. [CrossRef]
66. Martin, F.; Bolliger, D.U. Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learn.* **2018**, *22*, 205–222. [CrossRef]
67. Skok, K. Uncertainty in games–potential benefits and disadvantages. *Homo Ludens* **2020**, *13*, 223–240. [CrossRef]
68. Fioravanti, F.; Delbianco, F.; Tohmé, F. The relative importance of ability, luck and motivation in team sports: A Bayesian model of performance in the English Rugby Premiership. *Stat. Methods Appl.* **2023**, *32*, 715–731. [CrossRef]
69. Rubin, R.M.; Hubbard, J.A. Children's verbalizations and cheating behavior during game playing: The role of sociometric status, aggression, and gender. *J. Abnorm. Child Psychol.* **2003**, *31*, 65–78. [CrossRef]
70. Marlow, C.; Kelsey, C.; Vaish, A. Cheat to win: Children's judgements of advantageous vs. disadvantageous rule breaking. *Cogn. Dev.* **2023**, *66*, 101328. [CrossRef]
71. Tang, T.J.; Nine, T.W.; Wang, C.Y. Preschoolers' Mathematics Game Preferences and Learning Performance through Designing a Degree of Freedom for a Tablet Game. *Educ. Inf. Technol.* **2023**, *28*, 16311–16331. [CrossRef]
72. Romero, M.; Sawchuk, K.; Ouellet, H. Expanding the Game Design Play and Experience framework for Game Based Lifelong Learning (GD-LLL-PE). In *Cross-Generational and Age-Oriented Topics*; Springer: Cham, The Netherlands, 2017; pp. 1–11.
73. Geography New Lower Secondary Curriculum Syllabus. Available online: https://www.yaaka.cc/geography-new-lower-secondary-curriculum-syllabus/ (accessed on 17 December 2023).
74. Sustainable Development Goals. Available online: https://unric.org/en/sdg-1/ (accessed on 28 November 2023).
75. Ardiyanto, J.; Handayani, W.K.O.; Raharjo, J.T.; Pujiastuti, S.E.R. The Role of Learning Repetitive Strategy in Determining Learning Performance Skill: An Insight from Health Vocational School. *Health Educ. Health Promot.* **2023**, *11*, 261–266. [CrossRef]
76. Berti, E.A. The development of political Understanding in Children between 6–15 years old. *Hum. Relat.* **1988**, *41*, 437–446. [CrossRef]

77. Davidson, C.M.; Amso, D.; Anderson, C.L.; Diamond, A. Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia* **2006**, *44*, 2037–2078. [CrossRef] [PubMed]
78. Education in Uganda. Available online: https://teachthemtofish.org/education-in-uganda/#:~:text=Primary%20education%20in%20Uganda%20consists,6%20and%2013%20years%20old (accessed on 28 November 2023).
79. Franklin, S.V.; Sayre, E.C.; Clark, J.W. Traditionally taught students learn; actively engaged students remember. *Am. J. Phys.* **2014**, *82*, 798–801. [CrossRef]
80. Piipponen, O. Students' perceptions of meaningful intercultural encounters and long-term learning from a school story exchange. *Int. J. Educ. Res.* **2023**, *119*, 102169. [CrossRef]
81. Rosenshine, B. Principles of instruction: Research-based strategies that all teachers should know. *Am. Educ.* **2012**, *36*, 12–19.
82. Cooperstein, E.S.; Kocevar-Weidinger, E. Beyond active learning: A constructivist approach to learning. *Ref. Serv. Rev.* **2004**, *32*, 141–148. [CrossRef]
83. Rasouli, F. The impact of developing short-term memory on the interpretation performance of students. *Cihan Univ.-Erbil J. Humanit. Soc. Sci.* **2022**, *6*, 64–68. [CrossRef]
84. Subramaniam, T.; Hassan, S.; Tan, A.J.; Rahman, A.; Ramlah, S.; Tay, J.S. Impact of cardiac life support training on retention of knowledge measured by pretest, immediate posttest, and 6-months posttest. *Int. E-J. Sci. Med. Educ.* **2022**, *169*, 28–35. [CrossRef]
85. Cepeda, N.J.; Vul, E.; Rohrer, D.; Wixted, J.T.; Pashler, H. Spacing effects in learning: A temporal ridgeline of optimal retention. *Psychol. Sci.* **2008**, *19*, 1095–1102. [CrossRef]
86. Roediger, H.L.; Butler, A.C. The critical role of retrieval practice in long-term retention. *Trends Cogn. Sci.* **2011**, *15*, 20–27. [CrossRef]
87. Soderstrom, N.C.; Bjork, R.A. Learning versus performance: An integrative review. *Perspect. Psychol. Sci.* **2015**, *10*, 176–199. [CrossRef] [PubMed]
88. Madeni, F.; Horiuchi, S.; Iida, M. Evaluation of a reproductive health awareness program for adolescence in urban Tanzania-A quasi-experimental pre-test post-test research. *Reprod. Health* **2011**, *8*, 34–42. [CrossRef]
89. Loyens, S.M.; Jones, S.H.; Mikkers, J.; van Gog, T. Problem-based learning as a facilitator of conceptual change. *Learn. Instr.* **2015**, *38*, 34–42. [CrossRef]
90. Krewulak, K.D.; Bull, M.J.; Ely, E.W.; Davidson, J.E.; Stelfox, H.T.; Fiest, K.M. Effectiveness of an intensive care unit family education intervention on delirium knowledge: A pre-test post-test quasi-experimental study. *Can. J. Anaesth.* **2020**, *67*, 1761. [CrossRef]
91. Craig, S.; Stark, P.; Wilson, C.B.; Carter, G.; Clarke, S.; Mitchell, G. Evaluation of a dementia awareness game for undergraduate nursing students in Northern Ireland: A Pre-/Post-Test study. *BMC Nurs.* **2023**, *22*, 177. [CrossRef] [PubMed]
92. McCormick, M.P.; Neuhaus, R.; Horn, E.P.; O'connor, E.E.; White, H.I.; Harding, S.; Cappella, E.; McClowry, S. Long-term effects of social–emotional learning on receipt of special education and grade retention: Evidence from a randomized trial of insights. *Aera Open* **2019**, *5*, 1–21. [CrossRef]
93. González-González, S.C.; Toledo-Delgado, A.P.; Muñoz-Cruz, V.; Arnedo-Moreno, J. Gender and Age Differences in Preferences on Game Elements and Platforms. *Sensors* **2022**, *22*, 3567. [CrossRef]
94. Ali, K.; Sawalha, A. The effect of digital educational games on motivation towards e-learning and life skills among primary school students in Arab societies. *Int. J. Humanit. Educ. Res.* **2021**, *3*, 74–89. [CrossRef]
95. Harrelson, D. Rated M for Monkey: An Ethnographic Study of Parental Information Behavior when Assessing Video Game Content for Their Children. Ph.D. Dissertation, University of North Texas, Denton, TX, USA, 2016.
96. Smit, R.; Hyry-Beihammer, K.E.; Raggl, A. Teaching and learning in small, rural schools in four European countries: Introduction and synthesis of mixed-/multi-age approaches. *Int. J. Educ. Res.* **2015**, *74*, 97–103. [CrossRef]
97. Tondello, F.G.; Mora, A.; Nacke, E.L. Elements of Gameful Design Emerging from User Preferences. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, Amsterdam, The Netherlands, 15–18 October 2017; pp. 129–142.
98. Pombo, N.; Lamas, D. Game-Based Learning for Young Children: A Case Study. In Proceedings of the 2022 IEEE Global Engineering Education Conference (EDUCON), Tunis, Tunisia, 28–31 March 2022; pp. 133–138. [CrossRef]
99. Charlier, N.; Ott, M.; Remmele, B.; Whitton, N. Not just for children: Game-based learning for older adults. In Proceedings of the European Conference on Games Based Learning, Cork, Ireland, 4–5 October 2012; pp. 1–8.
100. Lavruijsen, J.; Tracey, J.G.T.; Verachtert, P.; De Vroede, T.; Soenens, B.; Verschueren, K. Understanding school subject preferences: The role of trait interests, cognitive abilities and perceived engaging teaching. *Personal. Individ. Differ.* **2021**, *174*, 110685. [CrossRef]
101. Tempelaar, T.D.; Gijselaers, W.H.; van der Loeff, S.S.; Nijhuis, J.F. A structural equation model analyzing the relationship of student achievement motivations and personality factors in a range of academic subject-matter areas. *Contemp. Educ. Psychol.* **2007**, *32*, 105–131. [CrossRef]
102. Patrick, L.; Care, E.; Ainley, M. The Relationship between Vocational Interests, Self-Efficacy, and Achievement in the Prediction of Educational Pathways. *J. Career Assess.* **2011**, *19*, 61–74. [CrossRef]
103. Ajayi, B.O.; Moosa, M.; Aloka, J.A. Relationship between Career Interest and Career Decision-Making of Grade 12 Learners in Township Secondary Schools in South Africa. *Athens J. Educ.* **2023**, *10*, 307–322. [CrossRef]

104. Lazarides, R.; Gaspard, H.; Dicke, A.L. Dynamics of classroom motivation: Teacher enthusiasm and the development of math interest and teacher support. *Learn. Instr.* **2019**, *60*, 126–137. [CrossRef]
105. Kim, T.; Schallert, L.D. Mediating effects of teacher enthusiasm and peer enthusiasm on students' interest in the college classroom. *Contemp. Educ. Psychol.* **2014**, *39*, 134–144. [CrossRef]
106. Keller, M.M.; Goetz, T.; Becker, S.E.; Morger, V.; Hensley, L. Feeling and showing: A new conceptualization of dispositional teacher enthusiasm and its relation to students' interest. *Learn. Instr.* **2014**, *33*, 29–38. [CrossRef]
107. Hulleman, S.C.; Harackiewicz, M.J. Promoting Interest and Performance in High School Science Classes. *Science* **2009**, *326*, 1410–1412. [CrossRef]
108. Aeschliman, B.; Herzog, W.; Makarova, W. How to foster students' motivation in mathematics and science classes and promote students' STEM career choice. A study in Swiss high schools. *Int. J. Educ. Res.* **2016**, *79*, 31–41. [CrossRef]
109. Patra, A.; Chakraborti, T. Learn more, forget less: Cues from human brain. In Proceedings of the Asian Conference on Computer Vision, Kyoto, Japan, 30 November 2020; pp. 1–16.
110. Lalley, P.J.; Gentile, J.P. Classroom Assessment and Grading to Assure Mastery. *Theory Into Pract.* **2009**, *48*, 28–35. [CrossRef]
111. Kim, T.; Axelrod, S. Direct instruction: An educators' guide and a plea for action. *Behav. Anal. Today* **2005**, *6*, 111–120. [CrossRef]
112. Dunlosky, J.; Rawson, A.K.; Marsh, J.E.; Nathan, J.M.; Willingham, T.D. Improving Students' Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology. *Psychol. Sci. Public Interest* **2013**, *14*, 4–58. [CrossRef] [PubMed]
113. Firth, J.W. Teachers' Beliefs about Memory: A Vignette Study of Trainee and In-Service Teachers. *Stud. Psychol.* **2021**, *63*, 204–220. [CrossRef]
114. Driessen, G.; Sleegers, P. Consistency of Teaching Approach and Student Achievement: An Empirical Test. *Sch. Eff. Sch. Improv.* **2000**, *11*, 57–79. [CrossRef]