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Impact of Augmented Reality-Based Learning on Preparing Children for Creative Reading Skills in Childhood Education Stage

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ABSTRACT

This study investigated the impact of augmented reality (AR)-based learning on developing creative reading skills in early childhood education. Using validated instruments, including an AR-based learning guide, and a creative reading skills test, the study involved 254 primary school children from northern Jordan. The sample of the study was divided into an experimental group of 127 children who engaged with AR technology, and a control group of 127 children who received traditional teaching. Findings indicated that the experimental group scored significantly higher on the creative reading skills test than the control group. Statistical analysis using one-way ANOVA confirmed these differences as significant, underscoring the effectiveness of AR-based learning in improving creative reading skills. These results suggest that AR technology holds potential to develop learning outcomes in early childhood settings. Based on these findings, it is recommended to integrate AR technology into early childhood curricula to better support children's creative reading abilities. As an engaging and interactive tool, AR can nurture creative thinking and cognitive skills that go beyond traditional teaching. Additionally, AR transforms learning into a stimulating, multidimensional experience that enhances children's motivation to engage actively in the educational process. By creating virtual environments with interactive elements, AR aligns learning closely with real-world contexts, promoting innovative approaches to reading skill development. Further

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research should explore AR applications in other early childhood education areas, and expand AR-based educational tools, with an emphasis on adapting content to local cultural contexts to achieve effective, impactful results in children's skills development.

Keywords: Impact; Augmented Reality; Childhood; Creative Reading

1. Introduction

Reading is a fundamental pillar supporting both the learning and teaching processes. It plays a crucial role in the development of the human mind across various life stages. Reading facilitates the understanding of relationships between concepts, enhances mental balance, and expands experiences by assimilating the experiences of others and learning from the lessons and insights necessary to address educational and life challenges [1–3]. Thus, reading is not merely a means of acquiring knowledge but is essential for personal growth and intellectual advancement.

From a cognitive development perspective, reading plays a pivotal role in enhancing analytical and critical thinking skills. Engaging with a diverse range of texts exposes readers to various perspectives and ideas, fostering deeper analysis and evaluation of information. This process extends beyond superficial understanding to include a critical examination of content and its implications [4]. For example, literary fiction provides insights into human interactions and character relationships, while scientific literature offers tools for assessing evidence and analyzing results. This critical engagement supports the development of a sophisticated analytical mindset, enabling individuals to make informed and judicious decisions based on a thorough assessment of available information [5].

Furthermore, reading significantly contributes to improving writing and communication skills. Exposure to various literary and rhetorical styles enriches readers' vocabulary and expressive techniques [6, 7]. This diversity in writing styles—whether literary, journalistic, or academic—enhances the quality and effectiveness of written expression. Additionally, reading fosters oral communication skills by providing a rich base of content for discussion and idea exchange. The ability to articulate thoughts clearly and persuasively strengthens personal and professional relationships, facilitating positive interactions within various social contexts [4, 5].

Moreover, reading plays a crucial role in the development of imagination and creativity. Immersing oneself in diverse literary worlds allows readers to visualize new scenarios, characters, and experiences that may differ significantly from their daily lives. This engagement with imaginative content enhances creative thinking and problem-solving abilities, enabling individuals to explore innovative solutions and perspectives. Expanding creative capacity through reading contributes to cognitive flexibility and adaptability in the face of rapid changes and challenges [8–10].

On a psychological and emotional level, reading serves as an effective means of reducing stress and managing emotional well-being. Engaging with literature provides an escape from daily pressures, offering relaxation and respite. This stress-relief effect extends beyond the reading experience, positively impacting overall mental health and resilience. Thus, reading not only facilitates intellectual growth but also supports emotional stability and well-being [5, 10–12].

In summary, reading emerges as a comprehensive tool for personal and professional development. It enhances critical thinking and analytical skills, improves writing and communication abilities, fosters creativity and imagination, and alleviates stress. Through this multifaceted engagement, reading equips individuals with the knowledge and tools necessary to effectively navigate life's challenges, making it an indispensable element for achieving holistic personal and professional growth.

2. Literature Review

Reading is a complex mental process that goes beyond merely decoding letters and understanding superficial meanings. Successful reading requires analyzing texts and connecting information to various experiences and contexts, allowing individuals to extract deeper meanings and a broader understanding of the ideas presented [13].

When reading a text, the reader engages not only with the apparent information but also immerses themselves in

analyzing the broader context in which the text is presented. For example, when reading a novel, the reader needs to understand the characters, their motivations, and the conflicts they face. This requires the ability to interpret the narrative, symbols, and utilize personal experiences to gain a deeper understanding of the text. This type of reading enhances individuals' ability to relate texts to their personal experiences and surrounding circumstances, enabling them to extract new and valuable insights[14].

A deep understanding of texts involves the ability to infer indirect ideas and symbols that may be hidden between the lines. This includes understanding the historical and cultural context surrounding the text and analyzing how ideas within the text interact with current issues and daily life experiences. For instance, reading a philosophical text may require the reader to consider the fundamental issues discussed in the text and place them within a broader context through their understanding of the world and personal experiences[11, 15–19].

By deeply understanding texts, individuals develop the ability for creative thinking. Creative thinking involves analyzing texts in multiple ways, using ideas derived from texts to develop new solutions and innovate new ways of thinking, and viewing issues from unconventional angles[19, 20]. For example, reading texts about innovation may inspire the reader to apply concepts learned in practical or academic life in new ways.

Creative reading enhances individuals' ability to develop new and innovative ideas. This requires examining relationships between ideas and determining how to use information to create innovative solutions to challenges. For instance, when reading literary texts that contain symbols or cultural references, the reader must be able to interpret these symbols and understand how they relate to the main themes of the text. This in-depth analysis can lead to new conclusions and enhance individuals' ability to offer creative interpretations based on a comprehensive understanding of the information[21–23].

Moreover, creative reading stimulates individuals to provide innovative interpretations based on a thorough evaluation of information. When readers possess the ability to analyze texts creatively, they become more capable of generating new insights based on a deep and comprehensive understanding of the information. Analytical reading of his-

torical events may enable the reader to offer new interpretations of the long-term impacts of these events or propose new solutions to complex historical problems[22–24].

In conclusion, reading fosters creative thinking by encouraging individuals to analyze information in advanced ways and develop new and innovative solutions. Strong reading comprehension skills enable individuals to effectively engage with texts and provide new insights based on a thorough and objective analysis of information.

Studies indicate that creative reading enhances integrative thinking and increases learners' ability to interpret texts from multiple perspectives. Despite these benefits, educational institutions face challenges in effectively implementing creative reading practices due to insufficient focus on comprehensive text analysis and the application of creative thinking strategies. Research[25, 26] highlights that creative reading plays a crucial role in developing metacognitive thinking skills, which are essential for self-regulation and deep cognitive processes.

To address these challenges, experts recommend integrating advanced digital teaching techniques designed to enhance creative reading skills. Several studies[4, 25–32] emphasize the importance of incorporating these techniques into educational frameworks to improve learners' deep and innovative thinking, thereby enhancing their overall academic performance.

Among these digital innovations, Augmented Reality (AR) technology stands out as a significant advancement in promoting creative reading skills. AR offers a rich and interactive educational experience by blending digital elements—such as images, animations, and 3D models—with the real world, creating immersive learning environments that engage pupils and stimulate their imagination[26, 30].

In the context of creative reading, AR provides a multidimensional approach to interacting with texts. By visualizing narratives through interactive elements, AR helps pupils explore texts in a more dynamic manner. For instance, pupils can see historical scenes or scientific processes come to life, making it easier for them to understand and interpret complex ideas. AR can render historical events or scientific processes visually tangible, enhancing pupils' comprehension and fostering deeper connections with the material[2, 28, 31, 33–35].

Moreover, AR supports creative reading by encouraging pupils to engage with content in ways that traditional

methods do not. Through interactive features such as virtual annotations, multimedia explanations, and gamified learning experiences, pupils can interact with texts more creatively and critically[28, 32, 36]. This approach not only boosts comprehension but also stimulates creative thinking and problem-solving skills, as pupils are often required to analyze and interpret augmented elements.

The immersive nature of AR also contributes to a more engaging reading experience, which can be particularly beneficial for young learners who may struggle with conventional reading methods. By integrating AR into reading activities, educators can capture pupils' attention, sustain their interest, and motivate them to explore texts more deeply[14, 35].

In conclusion, AR technology enhances creative reading by providing interactive and engaging ways to experience and understand texts. It improves pupils' ability to visualize and interact with content, leading to a more engaging and profound reading experience. As educational environments increasingly adopt digital advancements, AR emerges as a powerful tool for developing and nurturing creative reading skills[36, 37].

In light of the above, it can be said that creative reading is a fundamental element in enhancing creative thinking and improving text interpretation skills by enabling learners to explore texts from multiple perspectives. However, educational institutions face significant challenges in effectively implementing creative reading practices. These challenges include insufficient focus on comprehensive text analysis and ineffective use of creative thinking strategies within curricula, which diminishes the effectiveness of traditional methods in developing these essential skills.

3. Problem of the Study

Despite strong evidence supporting the role of creative reading in developing metacognitive thinking and deep interpretative skills, there is a clear research gap in understanding how to effectively apply Augmented Reality (AR) techniques in educational contexts to enhance these capabilities. While current research acknowledges the benefits of AR in providing immersive and interactive learning experiences, there is a lack of systematic studies on how to integrate this technology into existing teaching strategies. This gap hinders the full potential of AR to contribute to the development of creative

reading skills.

The problem of this study is to address this gap by investigating how AR can be effectively utilized to enhance creative reading. The study aims to explore how AR can be integrated into educational curricula to improve text interaction and stimulate creative thinking among learners. By providing new insights into the application of AR in educational settings, this study seeks to bridge the gap between theoretical benefits and practical implementation, thereby enhancing the quality and effectiveness of education in fostering creative reading skills.

4. Aims and Questions of the Study

This study aims to explore how AR technology can improve creative reading skills among elementary school pupils by providing evidence of its effectiveness in enhancing the learning experience and developing linguistic skills. The study seeks to assess the impact of AR on the acquisition of creative reading skills in elementary pupils, such as originality, fluency, and flexibility. The results of the study highlight the importance of employing AR to improve creative reading skills and demonstrate how this technology can enhance pupils' ability to interact with and understand texts more deeply, representing a significant step towards improving the quality of education in Saudi Arabia.

In light of the above, the study raises the following question: Does the performance of pupils at the childhood education stage on the Creative Reading Skills Test differ depending on the teaching method (English language instruction based on augmented reality technology versus the traditional method) at a significance level of ($p \leq 0.05$).

5. Materials and Methods

5.1. Study Design

To achieve the study's objectives, a quasi-experimental design was used with two groups: an experimental group and a control group, employing both pre-test and post-test measurements. The sample was purposive for selecting the school and random for assigning classes to experimental and control groups. The design is a 2×2 factorial design based on the independent variables studying the instructional unit using Augmented Reality (AR) technology and the conven-

tional teaching method.

The design involves two groups: one experimental group applying AR technology and one control group applying the conventional teaching method. Both groups were subjected to tests on creative reading skills before and after the experiment. The following illustrates the study design:

G1: O1 × O1 **G2:** O1 – O1

Where: **O:** Performance on pre-test and post-test.

X: Treatment for the experimental group (G1).

–: No treatment for the control group (G2).

5.2. Participants

A convenient sample of 254 pupils from the childhood education grades for the second semester of the 2023/2024 academic year was selected from schools in northern Jordan. The sample was purposively chosen for the selection of schools and then randomly assigned to experimental and control groups. This selection process was based on the willingness and approval of teachers to use Augmented Reality (AR) technology for teaching reading.

The participants were divided into two groups: the experimental group, consisting of 127 pupils, and the control group, also consisting of 127 pupils. The academic performance of the pupils in both groups was similar. The sample included students with varying levels of achievement, including high achievers, very good students, good students, average students, and below-average students. This distribution ensures a balanced representation of different performance levels in both groups.

Additionally, all participants come from culturally and socially similar backgrounds, residing in the same geographical area. This geographic and socio-cultural homogeneity helps minimize external variables, ensuring that any differences in performance are more reliably attributed to the teaching methods employed.

5.3. Design and Preparation of Instructional Materials

This procedure involves preparing the teacher's guide and the student's handbook to use augmented reality technology in enhancing creative thinking skills. This can be described as follows:

Preparing the initial versions of the teacher's guide and student's handbook

- Introduction: The teacher's guide and student's handbook begin with an introduction defining the guide, its objectives, and the importance of using augmented reality technology in teaching. The introduction aims to enhance pupils' learning experiences by promoting creative thinking skills through direct interaction with digital elements, highlighting the significance of the technology in making teaching more interactive and engaging.

- Definition of Augmented Reality Technology: Augmented reality technology is defined by explaining how the digital world is integrated with the real world, emphasizing its importance in teaching. Examples are provided to illustrate how this technology can improve pupils' creative thinking skills.

- Steps for Implementing Augmented Reality in Teaching: The steps for implementing augmented reality begin with preparation, including identifying the necessary materials and tools, followed by execution, which involves explaining how to use the available applications and tools, and finally, evaluation through methods to assess the effectiveness of lessons using augmented reality.

- Educational Tools, Means, and Activities: The necessary educational tools, means, and activities are presented, including devices like smartphones and tablets, and applications and software that support augmented reality technology. Examples of educational activities that can be implemented to enhance story learning are provided.

- Timeline for Teaching the Experimental Group Pupils: A timeline for teaching the experimental group pupils is established, which includes distributing activities and lessons over a specified period to ensure the achievement of educational objectives.

- Assessment Methods: The adopted assessment methods are defined, using continuous and final evaluations to measure the achievement of educational objectives.

Presenting the initial versions of the teacher's guide and student's handbook to evaluators

The initial versions of the teacher's guide and student's handbook are presented to a group of evaluators specialized in curricula and language teaching methods. The goal is to ob-

tain the evaluators' opinions and recommendations to refine and improve the guide and handbook. Based on this procedure, the necessary modifications were made to the teacher's guide and student's handbook to enhance their quality and align them with the required educational objectives.

5.4. Creative Reading Skills Test

The Creative Reading Skills Test is designed to assess the impact of augmented reality-based learning on enhancing tenth-grade students' comprehension of scientific concepts, drawing from their study of three reading passages from early childhood education. This test was developed using the researchers' expertise and a review of language assessments emphasizing creative thinking skills, and has been approved by the Jordanian Ministry of Education.

The test comprised 26 multiple-choice questions, with a strong emphasis on ensuring that the items were linguistically and scientifically accurate, specific, clear, unambiguous, and appropriate for the students' age and cognitive level. The test incorporated dimensions of creative thinking skills, including fluency, originality, and flexibility.

- Fluency: The test aimed to measure students' ability to generate multiple and diverse ideas or responses related to the reading passages. Fluency reflects the students' capacity to think quickly and creatively, producing a range of ideas efficiently.
- Originality: The test also assessed students' ability to offer innovative and unique ideas. Originality indicates how well students can present unconventional or distinctive answers that demonstrate creativity and originality in their thinking.
- Flexibility: The test focused on evaluating students' ability to adapt to different variables and understand texts from various perspectives. Flexibility refers to students' capacity to shift their cognitive strategies and approach problems from different angles in response to new situations or challenges.

The test was meticulously reviewed to ensure its appropriateness for the students' cognitive levels and age, ensuring its ability to accurately and objectively measure creative thinking skills. It reflects the effectiveness of using augmented reality techniques in enhancing students' scientific understanding in a creative and effective manner.

To validate the Creative Reading Skills Test, it was presented to a panel of educational experts from Jordanian universities, specializing in English language teaching, English language, digital technology, and assessment and evaluation. Based on the experts' feedback, some items were rephrased to be more suitable for the pupils' age level and more closely related to the subject of the reading passages. Consequently, the final version of the test included: test application instructions, 26 items distributed across 8 pages, and an answer sheet for the test items. The test duration was calculated by determining the time required to administer the test to a pilot sample, summing the time each participant took, and dividing it by the number of participants. The required test duration was found to be 30 minutes.

To support the construct validity of the Creative Thinking Skills Test, it was administered to a pilot sample of 23 pupils outside the study sample. The correlation coefficients between each item and the total test, as well as between each item and its respective domain, were calculated. The discrimination coefficients ranged between 0.39 and 0.79, while the difficulty coefficients ranged between 0.29 and 0.78, all of which were statistically significant ($p \leq 0.05$).

To ensure the reliability of the study instrument, reliability was verified using two methods: the first was the test-retest method, where the test was administered and then re-administered after two weeks to a group of 23 pupils outside the study sample. Pearson correlation coefficients between their responses on the two occasions ranged between 0.88 and 0.96. The second method involved using the Kuder-Richardson Formula 20 (KR-20), where internal consistency values ranged between 0.69 and 0.

5.5. Study Variables

This study included the following variables:
- Independent Variables: These include language instruction based on augmented reality for the experimental group, and instruction using the traditional method for the control group.
- Dependent Variables: These include the improvement of creative reading skills (fluency, originality, flexibility).

6. Results

The main research question was: Does the performance of pupils at the childhood education stage on the Creative

Reading Skills Test differ depending on the teaching method (English language instruction based on augmented reality technology versus the traditional method) at a significance level of) $p \leq 0.05$ (To answer this question, the means, standard deviations, and adjusted means of the pupils' performance on the subscales and the total score of the Creative Reading Skills Test were calculated according to the teaching method (English language instruction based on augmented reality technology versus the traditional method). **Table 1** presents these results.

Table 1. Arithmetic means, standard deviations, and adjusted means of the pupils' performance.

Test Domains	Group (Learning Method)	Pre-Test		Post-Test		Adjusted Mean	No.
		Mean	Std. Dev.	Mean	Std. Dev.		
Fluency	Experimental group	4.01	1.73	5.94	0.94	6.17	127
	Control group	4.21	1.54	4.81	1.09	4.83	127
	Total	4.11	1.58	5.34	0.98	5.53	254
Originality	Experimental group	3.67	1.23	4.56	0.93	4.76	127
	Control group	3.61	1.34	3.67	1.01	3.53	127
	Total	3.64	1.21	3.83	1.01	3.84	254
Flexibility	Experimental group	3.81	1.12	4.82	0.89	4.89	127
	Control group	3.92	1.17	2.82	1.02	2.94	127
	Total	3.86	1.15	4.65	0.99	4.95	254
Total creative reading skills score	Experimental group	11.49	1.06	18.67	1.04	18.48	127
	Control group	4.01	1.33	13.25	2.04	13.39	127
	Total	4.21	1.04	16.34	2.07	15.53	254

Table 1 presents the means, standard deviations, and adjusted means of early childhood students' performance on the creative reading skills test according to the teaching method used. Based on this, **Table 1** indicates the following:

- Fluency: The data analysis results reveal that the experimental group outperformed the control group in the post-test, with a mean of (5.94) and a standard deviation of (0.94), compared to the control group's mean of (4.81) and standard deviation of (1.09). This superiority is also reflected in the adjusted mean, where the experimental group had (6.17) compared to (4.83) for the control group. This suggests that the teaching method used with the experimental group significantly enhanced their fluency.

- Originality: The data indicate that the experimental group showed a notable improvement in originality after the intervention, with the mean increasing from (3.67) to (4.56). In contrast, the control group showed only a slight improvement, with the mean rising from (3.61) to (3.67). The adjusted mean for the experimental group (4.76) reflects a more substantial positive difference compared to the control group's mean of (3.53).

- Flexibility: Regarding flexibility, the data show that the experimental group had a post-test mean of (4.82) compared to (2.82) for the control group. The experimental group also had a higher adjusted mean (4.89) compared to (2.94) for the control group. This indicates a noticeable improvement in flexibility skills for the experimental group.

Additionally, the data analysis reveals clear differences between the two groups in the overall score for creative reading skills. The experimental group achieved a post-test mean of (18.67) with a standard deviation of (1.04), while the control group scored (13.25) with a standard deviation of (2.04). The adjusted mean for the experimental group (18.48) is significantly higher than that of the control group (13.39), which reinforces the effectiveness of the teaching method used in improving creative reading skills in the experimental group. These results underscore the importance of employing innovative teaching methods to develop creative reading skills in children.

To determine the statistical significance of the differences between the arithmetic means, a multivariate analysis of covariance (MANCOVA) was used for the sub-levels, and a univariate analysis of covariance (ANCOVA) was used for the total score. **Table 2** shows these results.

Table 2 provides a summary of the ANCOVA results

Table 2. Summary of analysis of covariance (ANCOVA) for post-test scores.

Test Domain	Source of Variation	Sum of Squares	Mean Squares	DF	F Value	Significance (p-Value)	Effect Size (η^2)
Fluency	Pre-test (covariate)	2.907	2.837	1	1.715	0.189	0.018
	Teaching method	47.825	49.664	1	27.925	0.000	0.238
	Error	167.952	1.86	251			
Originality	Pre-test (covariate)	6.507	6.616	1	9.325	0.135	0.093
	Teaching method	10.837	11.62	1	15.367	0.000	0.145
	Error	86.317	0.79	251			
Flexibility	Pre-test (covariate)	2.916	3.00	1	2.343	0.126	0.025
	Teaching method	16.856	16.74	1	14.473	0.000	0.138
	Error	114.815	1.08	251			
Overall	Hotelling's T^2 = 0.478, p = 0.000						

for post-test scores in three domains: fluency, originality, and flexibility. Below is a refined analysis for each domain:

(1) First domain—Fluency

- Pre-test (Covariate): The pre-test did not show a statistically significant effect, with an F-value of 1.715 and a p-value of 0.189. This indicates that the pre-test had no substantial impact on post-test fluency scores. The effect size (η^2) was small, at 0.018.

- Teaching Method: The teaching method had a significant and strong effect on fluency, with an F-value of 27.925 and a p-value of less than 0.001. The effect size (η^2) was relatively large, at 0.238, indicating that the teaching method accounted for 23.8% of the variance in fluency scores.

(2) Second domain—Originality

- Pre-test (Covariate): Despite an F-value of 9.325, the p-value of 0.135 suggests that the pre-test did not have a statistically significant effect on originality. The effect size (η^2) was moderate, at 0.093.

- Teaching Method: The teaching method had a significant effect on originality, with an F-value of 15.367 and a p-value of less than 0.001. The effect size (η^2) was moderate, at 0.145, indicating that the teaching method explained 14.5% of the variance in originality scores.

(3) Third domain—Flexibility

- Pre-test (Covariate): The pre-test did not have a statistically significant effect on flexibility, with an F-value of 2.343 and a p-value of 0.126, suggesting no significant impact of the pre-test on flexibility. The effect size (η^2) was small, at 0.025.

- Teaching Method: The teaching method had a statistically significant effect on flexibility, with an F-value of 14.473 and a p-value of less than 0.001. The effect size (η^2) was moderate, at 0.138, indicating that the teaching method accounted for 13.8% of the variance in flexibility scores.

Overall Results: Hotelling's T^2 test revealed a statistically significant overall effect of the teaching method on the three domains (fluency, originality, and flexibility), with a T^2 value of 0.478 and a p-value of less than 0.001.

In conclusion, the results demonstrate that the teaching method had a substantial effect on the development of fluency, originality, and flexibility skills, while the pre-test had no significant effect on fluency and flexibility.

Additionally, ANCOVA was used to examine the effect of the teaching method on the overall Creative Reading Skills Test. **Table 3** presents these results.

The results of the ANCOVA analysis in **Table 3** demonstrate the effect of the teaching method on creative reading skills performance, after adjusting for the pre-test as a covariate.

- Pre-test (Covariate): The F-value for the pre-test is 6.67, which is statistically significant at the 0.008 level. This indicates that the pre-test had a significant effect on creative reading performance, accounting for approximately 8.9% of the variance in performance.

- Teaching method: The F-value for the teaching method is 44.47, statistically significant at the 0.001 level. This suggests a substantial impact of the teaching method on creative reading skills. The effect size (η^2) is 0.413, indicating a large effect, meaning the teaching method accounts for approximately 41.3% of the variance in creative reading performance.

- Error: The error term represents the unexplained variance, amounting to 698.98. In summary, the findings

Table 3. ANCOVA results for assessing the impact of the teaching method on creative reading skills performance.

Source of Variation	Sum of Squares	DF	Mean Squares	F Value	Sig.	Effect Size (η^2)
Pre-test (Covariate)	63.098	1	645.00	6.67	0.0080	0.089
Method	334.02	1	390.07	44.47	0.0010	0.413
Error	698.98	247	8.01			
Total Adjusted	1311.04	249				

suggest that the teaching method had a significant and strong influence on the development of creative reading skills among participants, even after controlling for the effect of the pre-test.

7. Discussion

The current research investigates the impact of augmented reality (AR) technology on developing creative reading skills (fluency, originality, and flexibility) in English among elementary school students in Jordan. The results revealed the importance of augmented reality technology in enhancing creative reading skills in English learning environments. This can be attributed to the technology's ability to stimulate pupils' interest and motivation by providing interactive and immersive experiences that capture their attention and encourage active participation in the educational process. Furthermore, augmented reality technology facilitates interaction with virtual elements, which contributes to improving pupils' communication skills and self-confidence, providing them with opportunities to apply the language in realistic and stimulating contexts.

The results of this study are consistent with previous research by researchers [19, 20, 22, 24, 28, 32, 38–40], which indicated that augmented reality techniques have multiple positive effects on pupils' reading skills. Specifically, the use of augmented reality significantly improved reading comprehension, with pupils in the experimental group achieving higher scores compared to the control group, demonstrating the effectiveness of this technology in enhancing text comprehension.

More importantly, these findings are consistent with previous studies [32, 38, 41, 42], which examined the importance of AR in teaching English language skills from teachers' perspectives. These studies demonstrated that AR contributes to improving language skills, reducing students' anxiety levels, enhancing their creativity, and increasing their collaboration and interaction in the classroom, ultimately fostering positive

attitudes toward using this technology in learning English.

The authors believe that these results can be attributed to the significant role AR plays in opening new horizons in education. This technology provides a learning environment that transcends the limitations of the traditional classroom, offering students an interactive experience that stimulates their creative reading skills. Based on the findings of this study, the following conclusions can be drawn:

- AR technology contributes to developing creative fluency skills by enabling the repetition of activities in innovative and enjoyable ways, increasing students' opportunities to practice the language and engage with it in non-traditional ways. This result aligns with previous studies [30, 31, 41], which emphasized that developing linguistic fluency skills among learners requires interactive language activities.
- AR technology enhances creative originality skills in language lessons by offering multi-dimensional activities that allow students to explore and experiment with new ways of using vocabulary and expressions, thus boosting their ability to create novel and unconventional styles of expression. In this context, educational studies [28, 36, 37] highlighted the importance of providing contemporary technologies that empower learners to employ vocabulary and expressions in contexts that encourage innovation and creativity in language use.
- AR activities offer learning opportunities that develop flexibility skills by allowing students to engage with a variety of educational scenarios that require quick thinking and adaptability to different learning situations. This finding aligns with previous studies [10, 14, 21, 27, 43, 44], which underscored the role of AR in enabling learners to practice creative flexibility skills in diverse ways.

Moreover, the positive impact of AR on these creative reading skills indicates that this technology creates comfortable learning environments that help alleviate the anxiety many students experience when learning a new language. By

reducing anxiety levels, students are better able to think creatively and flexibly without fear of making mistakes, thereby contributing to the development of creative reading skills. Additionally, the findings of this study provide clear evidence of the importance of direct interaction with learning materials through AR, which enhances students' sense of active participation. This increased engagement motivates them to collaborate with their peers and become more involved in educational activities. Such interaction transforms the learning process into an enjoyable and exciting experience, sparking students' curiosity and encouraging them to learn in innovative ways, ultimately improving academic performance and promoting positive attitudes toward the use of technology in education.

8. Conclusions and Recommendations

The study demonstrates that augmented reality (AR) technology significantly enhances creative reading skills—specifically fluency, originality, and flexibility—among elementary school students in Jordan. This positive impact highlights how AR fosters deeper engagement, creativity, and collaboration in English language learning. These findings are consistent with previous research, which underscores AR's potential to create dynamic and interactive learning environments that support language development. By reducing students' anxiety levels, AR enables learners to explore language in innovative, risk-free ways, making the classroom experience more engaging and supportive of creative expression.

These results carry important implications for educational practices. AR technology can serve as a powerful tool for not only improving language skills but also promoting creative thinking and active learning. Integrating AR into classroom activities allows students to engage with material in ways that go beyond traditional methods, potentially reshaping how language education is delivered. In this context, it is crucial for policymakers and educators to explore ways to incorporate AR into teaching methodologies, as this approach has shown great promise in encouraging student-centered learning and reducing the stress often associated with learning a new language.

To fully realize the benefits of AR, several recommen-

dations can be made. First, incorporating AR-based activities into the language learning curriculum is essential for fostering creativity and problem-solving skills. Additionally, it is important to provide teachers with proper training on how to effectively use AR in their lessons. This requires professional development programs that focus on equipping educators with the tools they need to integrate AR seamlessly into their classrooms. Furthermore, schools must allocate adequate resources, including both AR software and hardware, to support this technological integration. AR activities should be designed to encourage active, student-centered participation, allowing learners to take control of their own educational experiences through innovative and interactive exercises.

Despite the promising findings, this study has limitations. Conducted within the specific context of elementary school students in Jordan, the results may not be easily generalized to other regions or age groups. Additionally, the short-term nature of the AR intervention leaves unanswered questions about the long-term effects of AR on creative reading skills. External factors such as students' socioeconomic background or prior exposure to technology were not controlled, which may have influenced the outcomes.

Looking ahead, future research should aim to explore the long-term impact of AR on language skill development across a range of educational and cultural settings. Comparative studies involving different age groups, languages, and educational systems would provide valuable insights into the broader applicability of AR in language education. Moreover, further investigation is needed to identify the specific components of AR activities that most effectively enhance creativity. There is also growing interest in examining how AR might be combined with other emerging technologies, such as virtual reality (VR) and artificial intelligence (AI), to further enrich and diversify the learning experience.

Author Contributions

R.M.A. and A.A.A.-B. conceptualized the manuscript's focus, proposed the aims, prepared the draft manuscript, and wrote all the sections. R.M.A. and A.A.A.-B. also collected, analyzed, and interpreted the data. R.M.A. and A.A.A.-B. were major contributors to writing the manuscript. All authors read and approved the final version of the manuscript.

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Informed consent was obtained from all individual participants included in the study.

Date Availability Statement

The authors will make the raw data supporting the conclusions of this article available upon request, without any undue restrictions.

Conflict of interest

The authors declare that there is no conflict of interest.

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