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Vocabulary Learning of Textile Terms in Junior High School English as a Foreign Language via Augmented Reality

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Article

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ABSTRACT

This research focuses on the effect of applying augmented reality (AR) technology in teaching textile industry terms in English as a Foreign Language courses in junior high school. Two classes in junior high school with similar English levels were selected as the experimental subjects. The experimental group used AR technology for teaching, while the control group used traditional teaching methods. The experimental period spanned eight weeks. Through a pretest, a posttest, motivation questionnaires, interviews, memory retention tests, and other methods, data were collected from seven indicators: academic performance, motivation, experience, memory retention rate, classroom participation, application transfer ability, and learning time efficiency. The analysis of the results indicates that the learning method based on visualization technology shows significant advantages in enhancing students' depth of understanding of textile technology terminology, long-term memory retention, and their ability to apply this knowledge in simulated work scenarios. Furthermore, this method substantially improved learning efficiency. This research confirms that applying digital simulations and interactive models to professional education in the textile field is a highly efficient and feasible strategy.

KEYWORDS

textile technology, ctton, technical education, digital simulation, textile industry

INTRODUCTION

Amid the accelerating globalization, English, as an international common language, has become increasingly important. As such, teaching English is no longer limited to daily communication and basic grammatical knowledge. Instead, it has increasingly focused on the language's close integration with real industries to cultivate compound talents who can adapt to the needs of globalization. Augmented reality (AR) technology offers a novel solution by combining digital information with the real world to present abstract and hard-to-visualize physical concepts and phenomena through three-dimensional visualization [1]. With the international development of the textile industry, mastering English terms related to it will not only help students broaden their professional English knowledge but also enhance their language application ability in future career scenarios. Moreover, it lays the foundation for learners' participation in international exchanges and cooperation. At the same time, AR technology has gradually become an emerging tool in the field of education through its ability to integrate virtual information with real scenes. It can create an immersive and interactive learning environment for language learning, effectively stimulate students' interest and participation in learning, and bring new opportunities for the transformation of game-based English teaching models.

Scholars have conducted rich research in this context. For instance, Saavedra integrated AR teaching into physics subjects and emphasized that the new teaching method enhances students' interaction and participation in the learning process; the research highlights the need to design effective systems for AR learning to apply new technologies fully [2]. Valero highlighted that the use of AR technology involves innovative teaching methods adopted by teachers and improved student learning effectiveness [3]. Upon reviewing the application of AR basics in teaching through systematic literature, Lampropoulos concluded that this technology can become an effective educational tool in supporting lifelong learning for students and teachers, as well as face-to-face, hybrid, and online learning at all levels of education and work scenarios [4]. Czok noted that technological advances and growing interest in digital education have increased the use of AR in education [5]. However, previous research results on AR's potential for knowledge acquisition remain inconclusive. Vocabulary is an important part of teaching English as a Foreign Language (EFL) in junior high school. As such, most of the current research involves English vocabulary teaching at this level. Zhang reported that game-based English vocabulary teaching is taught in a mechanical way and not in a specific background, thus resulting in students having no memory of vocabulary scientific strategies and needing to memorize them by rote [6]. He believed that situational cognitive theory should be used to conduct vocabulary teaching scientifically [6]. Ruofan also analyzed the rote memorization method used by junior high school students in game-based English vocabulary learning and expressed that students may remember terms in the short term but cannot retain them for a long time [7]. Therefore, he proposed a mixed method to maximize the efficiency of vocabulary teaching [7]. In addition, Zhang affirmed the effectiveness of multimodal teaching for English vocabulary in junior high school; clinical comparative experiments confirmed the superiority of this method over game-based vocabulary teaching methods [8]. Qian noted that multimodel theory emphasizes dynamic language learning. Using this theory in teaching English vocabulary in junior high school has a positive effect on the cultivation of students' critical thinking and in-depth learning. It can also meet modern needs and enhance core abilities [9]. In addition, Zhou used a quantitative method to explore the impact of a metacognition strategy on junior high school students' English vocabulary acquisition. The study also explored the practical value of this training to provide reference for the reform of English vocabulary teaching in junior high schools [10].

Currently, the teaching content and methods of EFL courses in junior high school predominantly follow traditional models. As such, they have a relatively weak focus on professional terminology, thus failing to meet students' needs for practical English knowledge. With the advancement of industrial production, the demands for precision and efficiency in machine tool operations have grown increasingly stringent, while traditional control methods demonstrate inherent limitations. As an emerging technology that seamlessly integrates virtual information with the real world, AR has demonstrated remarkable potential in industrial applications. Therefore, its implementation in machine tool control systems must be explored [11]. Although numerous explorations have been conducted in the application of AR technology in education, most of these studies focus on general knowledge areas. Meanwhile, few studies have examined how English terms are taught in specific professional fields, such as the textile industry. This study explores the application of AR technology in teaching textile industry terms in EFL courses in junior high school, which has significant implications in multiple aspects. In terms of teaching innovation, this work can provide new methods and ideas for English teaching, thus promoting the transition from traditional to digital and intelligent teaching models. For student development, it helps improve students' outcomes in learning professional English terms, enhances their motivation and interest in learning, and cultivates their language application and practical skills. From the perspective of technology promotion, it verifies the feasibility and effectiveness of AR technology in specific teaching scenarios through practice. Hence, this research provides a practical basis for the widespread application of AR technology in English teaching and other subjects and promotes the innovation and development of educational technology.

Materials and Methods

Materials

AR learning resources. The development of AR learning applications will adhere to the principle of combining systematicness with fun. In terms of content structure, the application is divided into four main modules based on the textile production process: raw material processing, equipment operation, process processing, and finished product inspection. Each module includes specific knowledge points, such as the raw material processing module, which covers terms that are related to cotton picking and wool carding. For technical implementation, AR resources for textile equipment in educational scenarios will adopt a secondary development of the existing open-source resources model. The basic 3D model will be adapted from the general textile machinery model library in the Unity Asset Store (e.g., Cloth Simulation Toolkit), while core dynamic simulation modules (e.g., shuttle motion trajectories and warp/weft yarn interweaving logic) will reference physics engine parameters from Vuforia's official educational case studies. This approach significantly reduces technical barriers and capital investment (with individual equipment model development costs under CNY2,000). The solution prioritizes mobile deployment through lightweight apps (supporting Android 8.0 and above) that enable recognition functionality. Students can simply scan AR marker images in textbooks using smartphone cameras to trigger 3D model interactions. This function avoids the high procurement costs of head-mounted devices (averaging over CNY3,000 per unit) and campus network load pressure. For deployment, a "cloud-based lightweight deployment + local caching" architecture is adopted. Schools only need basic WiFi environments (bandwidth ≥ 10Mbps), which can allow teachers to preload resource packages via classroom all-in-one machines. Student devices can load resources within 30 seconds per session, thus accommodating most junior high school hardware configurations. For fabric material terminology, AR special effects are used to present the microscopic structure, such as the arrangement of protein fibers in silk and the antiwrinkle molecular chain structure of polyester fibers. This feature can help students intuitively understand the scientific principles behind professional terms. Additionally, interactive minigames, such as "Textile Terminology Puzzle Challenge" and "Equipment Component Name Quiz," are designed to reinforce students' memory and application of vocabulary.

Traditional learning materials. Traditional paper textbooks follow a step-by-step approach, which starts with an introduction to the basics of the textile industry and is followed by a systematic listing of core terms. Each portion is accompanied by Chinese and English definitions, examples, and simple illustrations. The vocabulary list is organized alphabetically, along with notes on the parts of speech and common collocations. This format allows students to search and review the materials easily. The exercises include various types, such as fill in the blanks, multiple choice, translation, and sentence creation. Then, they gradually increase in difficulty from simple to complex. For example, basic questions ask students to write down the corresponding terms based on pictures, while advanced questions require students to describe the textile production process using multiple terms, thus comprehensively assessing their understanding of the terms.

Methods

Experimental method: The two classes from junior high school were selected as the experimental subjects. The sample consisted of 70 students: 35 were in the experimental class, while the other 35 were in the control class. First, a unified English proficiency test was performed on all junior high classes in the selected school. The test included listening, reading, writing, and vocabulary. Two classes with similar average scores and score distribution were selected based on the test scores. At the same time, students were issued a learning background questionnaire to understand their awareness of the textile industry and whether they had been exposed to AR technology. This additional screening ensured that the two groups of students were comparable in terms of initial conditions. In addition, the head teacher and English teacher were consulted before the experiment to eliminate interfering factors that might affect the experimental results, such as class management style and students' special circumstances [12]. The experimental period spanned eight weeks. Figure 1 presents the arrangement during this time frame. In the experiment, the influence of teachers' factors was avoided by assigning one teacher who was responsible for teaching both classes. Finally, data collection and analysis were conducted. Then, the pretest and the learning motivation questionnaires were completed one week before the start of the experiment to ensure the timeliness of the data. During the experiment, classroom participation data were recorded once a week. Students' speeches, discussion performance, and questioning quality were marked in detail. The posttest and retest of the learning motivation questionnaire were conducted immediately after the experiment. A test for vocabulary memory retention was conducted one month later. Then, a vocabulary application transfer task was assigned two months later. Table 1 presents specific test indicators.

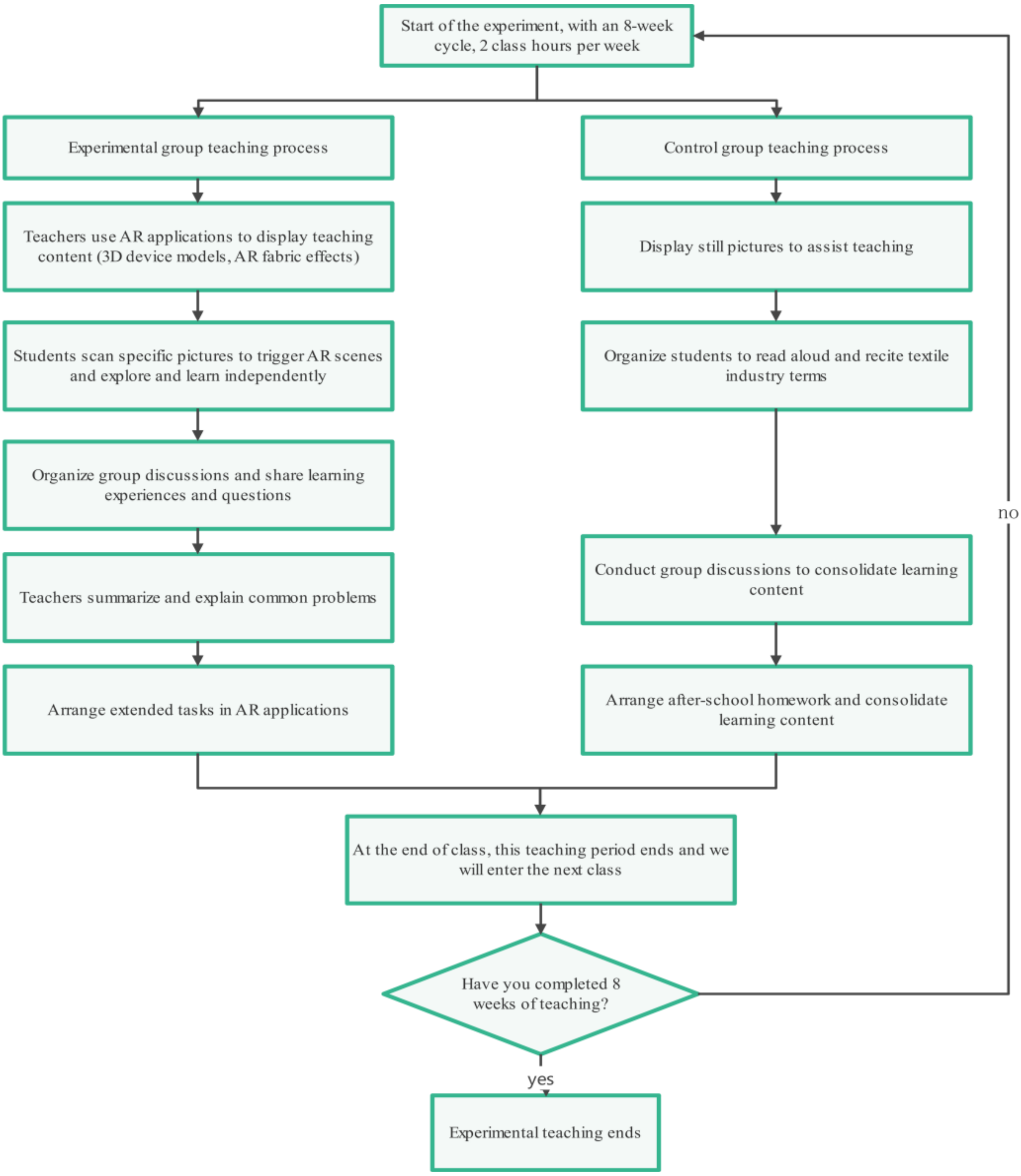

Figure 1. Experimental design flow chart

Data analysis method: All test scores and questionnaire data were entered into SPSS 26.0 statistical software. A paired sample t-test was used for intragroup differences, while an independent sample t-test was used for intergroup differences. These methods were used to explore the impact of AR technology on various indicators. The interview content was transcribed and analyzed using NVivo 1.0 software, which extracted key information from students' learning experiences.

Table 1. Evaluation indicators of the application effect of augmented reality technology in English as a Foreign Language courses in junior high school

Evaluating indicator	Computational method
Pretest and posttest scores	The test includes four types of questions: vocabulary recognition (multiple choice), spelling, definition matching, and sentence creation with a total score of 100 points. Scores from the pretest and posttest for each student are calculated. The average scores and standard deviations of the experimental group and the control group are determined separately. An independent sample t-test is used to compare the pretest average scores of the two groups, thus confirming that no significant difference exists in the students' English proficiency before the experiment. Then, the posttest average scores are compared to assess the impact of AR technology on academic performance.
Learning motivation questionnaire	Reference literature [13]. Some content of the "Biological Learning Motivation Scale (AMS-LB)," which evaluates students' learning motivation using a five-point Likert scale, is used. The questionnaire includes 20 questions that cover various dimensions, such as learning interest, learning goals, and self-efficacy. The total learning motivation scores of the two groups of students are calculated. Then, an independent sample t-test is performed on the postexperiment average scores of both groups to compare the differences.
Learning experience methods	The interview content is transcribed verbatim and analyzed using NVivo software [14]. The word frequency analysis is conducted using the total vocabulary of two interview transcripts as the baseline. The process begins with text cleaning to remove punctuation, function words, and meaningless modal particles, thus retaining only core lexical elements (nouns, verbs, adjectives, etc.). Subsequently, valid words undergo root consolidation (e.g., merging "comprehended" and "comprehending" into "comprehend"). Finally, the frequency of each target word in the corresponding group's transcript is calculated. This frequency is divided by the group's total valid vocabulary count and multiplied by 100 to obtain word frequency ratios (rounded to one decimal place). These ratios reflect the usage frequency differences between the two groups' expressions.
Vocabulary retention test	One month after the end of the experiment, the test is conducted in a similar way to the posttest, which has a total score of 100 points. The students' scores are calculated. Then, the average score and standard deviation of the experimental group and the control group are obtained. The difference between the two groups is compared by using an independent sample t-test to evaluate the long-term memory effect of vocabulary.
Students' participation	Teachers record the number of times students speak, their participation in group discussions, and the number of times they ask questions each week [15]. These three indicators are assigned different weights: speaking

	time (0.3), group discussion participation time (0.4), and asking questions (0.3). The weekly classroom participation score for each student is calculated as follows: Score = Speaking time × 0.3 + Group discussion participation time × 0.4 + Asking questions × 0.3. Then, the average participation scores for the experimental and control groups are calculated to compare the groups and assess changes within the same group over time. The independent sample t-test is used for intergroup comparisons, while the paired sample t-test is used for intragroup comparisons.
Vocabulary application migration task	New scenarios related to the textile industry, such as writing introductions for English textile products and simulating foreign trade negotiations, are assigned to students. Two English teachers score these tasks based on specific criteria, including vocabulary accuracy, richness, and sentence coherence (out of a total of 10 points). Then, the average score is used to determine the student's task score. The average scores and standard deviations of the experimental group and the control group are calculated. An independent sample t-test is used to analyze the differences between the two groups.
Total study time	The average total time for students in the experimental group and the control group to complete the same textile industry term learning task (such as mastering 50 terms) is recorded. Then, the difference between the two groups is compared by an independent sample t-test to analyze the learning time efficiency.

RESULT

Pretest and Posttest Scores

Figure 2 shows the pretest and posttest average scores of the experimental group and the control group. The independent sample t-test indicated no significant difference in the pretest average scores between the two groups ($t = 1.313$, $p = 0.195$). This outcome suggests that the English proficiency levels of both groups were similar before the experiment. However, a significant difference was observed in the posttest average scores ($t = 16.201$, $p < 0.001$), thus indicating that AR technology significantly improved the learning outcomes of the experimental group students for textile industry terminology.

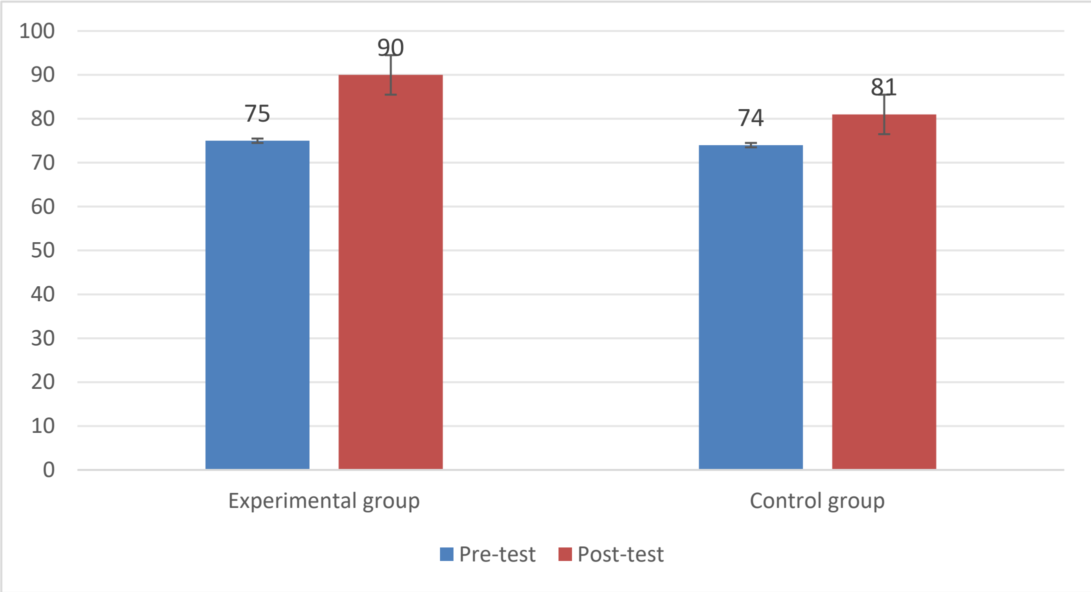

Figure 2. Comparison of pretest and posttest scores between the two groups

Learning Motivation Questionnaire

Figure 3 presents the statistical results of the learning motivation questionnaire for two groups of students before and after the experiment. The independent sample t-test indicated no significant difference in the total scores of learning motivation between the two groups before the experiment ($t = 0.637$, $p = 0.527$). However, after the experiment, the total scores of learning motivation in the experimental group were significantly higher than those in the control group ($t = 3.820$, $p < 0.001$). This outcome suggests that the use of AR technology in student learning has a positive impact on enhancing their learning motivation.

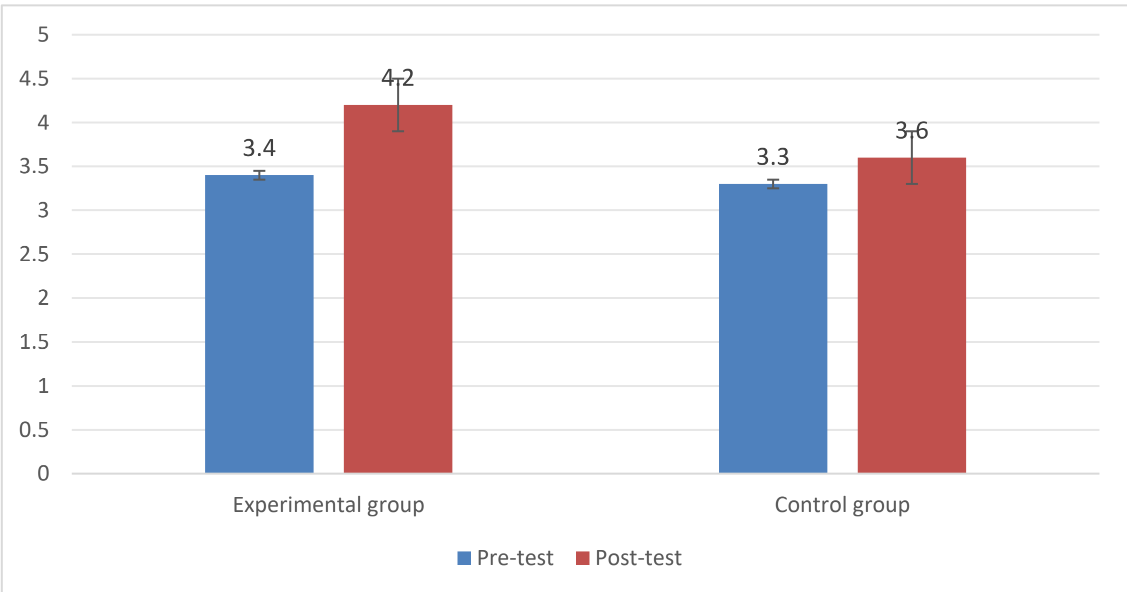

Figure 3. Comparison of the average scores of learning motivation questionnaire before and after the two groups of experiments

Learning Experience Interviews

The NVivo coding analysis demonstrated that the top 10 most frequently used words in the two groups of interview contents varied significantly. A high-frequency word analysis of the two interview groups revealed significant differences in their top 10 commonly used terms. The experimental group's core vocabulary included "interesting," "comprehend," "equipment," and "model," while the control group's key terms consisted of "engaging," "grasp," "device," and "simulation." The specific distribution is shown in Table 2.

Table 2. Top 10 words and word frequency in the two groups of interviews

Number	Experimental group (frequency, %)	Control group (frequency, %)
1	Interesting (18.5)	Engaging (16.2)
2	Comprehend (15.7)	Grasp (14.8)
3	Equipment (11.3)	Device (12.5)
4	Model (10.8)	Simulation (10.8)
5	Study (9.8)	Learn (9.9)
6	Difficulty (8.2)	Challenge (9.2)
7	Show (7.7)	Present (6.9)
8	Like (6.4)	Prefer (6.5)
9	Function (5.2)	Feature (5.8)
10	Time (4.9)	Duration (4.7)

Vocabulary Retention Test

Figure 4 presents the data on vocabulary retention after two sets of experiments. The experimental group showed a significantly higher average score than the control group. The independent sample t-test revealed a significant difference in the average scores between the two groups ($t = 4.669$, $p < 0.001$). This outcome suggests that AR technology, with its multisensory stimulation, effectively enhances students' vocabulary retention. As a result, students in the experimental group maintained better memory of textile industry terms even after a longer period, thus demonstrating a significant advantage over the control group in long-term vocabulary retention.

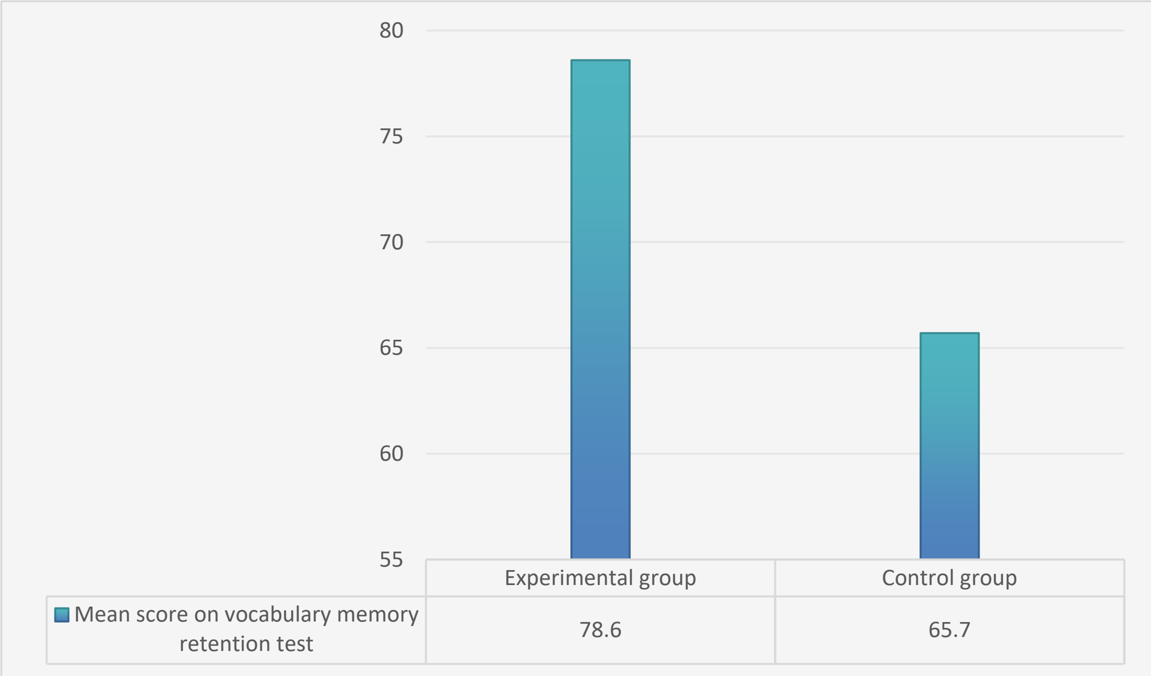

Figure 4. Average scores of the vocabulary retention test after two groups of experiments

Students' Participation

Descriptive statistics showed that the average weekly classroom participation score of the experimental group increased from 6.5 ± 0.8 at the beginning to 8.2 ± 0.7 at the end of the experiment. Meanwhile, the control group's score fluctuated between 6.4 ± 0.9 and 6.8 ± 0.9. The paired t-test results indicated a significant difference in participation scores before and after the experiment ($t = 7.729$, $p < 0.001$) for the experimental group. In addition, the independent sample t-test showed a significant difference in participation scores at the end of the experiment between the experimental group and the control group ($t = 5.765$, $p < 0.001$). This outcome indicates that AR technology significantly enhanced students' classroom participation, as shown in Figure 5.

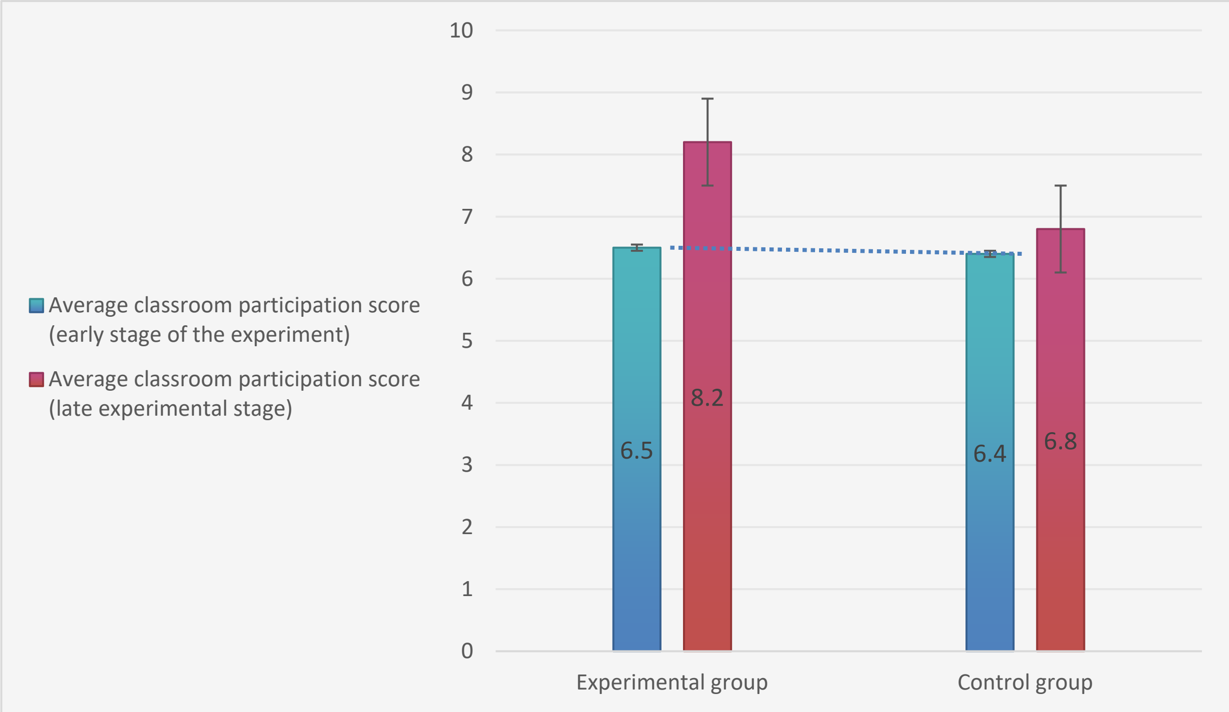

Figure 5. Average scores of classroom participation after two groups of experiments

Vocabulary Application Migration Task

Descriptive statistics showed that the experimental group scored an average of 7.8 ± 0.8 on the vocabulary application transfer task compared with 6.1 ± 0.9 for the control group. The independent sample t-test revealed a significant difference in mean scores between the two groups ($t = 7.733$, $p < 0.001$). This outcome indicates that the AR technology helped students effectively understand vocabulary in context and significantly enhanced their ability to apply learned vocabulary flexibly in new situations, as shown in Figure 6.

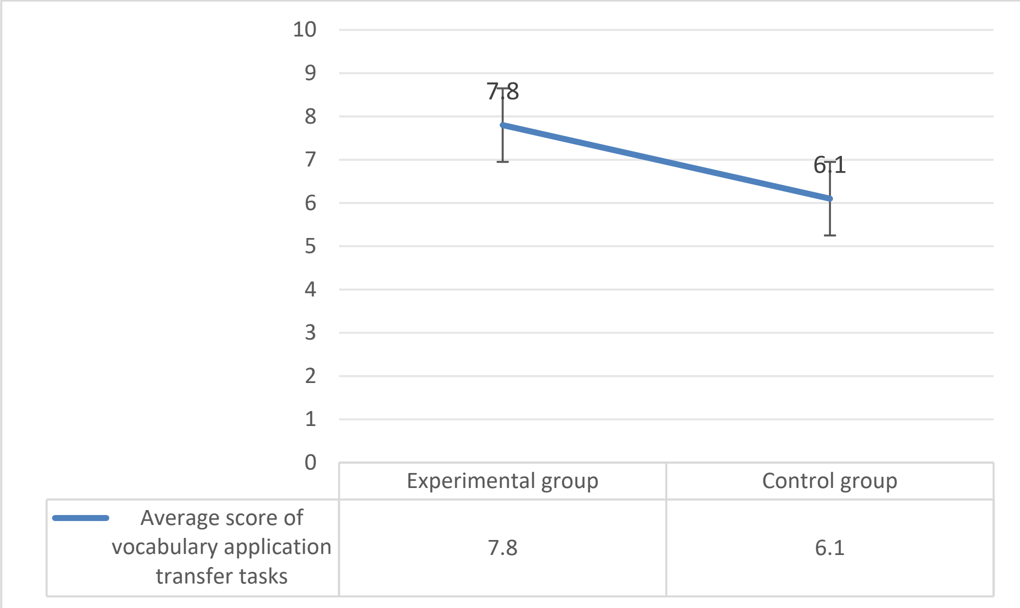

Figure 6. Average scores of vocabulary application transfer tasks after two groups of experiments

Total Study Time

Descriptive statistics showed that the average total study time for the experimental group was 4.2 ± 0.5 hours. For the control group, the average duration was 6.5 ± 0.8 hours. The independent sample t-test revealed a significant difference in the average total study time between the two groups ($t = 13.353$, $p < 0.001$). This outcome indicates that the intuitive presentation and interactive learning model of AR technology enabled students to grasp knowledge efficiently, thus significantly reducing study time, as shown in Figure 7.

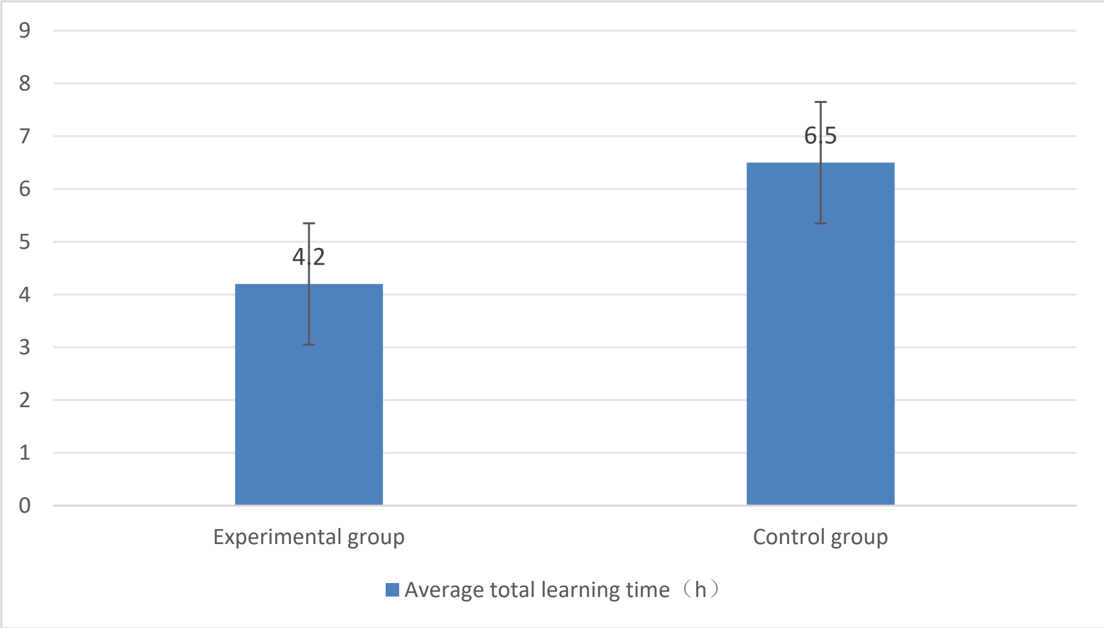

Figure 7. Average total study time (h) for the two groups

DISCUSSION

This experiment evaluated the effectiveness of AR technology in teaching textile industry terms in EFL courses in junior high school using multidimensional indicators. The results showed that AR technology had a positive and significant impact on students' learning. In terms of academic performance and memory retention, the posttest scores and vocabulary retention test scores of the experimental group were significantly higher than those of the control group. AR technology transforms abstract terms in the textile industry into visual scenes through 3D models and dynamic demonstrations, such as the dynamic process of yarn knitting in a virtual factory. This approach helps to reduce cognitive load by concretizing concepts and avoids the mental strain that students may experience when constructing abstract ideas on their own. Additionally, AR integrates information through multisensory stimulation. For example, when users click on virtual machinery, the definitions and sound effects are played simultaneously, thus reducing the external cognitive overload caused by fragmented information. In terms of specific elements, 3D models allow students to zoom in and rotate freely to understand the intricate details of mechanical structures. Interactive minigames reinforce active practice through an operation–feedback loop, which promotes knowledge understanding and memory retention through intuitive operations and immediate feedback. From the perspective of self-determination theory, students can control their interactive behaviors to meet their need for autonomy. Interactive tasks provide a sense of achievement through tiered challenges, while collaborative virtual textile projects enhance a sense of belonging through shared goals; these activities form a learning cycle of autonomous exploration, skill enhancement, and social connection [16].

In terms of learning motivation and classroom participation, the immersive and interactive learning environment created by AR technology effectively stimulates students' interest. Therefore, compared with traditional technology, AR has significant advantages in promoting the assembly process of complex products [17]. This technology-driven learning model satisfies students' curiosity about new things; moreover, it aligns with the psychological needs of autonomy, competence, and belonging as outlined in self-determination theory, thereby enhancing intrinsic motivation for learning [18]. The development of Industry 4.0 is driving the use of technologies, such as AR, for visualization and training applications in manufacturing [19]. In terms of vocabulary application transfer, students in the experimental group performed better than those in the control group. This outcome indicates that the realistic learning scenarios created by AR technology help students to apply their learned vocabulary flexibly to new contexts, thus facilitating knowledge transfer.

LIMITATIONS

This experiment selected only two classes from one school as the research subjects, thereby having a small sample size and a single source. This scope may not fully represent the learning situations of students from different regions and with varying levels of English proficiency. Furthermore, the generalizability of the findings requires further validation. Even with the same instructor, the high interactivity of AR group teaching may lead to variations in how the teacher intervenes, which can be a potential confounding factor that is worthy of discussion. The AR learning application that was used in the experiment has room for improvement in functionality and content, such as the lack of precision in some 3D models and the insufficient richness of interactive elements. In addition, the experiment spanned only eight weeks. As such, the long-term impact of AR technology on student learning outcomes remains to be thoroughly investigated.

FUTURE RESEARCH

Future research can expand the scope of this study by selecting students from multiple schools and regions, including those with varying English proficiency levels and learning backgrounds. This expansion can help to validate the effectiveness of AR technology in EFL courses in junior high school. It can also enhance the general applicability of the research findings. At the same time, the use of AR technology can integrate the information space of work instructions into products, which eliminates the effect of distraction to a large extent [20]. Collaboration with technical development teams can be established to enhance the stability and functionality of AR learning applications. This approach can promote additional interactive scenarios and practice modes. Researchers can also explore solutions for achieving high-quality AR teaching using low-cost devices, such as mobile phones, thus lowering the application threshold [21]. The experimental period can also be extended to track long-term learning outcomes and investigate the impact of AR technology on developing students' overall English proficiency.

CONCLUSION

This study conducted an empirical analysis and confirmed the effectiveness and feasibility of AR technology in teaching textile industry terminology as part of EFL courses in junior high school. AR technology significantly enhances students' academic performance, boosts their motivation to learn, improves their learning experience, and facilitates vocabulary retention and application transfer. Therefore, it offers new approaches and methods for innovative English teaching. However, the study also highlights issues and limitations in the practical application of AR technology in education. Future efforts should focus on optimizing technical and educational resources, broadening the research scope, and promoting the deep integration and widespread use of AR technology in education. Such efforts can provide robust support for cultivating talents with professional English skills and innovation capabilities.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

Author Contributions

Lianying Qian designed, collected and analyzed the data, and drafted the manuscript. Lianying Qian conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Lianying Qian participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Funding

Not applicable.

Conflict of Interest

The author declares no conflict of interest.

Ethics Approval and Consent to Participate

This survey was conducted in compliance with Ethics Committee of The First Junior High School of Xiaochang County. Participants were informed of the study's purpose and data usage prior to participation, and responses were collected anonymously. No personally identifiable information was stored.

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