



## THE IMPACT OF THE OK4R MOBILE PLATFORM ON VOCATIONAL STUDENTS' IMPROVEMENT OF SCIENCE READING COMPREHENSION AND LOGICAL THINKING

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**Abstract.** *In Taiwan, the education system places a strong emphasis on higher education. Students who perform well in the National High School Entrance Examination are given priority admission to public high schools, while those with lower scores tend to enroll in vocational schools.*

*It's worth noting that students with low scores in this examination often struggle with reading and natural literacy, typically scoring below level 2 in PISA assessments.*

*This study examined the impact of implementing the mobile platform OK4R reading strategy on students' comprehension of popular science reading and their logical thinking abilities. The research was conducted with two classes of first-year vocational school students.*

*The findings indicate that when students used the OK4R mobile platform for popular science reading, it had a positive effect on their popular science reading comprehension and their logical thinking skills. Notably, female students outperformed their male counterparts. The study also revealed that several factors, including gender, basic abilities, and other variables, influenced the effectiveness of the OK4R mobile platform for vocational students. Those with lower science scores appeared to benefit the most from this approach.*

**Keywords:** *OK4R, popular science reading, logical thinking, vocational high school students, reading comprehension*

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### Introduction

The 2018 PISA student performance report from the OECD indicates that Taiwanese students made slight progress overall. However, there has been a significant increase in the proportion of students achieving high levels (level 5 and above), while the performance of low-achieving students (level 2) has not seen significant improvement over the past decade. This lack of improvement for low-achieving students has been a persistent issue in Taiwan (Crato, 2021). The PISA report also highlights gender differences in academic performance. Girls tend to outperform boys in reading literacy, while boys generally do better than girls in understanding scientific passages. One possible explanation is that boys may have a stronger background in scientific content, leading to higher overall science scores (Lee, 2015). Research on Polish vocational students suggests that their reading literacy is lower than that of high school students. After implementing teaching interventions, girls tend to demonstrate greater improvements in reading skills compared to boys, and their scientific skills also show more improvement than those of boys (Tereszewski & Walczyński, 2015). Conversely, studies by Sanchez and Wiley (2010) have shown that traditionally, boys have outperformed girls in visual-spatial and overall science learning, which can have an impact on career decisions. However, further research has shown that the use of illustrations and animation effects can effectively reduce these gender differences. Additionally, Ghazivakili et al. (2014) found that learning style, age, and gender are related to the learning environment. Girls tend to excel in inference and critical thinking skills, but there are no significant gender differences in evaluation, analysis, inductive reasoning, or deductive reasoning. Overall, the studies mentioned highlight the intricate interaction of various factors, including gender, teaching methods, and learning environments, in influencing students' academic performance in reading and science.



Yore and Denning (1989) identified three key abilities in scientific reading: vocabulary ability, comprehension ability, and discussion ability. The importance of popular science courses and popular science reading is underscored by Guthrie et al. (2000), who found that the effective use of reading strategies can enhance students' intrinsic motivation for scientific reading. Several strategies and teaching methods have been found to improve students' reading motivation, learning ability, and the effectiveness of comprehending scientific texts or popular science articles. These strategies include the application of reading comprehension strategies, the use of multimedia elements like animations and images, questioning strategies, and interactive teaching methods (Baird-Thompson, 2023; Barak et al., 2011; Dalacosta et al., 2009; Mason et al., 2013). Ozuru et al. (2009) noted a positive correlation between integrated comprehension ability and students' prior knowledge, indicating that higher reading ability benefits from reading highly cohesive texts. Akin et al. (2015) went further to find that reading scientific texts not only enhances academic performance but also significantly improves critical thinking and critical reading skills. In practical teaching, educators must pay close attention to students' reading processes, especially in the context of popular science. Using reading strategy tools to facilitate interaction with the text and construction of knowledge can be a valuable approach to effectively employ auxiliary tools and enhance the overall reading experience (Jamshidifarsani et al., 2019; Ponce et al., 2020; Wang et al., 2010).

Logical thinking involves the process of using concepts, judgments, and reasoning to reflect on reality during the acquisition of knowledge. The ability of individuals to set independent goals or beliefs is considered a fundamental aspect of the development of formal thinking. Structuring logical thinking abilities in childhood is crucial for future cognitive development (Handley et al., 2004). Courses and educational materials, particularly popular science books that align with the school curriculum or cater to the age and level of students, can gradually cultivate and establish students' logical thinking. These resources play a vital role in enhancing mathematical logic skills and serve as valuable supplementary teaching materials alongside formal science education (Dewi & Hulyadi, 2015; Hodijah et al., 2018; Sadi & Çakiroğlu, 2015). Research by Tobin and Capie (1981) employed the Test of Logical Thinking (TOLT) to assess five modes of formal reasoning, including controlled variables, proportional reasoning, combined reasoning, probabilistic reasoning, and correlational reasoning. The results demonstrated the validity and reliability of these measures. Bayram and Comek (2009) conducted activities that integrated network-assisted chemistry teaching and discovered a significant correlation between students' chemistry scores and their scientific learning attitude and logical thinking abilities. Popular science e-books have been used as effective tools to explain abstract scientific concepts and integrate logical thinking with knowledge content. It has been established that engaging in popular science reading enhances comprehension and positively impacts students' logical thinking abilities (KILIÇ & SAĞLAM, 2015; Nigro, 2022; Riyanti & Karyanto, 2019).

The OK4R strategy, which was derived from SQ3R and modified by Pauk (1964), has been found to be an effective tool in improving students' reading comprehension skills and enhancing reading effectiveness, as noted by Wulandari and Amri (2013). The OK4R strategy comprises six steps: Overview (O), Keywords (K), Read (R1), Recite (R2), Relate (R3), and Review (R4) (Ewumi et al., 2013; Pratiwi, 2019; Tursiva & Ernalis). By employing the OK4R reading steps in teaching, students can read in an organized and efficient manner. This approach helps them easily identify key or main points in each paragraph, facilitating a better understanding of the text, and it also aids in retaining the information in their memory for an extended period (Karimaliana et al., 2020; Safitri, 2017; Wulandari, 2018).

In recent years, numerous studies have demonstrated the effectiveness of mobile learning in educational settings (Ghazivakili et al., 2014; Gil-Flores et al., 2012; Hsu et al., 2013). For example, Huang et al. (2010) employed Mobile Personal Learning Environments (MPLS) on Personal Digital Assistants (PDA) for outdoor learning courses, which received high praise from students and proved to be a valuable tool for enhancing learning experiences outside the classroom. Inside the classroom, teachers can harness mobile platforms and software to boost student engagement and encourage cooperation, fostering a deeper understanding of collaborative work among students. This approach has become a prominent and widely utilized teaching method worldwide (Štorková & Kysela, 2015).

Comparative research by Lin (2014), which pitted mobile devices against personal computers, found that mobile devices outperformed the PC group in terms of student participation, reading times, and reading effectiveness, particularly in the context of extensive reading. Similarly, Lee (2015) employed the C-QRAC reading strategy for online cooperative learning with scientific texts. The use of online reading strategies led to significant improvements in students' scientific text reading proficiency and critical thinking skills, underscoring the benefits of employing such strategies in educational settings. Digital assistance systems, incorporating graphics, color changes, and game play, boost student learning motivation and efficiency compared to traditional methods. Mobile devices show superior impact over personal computers (Su & Cheng, 2013; Yang & Chang, 2013).

### *Research Aim and Research Questions*

This study aims to examine the impact of using the OK4R mobile platform for students' science reading ability and logical thinking ability. The specific research goals are as follows: Examine how the use of OK4R reading steps on mobile platforms affects students' science reading ability. This involves assessing whether this approach enhances students' comprehension of scientific content. Explore the impact of using the OK4R reading steps on the mobile platform on students' logical thinking ability. This objective seeks to determine whether employing the OK4R strategy on mobile devices enhances students' logical thinking skills. Compare the differences in the improvement of popular science reading comprehension and logical thinking abilities among vocational students of different genders using the OK4R platform on mobile devices versus traditional paper-based OK4R for popular science reading. This aspect of the study aims to discern any gender-related variations in the effectiveness of the OK4R strategy on mobile platforms. Investigate how gender, basic abilities, and other factors influence the effectiveness of vocational students' use of the OK4R reading steps for popular science reading on the mobile platform. This objective will assess whether specific factors, such as gender or basic abilities, impact how students benefit from using the OK4R strategy on mobile devices for science reading.

### **Research Methodology**

#### *Research Design*

This study utilized experimental research methods to examine the impact of the "OK4R mobile platform" on students' science reading ability and logical thinking ability. A control and experimental group design was employed to address the research questions and assess the effects of extended reality education on student learning responses and performance. In experimental research, researchers collect data to determine the effects of specific treatments. In this context, the study likely involved providing a particular treatment, which is the use of the "OK4R mobile platform," to an experimental group of participants, with the aim of assessing the benefits of this treatment on their science reading and logical thinking abilities (Creswell & Creswell, 2017). The research was carried out during the period between March and May in 2023.

#### *Participants*

This study involved 90 first-year students from a vocational school in Taiwan, comprising two classes with 45 students in each class. The participants were selected through a convenient sampling method and comprised 33 males and 57 females. The participants indicated that they used tablets and smartphones before participating in this research.

#### *Procedures*

In a quasi-experimental design, the study participants were divided into two groups, with 45 students in the experimental group and 45 students in the control group. Both groups of students were taught by the same lecturer. The study focused on a Chinese liberal arts reading course and selected popular science articles for teaching. Over the course of six weeks, students participated in a popular science reading course, covering one section each week, with each section lasting fifty minutes.

Every week, a text was uploaded to the platform for the students. In the first week, the OK4R mobile platform and the six steps of reading were introduced. Students in the experimental group used the platform during class to read the article, which took about 20 minutes. They also used the OK4R reading steps to summarize the key points, ask questions, and engage in critical thinking. In contrast, the control group used paper books to carry out the OK4R reading steps in the classroom. Following their reading sessions, both groups were given a paper-based reading test, which included multiple-choice questions and short-answer questions.

#### *Tools*

The tools used in this study include "The OK4R Mobile Platform," "The Popular Science Reading Comprehension Test" and "Logical Thinking Ability Test."

### OK4R Mobile Platform

The "OK4R mobile platform" is a specialized mobile application designed and developed based on the OK4R reading strategy. This platform enables students to effectively implement the OK4R strategy when reading popular science articles. The platform has been created using APP Inventor2. To access it, students scan a QR code to download the APP program, and upon opening it, they enter their student seat number to log in to the system. The platform's interface is primarily divided into two main parts: Steps and Operation Instructions: In this section, students can find guidance and instructions for each of the six steps of the OK4R reading strategy. This part serves as a reference to help students understand and follow the OK4R approach. Reading Interface: The second part of the platform is dedicated to the reading process itself. Once students enter this section, they can use touch-screen interactions to navigate through the six steps of OK4R in sequence while reading the assigned popular science article. Upon completing these steps, students can proceed to take a paper test, likely aimed at assessing their comprehension and application of the strategy.

Additionally, the platform offers tools and storage functions that allow students to upload their personal reading history to the cloud. This digitizes the learning process, providing a record of their reading activities and progress. Overall, the OK4R mobile platform is a digital tool designed to enhance the application and effectiveness of the OK4R reading strategy for popular science articles. The platform interface is shown in Figure 1.

**Figure 1**  
OK4R Mobile Platform



### Popular Science Reading Comprehension Test

In this study, the reading comprehension ability test used articles with scientific topics from the Taiwan PISA reading literacy sample test questions. The pre-test featured an article titled "Bat," and the post-test used an article titled "Little Black Mosquito," which was modeled after the PISA test questions. Each question within the articles was scored according to specific scoring rules.

Here's a breakdown of the pre-test and post-test:

Pre-test ("Bat"): "Message from this Article": 3 questions, including 2 questions on retrieval and retrieval and 1 question on integration and interpretation. "External Knowledge": 3 questions for reflection and evaluation. A total of 4 multiple-choice questions and 2 short-answer questions.

Post-test ("Little Black Mosquito"): "Message of this Article": 3 questions, comprising 2 questions on retrieval and 1 question on integration and interpretation. "External Knowledge": 3 questions for reflection and evaluation. A total of 4 multiple-choice questions and 2 short-answer questions.

To ensure the quality and reliability of the test questions, expert validation was conducted. Three Chinese teachers from junior high school and vocational school assessed the test questions. They evaluated whether the selected texts' nature, length, and the content of the developed questions aligned with the definition of popular science reading and matched the information in the articles and the external knowledge measurement objectives of PISA.

Moreover, the difficulty level of the post-test questions was compared with that of the pre-test questions by students from Class 3 of the Applied English Department, who shared a similar background with the experimental students. The accuracy rate for the post-test was found to be 0.61, which was comparable to the accuracy rate of 0.55 in the pre-test "Bat" among the experimental students. This suggests that the difficulty level of the two tests was similar.

### *Logical Thinking Ability Test*

This study employed three-paragraph argument questions, which have been used in previous research (Markovits & Nantel, 1989; Toplak et al., 2014), to evaluate their impact on improving logical thinking ability. Each question was designed to present a conflict between logical validity and conclusion credibility, including scenarios with believable conclusions but invalid inferences, as well as unconvincing conclusions but valid logical inferences. These questions encompassed 3 questions for each of the four types of logical structures, resulting in a total of 12 questions. The reliability of the items was assessed and found to have good half-half reliability (0.51) and internal consistency (.64). Since the research was not originally designed for high school vocational students, the study conducted pre- and post-test replication reliability with a group of 41 students, consisting of 19 girls and 22 boys, from the first-grade elite class of the high school where they teach. The reliability of this assessment was determined to be 0.773 ( $p < 0.001$ ), indicating strong internal consistency. Additionally, the accuracy rates for the pre-test and post-test were 54% and 51%, respectively, demonstrating the test's ability to discriminate between different levels of logical thinking ability.

### *Data Analysis*

This study used SPSS statistical software for quantitative statistical analysis. Background variables such as subjects' gender, Chinese literacy scores and science scores were collected. The independent sample *t*-test was used to compare the improvement effect of popular science reading comprehension and logical thinking ability between the experimental group and the control group after the OK4R reading steps. Paired samples *T*-test tests the improvement effect of pre- and post-test in different groups and genders. A two-factor multivariate analysis was conducted to compare the differences between higher vocational students of different genders in using the OK4R platform and paper OK4R for popular science reading. Pearson product-difference correlation analysis was used to explore the relationship between gender, Chinese literacy scores, science scores, popular science reading comprehension ability and logical thinking ability. Finally, a multiple regression analysis was conducted to explore the prediction of gender, Chinese literacy scores, science scores, platform use, and their interaction on science reading comprehension and logical thinking abilities.

## **Research Results**

### *Independent Samples T-test on the Improvement Scores of the Experimental Group and the Control Group*

In Table 1, the results show a significant difference between the experimental group and the control group in terms of improvement scores in popular science reading. However, there is no significant difference in improvement scores for logical thinking ability between the two groups.



**Table 1***Comparison Table of Progress Scores Between the Experimental Group and the Control Group*

Item	The experimental group	The control group	<i>t</i>	<i>p</i>
Progress in popular science reading	.89(1.335)	.22(1.565)	-2.174	.032*
Logical thinking progress	1.40(2.580)	1.22(2.131)	-.356	.722

\**p*<.05; \*\**p*<.01; \*\*\**p*<.001*Differences in the Improvement of Popular Science Reading Ability Between Different Genders and Different Groups*

Based on the data presented in Table 2, girls outperformed boys in popular science reading among a total of 90 experimental students.

**Table 2***Two-Factor Variance Analysis of Gender and Group on Popular Science Reading*

Source of variation	SS	df	MS	F	<i>p</i>
Gender	5.549	1	5.549	4.555	.036*
Group	4.007	1	1.007	3.289	.073
Gender * Group	1.975	1	1.975	1.621	.206
Total	1471.000	90			

\**p*<.05; \*\**p*<.01; \*\*\**p*<.001*Differences in the Improvement of Logical Thinking Ability Between Different Genders and Different Groups*

The improvement of their logical thinking according to different genders and different groups is shown in Table 3. The analysis is as follows: in terms of logical thinking ability, girls perform better than boys. The experimental group has better logic improvement than the control group. The OK4R mobile platform has a better impact on logic. The improvement of thinking is effective.

**Table 3***Two-Factor Variation Analysis of Gender and Group on Logical Thinking*

Source of Variation	SS	df	MS	F	<i>p</i>
Gender	73.192	1	73.192	1.517	.002**
Group	37.034	1	37.034	5.321	.023*
Gender * Group	5.118	1	5.118	.735	.394
Total	3079.000	90			

\**p*<.05; \*\**p*<.01; \*\*\**p*<.001

*Correlation Between Variables*

Pearson product-moment correlation analysis was employed to examine the relationships between various variables, including gender, Chinese literacy scores, science scores, popular science reading comprehension abilities, logical thinking abilities, and others. The findings are outlined in Table 4. There were 14 positive correlations among the variables, indicating that these factors tend to influence one another. Notably, gender was found to affect popular science reading comprehension before the test, logical thinking pre-test, and logical thinking post-test scores. High scores in Chinese literacy were positively associated with high scores in popular science reading pre-tests and popular science reading tests, suggesting a relationship between linguistic skills and science comprehension. Similarly, high scores in science were positively correlated with high scores in popular science reading pre-tests and logical thinking post-tests, highlighting a connection between science proficiency and cognitive abilities. This variable exhibited positive correlations with gender, Chinese literacy scores, and science scores, indicating that these factors influence performance in the popular science reading pre-tests. High scores in logical thinking pre-tests were associated with improvements in both popular science reading post-tests and logical thinking post-tests, suggesting a link between critical thinking skills and comprehension. Those who scored high in the logical thinking post-test tended to have higher logical thinking progress scores, highlighting the importance of ongoing development in this skill. Notably, there were two significant negative correlations: between the popular science reading pre-test and progress scores, and between the logical thinking pre-test and progress scores. This suggests that the use of OK4R reading techniques can be particularly beneficial for individuals who initially perform poorly in popular science reading and logical thinking.

**Table 4**  
*Pearson Product-Difference Correlation Analysis of Nine Variables*

	Gender	Chinese literacy	science	Popular science reading pre-test	Logical thinking pre-test	Popular science reading post-test	Logical thinking post-test	Progress in popular science reading	Logical thinking progress
Gender	-								
Chinese Literacy	.044	-							
Science	-.107	.307**	-						
Popular Science Reading Pre-test	.213*	.325**	.312**	-					
Logical Thinking Pre-test	.235*	.103	.193	.196	-				
Popular Science Reading Post-test	.201	.111	.181	.089	.210*	-			
Logical Thinking Post-test	.296**	.156	.237*	.068	.624**	.351**	-		
Progress in Popular Science Reading	.005	-.143	-.080	-.637**	.024	.712**	.224*	-	
Logical Thinking Progress	.091	.078	.077	-.137	-.369**	.184	.496**	.239*	-

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$

*Predictive Analysis Between Variables in the Experimental Group*

In this predictive analysis, the goal was to understand how three variables (gender, Chinese literacy scores, and science scores) relate to the experimental group's improvement in science reading comprehension scores when using the OK4R mobile platform for popular science reading. Multiple regression analysis was employed

to uncover the predictors of platform effectiveness, and the results are summarized in Table 5. Students in the experimental group who used the OK4R mobile platform experienced significant improvements in both popular science reading comprehension and logical thinking abilities. The analysis revealed a negative predictive relationship between the students' scores in science and their progress in popular science reading comprehension. This means that students who initially scored lower in science exams experienced more significant improvements in their reading comprehension when using the OK4R platform for popular science reading.

**Table 5**

*Multiple Regression Analysis of Three Variables on the Experimental Group's Improvement in Science Reading Comprehension and Logical Thinking*

	<i>b</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<b>Popular Science Reading</b>					
Constant	1.592	1.007		1.581	.122
Gender	.391	.408	.146	.959	.344
Chinese Literacy	.060	.294	.032	.203	.840
Science	-.748	.335	-.346	-2.235	.031*
<b>Logical Thinking</b>					
Constant	-1.940	1.875		-1.035	.307
Gender	.911	.759	.189	1.200	.238
Chinese Literacy	.345	.547	.102	.631	.532
Science	.429	.623	.111	.689	.495

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$

#### *Predictive Analysis Among Variables in the Control Group*

In this predictive analysis, the focus was on understanding how three variables (gender, Chinese literacy scores, and science scores) relate to the control group's science reading comprehension improvement scores when using the paper-based OK4R approach for popular science reading. Multiple regression analysis was performed to identify the predictors of the paper-based OK4R's effectiveness, and the results are presented in Table 6. Students in the control group, even when using the paper-based OK4R method for popular science reading, experienced an improvement in their logical thinking abilities. The analysis did not reveal any of the three variables (gender, Chinese literacy scores, and science scores) as predictors of the progress in science reading comprehension or logical thinking improvement for the control group.

**Table 6**

*Multiple Regression Analysis of Three Variables on the Improvement in Science Reading Comprehension and Logical Thinking in the Control Group*

	<i>b</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<b>Popular Science Reading</b>					
Constant	1.094	1.312		.834	.409
Gender	-.116	.516	-.035	-.224	.824
Chinese Literacy	-.572	.340	-.273	-1.685	.100
Science	.371	.368	.167	1.008	.319



	<i>b</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<b>Logical Thinking</b>					
Constant	.841	1.853		.454	.652
Gender	.147	.728	.032	.202	.841
Chinese Literacy	-.022	.480	-.008	-.046	.963
Science	.101	.520	.033	.194	.847

\* $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

*Predictive Analysis of the Five Variables of All Students on the Improvement Scores of Popular Science Reading Comprehension*

The results of a multiple regression analysis were conducted to investigate the impact of various factors on the improvement of popular science reading comprehension in both an experimental group and a control group of students. In the experimental group, it was found that students' science scores negatively predicted their progress in popular science reading. However, this effect was not observed in the control group. To further explore the impact of different variables on students' progress in popular science reading comprehension, an interaction term between group (experimental or control) and science scores was added as a predictor. Additionally, an interaction term between Chinese literacy scores, science scores, group, and science scores was included in the analysis. The results are presented in Table 7. Among all students, it was found that the use of the OK4R mobile platform was an effective predictor of improvement in science reading comprehension. In the experimental group specifically, it was observed that students' natural science performance negatively predicted their progress in science reading.

**Table 7**

*Multiple Regression Analysis of the Five Variables of All Students on the Progress Scores of Popular Science Reading Comprehension*

	<i>b</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<b>Popular Science Reading</b>					
Constant	1.438	.650		2.211	.030
Gender	.171	.330	.055	.518	.606
Group	1.243	.480	.838	2.589	.011*
Chinese literacy	-.264	.227	-.128	-1.162	.249
Science	-.183	.252	-.081	-.726	.470
Group*Science	-.474	.241	-.634	-1.965	.053*

\* $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

*Predictive Analysis of the Five Variables of All Students on Their Logical Thinking Progress Scores*

In a multiple regression analysis, several predictor variables were used to predict the improvement in logical thinking ability among all students. These predictor variables included gender, whether the platform was used or not, Chinese literacy scores, science scores, and the interaction between group and science scores. However, the results, as presented in Table 8, indicate that none of the predictor variables reached statistical significance in predicting the improvement in logical thinking ability. This means that gender, platform usage, Chinese literacy scores, science scores, and the interaction between group and science scores were not found to be significant predictors of changes in logical thinking ability among the students.

**Table 8***Multiple Regression Analysis of the Five Variables of All Students on Their Progress in Logical Thinking*

	<i>b</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<b>Logical Thinking</b>					
Constant	-.113	1.029		-.110	.913
Gender	.559	.521	.120	1.071	.287
Group	-.400	.760	-.179	-.526	.600
Chinese Literacy	.164	.359	.053	.455	.650
Science	.287	.398	.084	.720	.474
Group*Science	.199	.381	.177	.522	.603

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ 

## Discussion

The aim of this study is to assess the effectiveness of the OK4R reading strategy when delivered through a mobile platform app in improving students' popular science reading comprehension and enhancing their logical thinking abilities. Additionally, the research endeavors to examine how various factors, including gender and students' fundamental cognitive abilities, may impact the results and outcomes of this educational approach. To facilitate this study, a teaching tool was created, which is grounded in the OK4R reading strategy, and was implemented through a mobile platform app. The research findings indicate significant differences when comparing the pre- and post-test scores of popular science reading comprehension between the experimental group (using the OK4R mobile platform) and the control group (employing traditional paper-based OK4R reading steps). Specifically, the experimental group exhibited notably higher improvement scores compared to the control group.

Furthermore, in terms of correlations, the study revealed that progress scores in popular science reading comprehension were not significantly affected by gender. However, there was a negative correlation between these progress scores and the pre-test scores of popular science reading, suggesting that students with lower initial scores tended to benefit more from the intervention. Multiple regression analysis also demonstrated a significant relationship between the progress scores of popular science reading and the group (OK4R mobile platform or traditional paper-based steps). This indicates that the use of the OK4R mobile platform was an effective predictor of improved science reading comprehension for all students. Overall, the results suggest that using the OK4R mobile platform for science reading can effectively enhance science reading comprehension for both male and female students, with the greatest benefits observed among those who initially had lower scores in science reading ability.

The analysis of pre-test and post-test scores for logical thinking abilities between the experimental group (using the OK4R reading steps) and the control group revealed a significant difference. This suggests that popular science reading, regardless of the platform used, effectively enhances logical thinking abilities when employing the OK4R reading strategy. In terms of correlations, there were no significant differences in logical thinking progress scores between genders. However, a positive correlation was observed between logical thinking progress scores and popular science reading progress scores, indicating that as students' popular science reading improved, their logical thinking abilities also improved. Conversely, there was a negative correlation between logical thinking progress scores and their respective pre-test achievements, suggesting that students with lower initial logical thinking scores experienced more significant improvements. Multiple regression analysis did not identify any predictor variables for the improvement in logical thinking. However, it was concluded that utilizing the OK4R reading steps for popular science reading effectively enhances logical thinking abilities for both male and female students. Additionally, students who demonstrated higher progress in science reading also showed greater improvements in logical thinking, with the most significant improvements observed among those who had lower pre-test scores in logical thinking ability.

However, from the perspective of gender learning outcomes, there is no significant difference in the two basic abilities of the subjects of this study in the Chinese Language and Literature Examination and Natural Science

Examination scores. However, the performance of women in the pre-test of popular science reading and the pre-test of logical thinking is significantly better than that of men. When using the OK4R mobile platform for popular science reading, both boys and girls can effectively improve their science reading comprehension and logical thinking abilities. Gender cannot significantly predict the improvement of science reading comprehension and logical thinking abilities. This is consistent with Sanchez and Wiley (2010) in the literature. Research by "Men have traditionally performed better than women in visual-spatial abilities and overall science learning", and research by Lee (2015) "Gender differences have an impact on scientific reading and learning outcomes, but teaching strategies or methods can also be used, leveling out gender differences in the effectiveness of popular science reading.

In the study involving a total of 90 experimental students, the distribution of students across groups and gender is as follows: In the experimental group, there were 19 boys and 26 girls, while in the control group, there were 14 boys and 31 girls, resulting in a total of 33 boys and 57 girls across both groups. The analysis of differences in scores for science reading ability and logical thinking ability after popular science reading, based on gender and platform usage, was conducted using a two-factor multivariate analysis. The results revealed significant differences between genders in both popular science reading ability and logical thinking ability. However, there was no significant interaction between gender and group, indicating that, overall, females outperformed males in both popular science reading and logical thinking abilities. Furthermore, a significant difference was observed in logical thinking ability between the two groups, with the experimental group, which utilized the OK4R mobile platform, demonstrating superior performance in logical thinking abilities compared to the control group. In summary, the findings suggest that there are notable gender differences in popular science reading and logical thinking abilities, with females performing better than males in both areas. Additionally, the use of the OK4R mobile platform in the experimental group led to enhanced logical thinking abilities compared to the control group.

The analysis of predictor variables, including students' gender, group (experimental or control), Chinese literacy scores, and science scores, revealed significant findings regarding popular science reading comprehension progress scores and logical thinking progress scores.

The experimental group using the OK4R mobile platform was found to be a significant predictor of popular science reading comprehension improvement, suggesting that this platform positively impacts students' progress in popular science reading.

Science scores in the experimental group had a negative predictive effect on popular science reading comprehension improvement, indicating that higher science scores were associated with less progress in popular science reading. Chinese literacy scores did not significantly affect popular science reading comprehension or logical thinking abilities.

The interaction between group and science scores was a significant and negative predictor of science reading improvement, suggesting that the design of the OK4R mobile platform was particularly beneficial for low-achieving students in improving their science reading abilities. There was no significant correlation between gender and the two basic scores (Chinese literacy and science), but there was a positive correlation between pre-test scores for popular science reading and logical thinking. After experimental teaching, there was a significant improvement in women's logical thinking post-test scores. However, there was no significant correlation between the overall progress in science reading and logical thinking progress scores.

The study revealed several important findings: Female students performed better in both the science reading pre-test and logical thinking pre-test compared to their male counterparts. Female students also exhibited greater improvement in logical thinking, as indicated by their post-test scores. Interestingly, students with lower scores in science achieved better results in popular science reading when using the OK4R platform. The greater the progress made, the more significant the benefits observed. Overall, the study demonstrated that the OK4R platform is particularly effective in improving popular science reading comprehension for students who have lower scores in natural science. This suggests that the platform can be especially beneficial for those who may initially struggle with science-related content. These findings underscore the potential of the OK4R platform to address disparities in science reading comprehension and benefit students, especially those who face challenges related to their performance in science scores. Therefore, echoing the research of Karimaliana et al. (2020) and Lee (2015) that employed similar strategies for enhancing reading and critical thinking skills in the context of scientific texts.

## Conclusions and Implications

The study indicates that the application of OK4R reading strategies is effective in improving students' science reading comprehension and logical thinking abilities.

The study also highlights the following key points: Gender alone does not seem to predict differences in academic performance, as there were no significant gender disparities in Chinese literacy and science scores. The study found that women outperformed men in the pre-tests of popular science reading and logical thinking, emphasizing that gender is not the sole determinant of improvements in these abilities. Both male and female students benefitted from the OK4R reading steps, leading to improvements in science reading comprehension and logical thinking. This suggests that these strategies are equally effective for both genders and that gender is not a significant predictor of progress in these areas. While there were improvements in both genders in pre-test and post-test scores, the gender difference in the post-test of popular science reading was only marginally significant. This raises questions about the extent to which OK4R reading strategies can reduce gender disparities in popular science reading, with the study hinting that the effect might not be substantial.

The study provides valuable insights into the effectiveness of OK4R reading strategies in enhancing science reading comprehension and logical thinking abilities for students of all genders. However, it also suggests that further research is needed to determine the full impact of these strategies on reducing gender differences in popular science reading.

### Recommendations

The study hints at the need for further research with larger participant samples and extended training periods to assess the full impact of OK4R reading strategies in reducing gender disparities in popular science reading.

### Declaration of Interest

The authors declare no competing interest.

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