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The Effect of the Reading to Learn (R2L) Learning Model on Students' Scientific Literacy in the Human Digestive System

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Abstract

Scientific literacy requires students to interpret evidence and explain everyday phenomena. This study examined the effect of the Reading to Learn (R2L) model on eighth-grade students' scientific literacy concerning the human digestive system, alongside instructional implementation and student responses. A quantitative quasi-experimental nonequivalent control group design was employed. From a population of 115 students, 52 were selected through purposive sampling, comprising 26 students in the R2L group and 26 in the conventional instruction group. Data were collected using a validated 31-item scientific literacy test, an observation sheet, and a student response questionnaire. Scientific literacy differed significantly between the groups, with the calculated t value exceeding the critical value (9.603 > 2.009). Observed instructional implementation reached 91.67% for teacher activities and 82.87% for student activities. Student responses were positive, with a response score of 78.70%. These findings provide contextual support for R2L as a promising approach to scientific literacy instruction on the human digestive system. They also identify additional note-making support as an area for instructional refinement and highlight the need for broader replication.

Keywords: Reading to Learn; Scientific Literacy; Human Digestive System; Eighth-Grade Students; Science Education

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INTRODUCTION

Scientific literacy has become an essential educational competency as students are increasingly expected to understand scientific information, evaluate evidence, and make informed decisions about issues affecting their lives (Fortus et al., 2022; Osborne, 2023; Osborne & Allchin, 2025). Scientific literacy extends beyond acquiring scientific concepts to include explaining natural phenomena, evaluating scientific investigations, and interpreting data and evidence Organisation for Economic Co-operation and Development, 2019). These competencies are particularly relevant to science education, where students need opportunities to connect classroom knowledge with situations encountered in everyday life. Rahma et al. (2026) emphasize the importance of scientific literacy in developing critical thinking, problem-solving, and other competencies associated with contemporary education. Nevertheless, international assessments continue to reveal substantial differences in scientific literacy achievement. The PISA 2022 results indicated that only 34% of Indonesian students achieved at least Level 2 proficiency in science, compared with the OECD average of 76% (OECD, 2023). The most recent PISA 2025 results reported that 37% of Indonesian students reached this proficiency level, compared with the OECD average of 74% (OECD, 2026). These findings indicate that developing students' ability to understand and apply scientific knowledge remains a significant concern in Indonesian education.

Science learning at the junior secondary level should give students opportunities to investigate phenomena, exchange ideas, evaluate information, and construct explanations supported by scientific evidence. Classroom practices, however, do not always provide sufficient opportunities for such engagement. (Algozi et al., 2025) found that students' participation in science learning was closely related to the instructional strategies adopted by teachers, particularly their use of questioning, discussion, and meaningful learning activities. Preliminary observations and interviews with science teachers at one of the public junior high schools in Padang city raised a similar concern: classroom instruction was predominantly teacher-centered, with lectures and individual assignments serving as the main learning activities. Students generally listened to explanations and recorded information, while relatively few actively participated in questioning or discussion. A preliminary scientific literacy assessment involving 115 eighth-grade students was subsequently conducted using three questions on Earth and Solar System concepts, each representing one scientific literacy competency. The results showed that 48.70% of students correctly answered the question on explaining phenomena scientifically, 32.17% answered the question on evaluating and

designing scientific investigations, and only 19.13% correctly answered the question on interpreting scientific data and evidence. The average proportion of correct responses across the three items was 33.33%. Although this brief assessment cannot provide a comprehensive measurement of scientific literacy, the findings suggest particular difficulties in evaluating investigations and interpreting scientific evidence, highlighting the need for more purposeful instructional support.

The human digestive system provides a relevant context for developing scientific literacy because its concepts involve interconnected biological structures, physiological processes, and everyday health-related decisions. Understanding digestion requires students to recognize the relationships among digestive organs, enzyme activity, nutrient absorption, and factors affecting digestive health. Students must also explain how these processes operate and apply their understanding to situations involving nutrition, dietary choices, and digestive disorders. Learning difficulties may arise when instruction emphasizes memorizing organ names and functions without sufficiently exploring the relationships among biological processes. Research by Oktaviana et al. (2023) demonstrated the potential of inquiry-oriented learning materials to support scientific literacy in the human digestive system topic, indicating that this subject can be approached through scientific reasoning rather than factual recall alone. Scientific texts also play an important role in such learning because explanations of biological processes frequently involve specialized terminology, sequential relationships, and information that students must interpret carefully. Instructional approaches that help students identify relevant information, establish conceptual connections, and communicate scientific explanations may therefore be particularly valuable when learning about the human digestive system.

The Reading to Learn (R2L) model offers a structured approach to supporting students' understanding of written information through guided reading, collaborative interpretation, and knowledge reconstruction. Developed within the genre-based literacy tradition, R2L emphasizes explicit instructional support that enables learners with different levels of reading proficiency to engage with increasingly complex texts (Rose & Martin, 2012). Acevedo et al. (2023) describe R2L as an inclusive literacy pedagogy that supports students' participation in learning through carefully organized reading and writing activities. The instructional sequence adopted in the present research consists of four stages: preparing for reading, detailed reading, note-making, and joint construction. During preparation, teachers activate prior knowledge and introduce the context of the reading. Detailed reading

guides students toward identifying relevant information and understanding relationships among concepts, while note-making encourages them to select and organize important ideas. Joint construction then provides opportunities to discuss interpretations and reconstruct information using their own language. Lestari et al. (2022) highlight the value of guided textual engagement in supporting reading comprehension, particularly among learners who require additional assistance. The successful implementation of R2L, however, also depends on how teachers organize and facilitate its activities, as illustrated by the implementation challenges reported by (Hadi & Ramadhani, 2024). These pedagogical characteristics suggest that R2L may help students move beyond reading scientific information toward interpreting and communicating scientific understanding.

Empirical investigations have explored the application of R2L across different science learning contexts, providing evidence of its potential contribution to students' literacy development. Fitria (2022) examined students' literacy competencies in junior secondary science learning using the R2L model, drawing attention to the relationship between literacy-oriented instruction and scientific understanding. Arif et al. (2023) investigated R2L in the context of static electricity and reported favorable scientific literacy outcomes among students receiving R2L instruction. Similar findings were presented by Oktavia & Aulia (2023), whose quasi-experimental study identified a significant effect of R2L on students' scientific literacy concerning addictive, additive, and psychotropic substances. Alam Sad and Yurnetti (2024) also reported higher scientific literacy scores among students taught through R2L on the topic of work and simple machines. More recently, Hakiim et al. (2025) documented improvements in scientific literacy through classroom action research involving Earth and Solar System concepts. Collectively, these studies suggest that structured reading and collaborative knowledge construction can contribute to science learning across different subject areas. The variation in instructional contexts and research designs nevertheless indicates the importance of examining how R2L performs under specific classroom conditions rather than assuming that similar outcomes will occur in every learning environment.

Research directly related to the human digestive system provides a particularly important basis for positioning the present study. Arif, Rusma, Putri, et al. (2023) examined the influence of R2L on junior secondary students' scientific literacy in the human digestive system topic and reported a significant difference between experimental and control groups. Their research, conducted in a junior high school in Bukittinggi, establishes that the

relationship between R2L and scientific literacy in this topic has previously been investigated. Aulia & Oktavia (2025) subsequently examined the application of R2L to the same biological topic at one of the public junior high schools in Padang City, although their study focused on students' cognitive abilities rather than scientific literacy as a distinct learning outcome. Orchida & Oktavia (2025) also reported positive effects of R2L on science learning achievement, further supporting its potential instructional value. These findings contribute to the growing evidence concerning R2L in science education, but they also reveal differences in the competencies assessed, the instructional settings, and the characteristics of participating students. Scientific literacy requires more than the retention of subject knowledge; it involves the ability to use that knowledge in scientific explanations, the evaluation of investigations, and the interpretation of evidence. Examining R2L in additional classroom contexts is therefore relevant to understanding the consistency and applicability of its reported effects.

The existing literature provides a theoretical and empirical basis for applying R2L in science education, yet the effectiveness of this model needs to be examined in relation to the learning difficulties identified in particular school environments. The preliminary assessment at one of the public junior high schools in Padang City revealed especially limited performance in interpreting scientific evidence and evaluating scientific investigations, while classroom observations indicated that students had relatively few opportunities to discuss and reconstruct scientific information. These findings establish a local instructional problem that warrants examination through a structured, literacy-oriented learning approach. The present study builds on previous R2L research by investigating its application in a different junior secondary school context, with scientific literacy treated as the primary outcome rather than general cognitive achievement. Its contribution lies in providing additional context-specific empirical evidence regarding the usefulness of R2L for supporting scientific literacy in biology-related learning. Accordingly, this study aims to determine the effect of the Reading to Learn (R2L) model on eighth-grade students' scientific literacy in learning the human digestive system at one of the public junior high schools in Padang City.

METHODS

This study employed a quantitative approach with a quasi-experimental method using a nonequivalent control group design to examine the effect of the Reading to Learn (R2L)

model on students' scientific literacy. This design allows researchers to investigate the effects of instructional interventions without randomly assigning participants to experimental and control groups (Sugiyono, 2022). The study was conducted at one of the public junior high schools in Padang City during the first semester of the 2026/2027 academic year. The population consisted of 115 eighth-grade students, with two classes selected through purposive sampling based on their relatively similar average academic achievement. Class VIII-F served as the experimental group and received instruction using the R2L model, while Class VIII-G served as the control group and participated in conventional learning activities. Both groups completed pretests and posttests to measure changes in scientific literacy. The intervention covered 16 instructional periods on the human digestive system. Learning activities in the experimental group followed four R2L stages: preparing for reading, detailed reading, note-making, and joint construction. These stages guided students in identifying scientific information, organizing important concepts, and collaboratively reconstructing their understanding. The control group received teacher-centered instruction involving explanations, note-taking, exercises, and assignments.

Researchers collected data using scientific literacy tests, an instructional implementation observation sheet, and a student response questionnaire. The scientific literacy instrument initially comprised 40 questions in multiple-choice, true-or-false, and complex multiple-choice formats. Following expert validation by three science education lecturers and item analysis, 31 questions were retained to assess three scientific literacy competencies: explaining phenomena scientifically (10 items), evaluating and designing scientific investigations (11 items), and interpreting scientific data and evidence (10 items). Reliability testing produced a KR-20 coefficient of 0.679 for the multiple-choice and true-or-false items, whereas the complex multiple-choice items yielded a Cronbach's alpha coefficient of 0.308, indicating low reliability. The observation sheet was used to evaluate the implementation of R2L activities, while a four-point Likert-scale questionnaire assessed students' responses regarding relevance, attention, satisfaction, and confidence. Data analysis involved descriptive statistics and inferential procedures following (Sundayana, 2021). The Lilliefors test was used to assess normality, while the F-test examined variance homogeneity. Depending on the distribution and homogeneity of the data, hypothesis testing was planned using an independent-samples t-test, a t-test for unequal variances, or the Mann–Whitney U test. Instrument validity was analyzed using Microsoft Excel, while observation and

questionnaire responses were summarized as percentages to describe instructional implementation and students' learning experiences.

RESULTS

1. Students' Scientific Literacy Skills

To determine the effect of the Reading to Learn (R2L) learning model on students' scientific literacy as a whole, calculations were carried out across all scientific literacy competencies. In the control class, the mean pretest score was 54.84, and the mean posttest score was 73.70. In the experimental class, the mean pretest score was 57.20, and the mean posttest score was 86.60. The mean posttest score of the experimental class was higher than that of the control class, as shown in Figure 1.

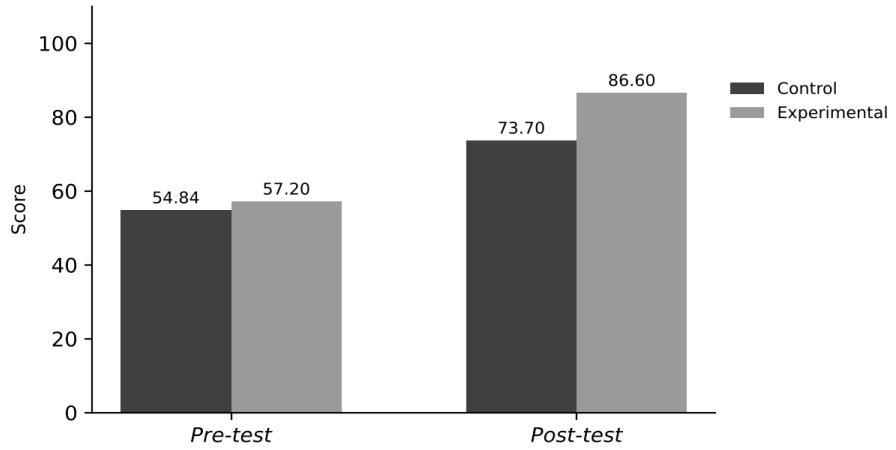


Figure 1. Scientific Literacy Across All Competencies

To assess the effect of the Reading to Learn (R2L) model on students' scientific literacy, we conducted statistical tests. These began with a normality test (Lilliefors test), followed by a homogeneity test (F-test) and a test of the difference between two means (t-test), as shown in Table 1.

Table 1. Normality, Homogeneity, and Two-Mean Difference Tests of Pretest and Posttest Scientific Literacy Across All Competencies

Pretest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.126	Normal	0.443	Homogeneous	0.797	**H_0 Accepted (Not Different)**
E	0.088	Normal				

Posttest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.113	Normal	1.036	Homogeneous	9.603	**H_0 Rejected (Different)**
E	0.151	Normal				

Based on the data in Table 1, the data were normally distributed and homogeneous; therefore, a t-test could be used to determine the statistical difference between the two classes. The t-test yielded $t_{calculated}$ = 0.797, which is smaller than ttable = 2.009, meaning that H_0 was accepted and H_a was rejected; thus, the pretest results did not differ. This indicates that students' initial abilities across all competencies were equivalent.

After the treatment, the posttest data of the control and experimental classes were found to be normally distributed and homogeneous according to the normality and homogeneity tests. Therefore, a t-test was used to determine the difference between the two classes. The test showed that $t_{calculated}$ = 9.603 > ttable = 2.009, meaning that H_0 was rejected. This indicates a significant difference between the posttest results of the control class and the experimental class. The pretest and posttest data for each scientific literacy competency are shown in Figure 2.

As shown in Figure 2, in the control class, the mean pretest score was 54.23, and the mean posttest score was 74.23. In the experimental class, the mean pretest score was 59.62, and the mean posttest score was 88.85. The mean posttest score of the experimental class was higher than that of the control class.

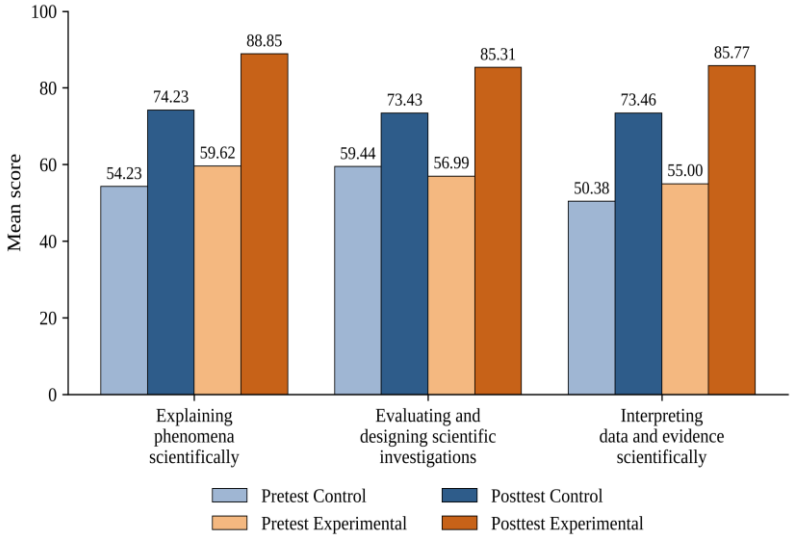


Figure 2. Scientific Literacy Scores for Each Competency

Figure 2 presents the average pretest and posttest scores for each scientific literacy competency. In explaining phenomena scientifically, the average score for the control group increased from 54.23 to 74.23, while the experimental group's score rose from 59.62 to 88.85. Regarding the evaluation and design of scientific inquiries, the control group showed an increase from 59.44 to 73.43, whereas the experimental group improved from 56.99 to 85.31. In the interpretation of scientific data and evidence, the average score for the control group climbed from 50.38 to 73.46, compared to an increase from 55.00 to 85.77 for the experimental group. For all three competencies, the experimental group achieved higher average posttest scores than the control group.

a. Scientific Literacy Ability in the Competency of Explaining Phenomena Scientifically

To determine differences in scientific literacy ability in the competency of explaining phenomena scientifically, statistical tests were conducted, beginning with a normality test, a homogeneity test, and a test of the difference between two means, as shown in Table 2.

Table 2. Normality, Homogeneity, and Two-Mean Difference Tests of Pretest and Posttest Scientific Literacy in the Competency of Explaining Phenomena Scientifically

Pretest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.109	Normal	1.218	Homogeneous	0.977	**H_0 Accepted (Not Different)**
E	0.137	Normal				
Posttest						
Class	**Normality Test**		**Homogeneity Test**		**Mann–Whitney Test**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.158	Normal	2.341	Not Homogeneous	3.772	**H_0 Rejected (Different)**
E	0.219	Not Normal				

Based on the statistical tests in Table 2, the test of the difference between pretest means yielded $t_{calculated} = 0.977$ ($t_{calculated} < t_{table} = 2.009$), meaning that H_0 was accepted; thus, the pretest results did not differ. This indicates that students' initial abilities in the competency of explaining phenomena scientifically were equivalent. Meanwhile, the posttest data of the experimental class ($L_{max} = 0.219$) were not normally distributed ($L_{max} > L_{table} = 0.173$), so the test of the difference between two means was conducted using the Mann–

Whitney test. The result was $Z = 3.772$ with $p < 0.001$ ($\alpha = 0.05$), meaning that H_0 was rejected. This indicates a significant difference between the posttest results of the control class and the experimental class in the competency of explaining phenomena scientifically.

b. Scientific Literacy Ability in the Competency of Evaluating and Designing Scientific Investigations

To determine differences in scientific literacy ability in the competency of evaluating and designing scientific investigations, statistical tests were conducted, beginning with a normality test, a homogeneity test, and a test of the difference between two means, as shown in Table 3.

Table 3. Normality, Homogeneity, and Two-Mean Difference Tests of Pretest and Posttest Scientific Literacy in the Competency of Evaluating and Designing Scientific Investigations

Pretest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.138	Normal	1.524	Homogeneous	−0.565	**H_0 Accepted (Not Different)**
E	0.134	Normal				
Posttest						
Class	**Normality Test**		**Homogeneity Test**		**Mann–Whitney Test**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.219	Not Normal	1.318	Homogeneous	3.792	**H_0 Rejected (Different)**
E	0.189	Not Normal				

Based on the statistical tests in Table 3, the test of the difference between pretest means yielded $t_{calculated} = -0.565$ ($t_{calculated} < t_{table} = 2.009$), meaning that H_0 was accepted; thus, the pretest results did not differ. This indicates that students' initial abilities in the competency of evaluating and designing scientific investigations were equivalent. Meanwhile, the posttest data of the control class ($L_{max} = 0.219$) and the experimental class ($L_{max} = 0.189$) were not normally distributed ($L_{max} > L_{table} = 0.173$), so the test of the difference between two means was conducted using the Mann–Whitney test. The result was $Z = 3.792$ with $p < 0.001$ ($\alpha = 0.05$), meaning that H_0 was rejected. This indicates a significant difference between the posttest results of the control class and the experimental class in the competency of evaluating and designing scientific investigations.

c. Scientific Literacy Ability in the Competency of Interpreting Scientific Data and Evidence

To determine differences in scientific literacy ability in the competency of interpreting scientific data and evidence, statistical tests were conducted, beginning with a normality test, a homogeneity test, and a test of the difference between two means, as shown in Table 4.

Table 4. Normality, Homogeneity, and Two-Mean Difference Tests of Pretest and Posttest Scientific Literacy in the Competency of Interpreting Scientific Data and Evidence

Pretest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.156	Normal	1.522	Homogeneous	1.059	**H_0 Accepted (Not Different)**
E	0.155	Normal				
Posttest						
Class	**Normality Test**		**Homogeneity Test**		**Test of Difference Between Two Means**	
	Sig.	Distribution	Sig.	Distribution	Sig.	**Hypothesis**
K	0.157	Normal	1.548	Homogeneous	3.692	**H_0 Rejected (Different)**
E	0.161	Normal				

Based on the statistical tests in Table 4, the test of the difference between pretest means yielded $t_{calculated} = 1.059$ ($t_{calculated} < t_{table} = 2.009$), meaning that H_0 was accepted; thus, the pretest results did not differ. This indicates that students' initial abilities in the competency of interpreting scientific data and evidence were equivalent. Meanwhile, the test of the difference between posttest means of the control and experimental classes yielded $t_{calculated} = 3.692$ ($t_{calculated} > t_{table} = 2.009$), meaning that H_0 was rejected. This indicates a significant difference between the posttest results of the control class and the experimental class in the competency of interpreting scientific data and evidence.

2. Implementation of the Reading to Learn (R2L) Model

The implementation of the Reading to Learn (R2L) model was evaluated through classroom observations conducted during the instructional intervention in the experimental group. The observations focused on teacher and student activities across four instructional stages: preparing for reading, detailed reading, note-making, and joint construction. Six classroom meetings were observed to determine how consistently the planned learning

activities were implemented. The results indicated that the R2L model was implemented successfully, with an average implementation percentage of 91.67% for teacher activities and 82.87% for student activities. Both percentages fell within the very good category according to the assessment criteria adopted in the study. The implementation percentages for each instructional stage are presented in Figure 3.

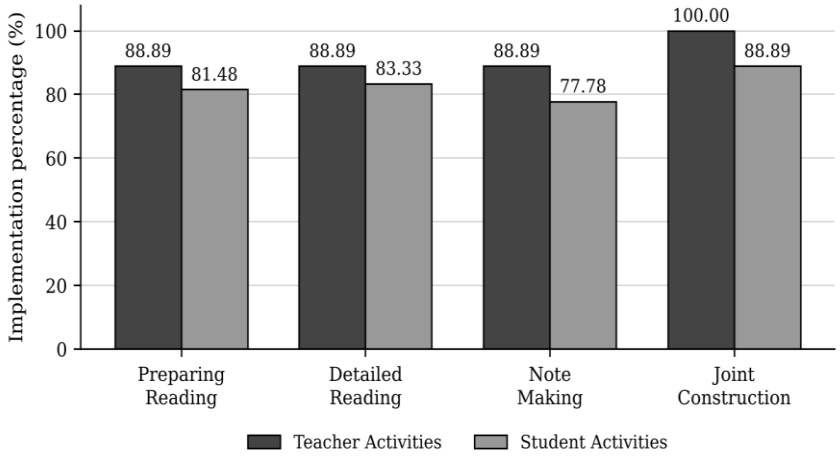


Figure 3. Implementation of the Reading to Learn Model Across Instructional Stages

Figure 3 shows that joint construction achieved the highest implementation percentage for both teacher activities (100.00%) and student activities (88.89%). These results indicate that the collaborative reconstruction activities were carried out particularly consistently during the observed lessons. Student participation was lowest during note-making (77.78%), suggesting that selecting and organizing information from scientific texts required greater instructional support. The implementation results also varied across the three observation periods. During the first period, teacher and student activities reached 85.71% and 76.19%, respectively. These percentages increased to 95.24% and 85.71% during the second period. During the third period, teacher implementation decreased slightly to 90.48%, while student implementation remained at 85.71%. The results show that the R2L instructional stages were generally maintained at a high level throughout the intervention, despite variations in student participation across activities.

3. Students' Responses to the Reading to Learn Model

Students' responses to the R2L learning experience were examined using a questionnaire administered to 26 students in the experimental group. The questionnaire consisted of 20 statements covering four indicators: relevance, attention, satisfaction, and

confidence. Each indicator contained five statements, with responses measured using a four-point Likert scale. The analysis showed that 17 students (65.38%) rated their learning experience as good, while nine students (34.62%) rated it as very good. No students were classified in the moderate, poor, or very poor response categories. Individual response percentages ranged from 61.25% to 90.00%, with an overall average of 78.70%, corresponding to the good category. Figure 4 shows individual students' responses to learning using the R2L model.

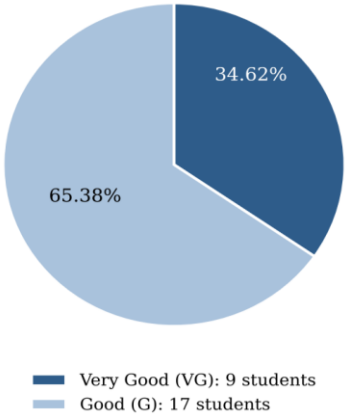


Figure 4. Overall Student Responses to Learning with the R2L Model

When examined by response indicator, relevance obtained the highest percentage, while confidence obtained the lowest; nevertheless, all four indicators remained in the good category. The percentage for each indicator is presented in Figure 5 below.

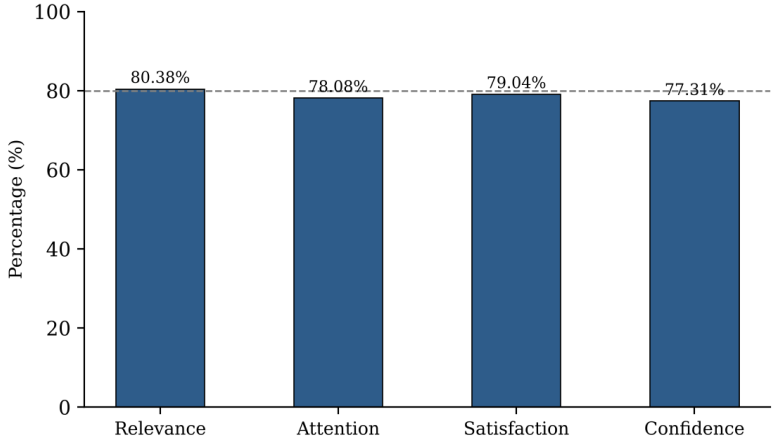


Figure 5. Average Percentage of Student Responses for Each Indicator

Figure 5 shows that relevance received the highest response percentage (80.38%), indicating that students generally regarded the reading materials and learning activities as

appropriate and useful for understanding science concepts. Satisfaction ranked second at 79.04%, suggesting that students responded positively to the learning experience and the opportunities provided to develop their understanding. The attention indicator reached 78.08%, reflecting favorable responses to activities involving guided reading, identifying important information, and participating in classroom discussions. Confidence received the lowest percentage (77.31%), although it remained within the good category. This result suggests that some students may still have experienced difficulties expressing their ideas or communicating scientific information independently. Overall, the questionnaire findings indicate that students responded positively to the R2L learning model, particularly regarding the relevance of instructional materials and their satisfaction with the learning activities.

The findings demonstrate that R2L instruction was implemented consistently and was associated with higher scientific literacy posttest achievement than conventional instruction. The experimental group achieved greater descriptive score gains across the three assessed competencies, and the statistical comparisons indicated significant posttest differences favoring R2L. Students' questionnaire responses further showed a generally positive learning experience, although confidence-related responses were relatively lower than those for the other indicators.

DISCUSSION

The findings of this study indicate that the Reading to Learn (R2L) model was implemented successfully and was associated with higher scientific literacy achievement among eighth-grade students studying the human digestive system. Classroom observations across six meetings showed that teacher activities averaged 91.67% implementation, while student activities reached 82.87%, both classified as very good. These findings suggest that the instructional procedures were generally followed and that students participated in activities that required them to read, identify scientific information, organize ideas, and reconstruct explanations. The implementation results are consistent with the pedagogical principles described by Rose & Martin (2012), who emphasize the importance of structured teacher guidance in supporting students' engagement with increasingly complex texts. The relatively high implementation percentages also indicate that literacy-oriented instruction can be integrated into junior secondary science lessons without separating reading activities from conceptual learning. Nevertheless, the gap between teacher and student implementation

suggests that successfully delivering instructional activities does not necessarily mean that all students are equally prepared to complete them independently.

Differences in implementation across the four R2L stages offer further insight into students' experiences during the intervention. Joint construction achieved the highest implementation rates, reaching 100% for teacher activities and 88.89% for student activities, whereas note-making recorded the lowest student participation at 77.78%. This pattern suggests that collaborative reconstruction was more consistently completed than the independent organization of scientific information. Students appeared to benefit from opportunities to discuss selected keywords and develop explanations with their peers, while identifying and organizing essential information into meaningful notes remained relatively demanding. Acevedo et al. (2023) explain that guided reading and text reconstruction support learners in moving from recognizing information toward producing more coherent explanations. The findings also underscore the importance of instructional scaffolding, as students may initially require considerable assistance before developing greater independence in processing scientific texts (Rose & Martin, 2012). Hadi & Ramadhani (2024), however, reported difficulties in implementing R2L consistently in an English language learning context. Although the instructional setting differed from the present study, their findings highlight that the success of R2L depends not only on the structure of the model but also on teachers' preparation, students' reading readiness, and the quality of instructional guidance.

The principal finding concerns the difference in scientific literacy achievement between students receiving R2L instruction and those participating in conventional learning. Before the intervention, the experimental and control groups obtained relatively similar mean pretest scores of 57.20 and 54.84, respectively, with no statistically significant difference. Following instruction, the experimental group's mean score increased to 86.60, compared with 73.70 in the control group. The corresponding score gains were 29.40 and 18.86 points, indicating a greater improvement in the experimental group. The posttest comparison produced a calculated t-value of 9.603, exceeding the critical value of 2.009 at the 5% significance level. These results support the research hypothesis that R2L instruction is associated with significantly higher scientific literacy achievement than conventional instruction in the participating classes. The observed difference may be understood in relation to the learning opportunities provided by R2L, particularly the integration of guided reading, collaborative discussion, and the reconstruction of scientific explanations. Rather than receiving information primarily through teacher explanations, students were encouraged

to examine the content of scientific texts and express their understanding through structured learning activities.

The overall findings are consistent with previous investigations reporting positive outcomes from R2L instruction in science education. Y. Fitria et al. (2022) emphasized the contribution of literacy-oriented learning activities to students' engagement with scientific knowledge in junior secondary education. Arif, Rusma, Putri, et al. (2023) reported favorable scientific literacy outcomes when applying R2L to static electricity, while Oktaviana et al. (2023) identified a significant effect of the model on scientific literacy in learning about addictive, additive, and psychotropic substances. Hakiim et al. (2025) similarly documented improvements in scientific literacy through R2L activities involving Earth and Solar System concepts. A particularly relevant comparison is the study by Arif, Rusma, & Alam Sad (2023), which investigated R2L and scientific literacy in the human digestive system topic using a quasi-experimental design. Their findings support the potential value of R2L in this area of science learning. The present study extends this evidence to another school context, where students' initial difficulties in evaluating investigations and interpreting scientific evidence were identified through a preliminary assessment. Although these studies generally point in a similar direction, differences in research designs, student characteristics, assessment instruments, and instructional conditions should be considered when interpreting their results.

The improvement in students' scientific literacy can also be examined through the instructional processes underlying R2L. Preparing for reading introduces students to the context of scientific information and helps them connect prior knowledge with unfamiliar concepts. Detailed reading then directs their attention toward relevant terminology, relationships among ideas, and explanations contained in the text. Note-making encourages students to organize the information they have identified, while joint construction provides opportunities to develop explanations collaboratively. Rose & Martin (2012) describe this progression as a means of supporting students' access to disciplinary knowledge through carefully structured literacy activities. Lestari et al. (2022) likewise highlight the contribution of guided reading to students' comprehension of textual information. These processes are particularly relevant to learning the human digestive system because students must understand relationships among organs, digestive enzymes, nutrient absorption, and biological processes rather than merely recall isolated facts. The higher achievement observed in the experimental group is therefore consistent with the possibility that structured

engagement with scientific texts supported students' conceptual understanding and their ability to respond to scientific literacy questions.

The competency of explaining phenomena scientifically showed the largest posttest difference between the two groups. Students in the experimental group achieved a mean score of 88.85, compared with 74.23 in the control group, and the statistical analysis indicated a significant difference. Explaining scientific phenomena requires students to select relevant scientific knowledge and use it to construct reasonable explanations of natural processes (OECD, 2019, 2023, 2026). The preparing for reading stage may have contributed to this competency by helping students activate their existing knowledge and establish a conceptual context before examining scientific texts. Joint construction may also have supported their ability to formulate explanations using their own words. In the context of the human digestive system, these activities provided opportunities to explain how digestive organs function, why enzymes are involved in digestion, and how biological processes relate to everyday experiences. The findings suggest that the combination of guided reading and collaborative explanation may be particularly useful for developing students' ability to communicate scientific concepts. Nevertheless, the contribution of individual R2L stages cannot be established independently because the stages were implemented as an integrated instructional sequence.

The competency of evaluating and designing scientific investigations also demonstrated a significant difference in favor of the experimental group. Its mean posttest score reached 85.31, compared with 73.43 in the control group. This competency requires students to recognize scientifically investigable questions, consider appropriate investigative procedures, and evaluate the relevance of evidence (OECD, 2019). R2L activities may have supported aspects of this reasoning by encouraging students to examine scientific information, identify relationships among concepts, and discuss the accuracy of their interpretations. Note-making and joint construction offered opportunities to organize information and reconsider explanations through interaction with teachers and peers. Acevedo et al. (2023) emphasize that text-based collaborative learning can support students in developing and communicating knowledge more systematically. However, guided reading and collaborative writing should not be considered equivalent to conducting scientific investigations. The improvement observed in this competency reflects students' performance on the assessment, while the specific processes through which R2L supported investigative reasoning require further examination. Integrating R2L with activities involving experimental

planning, variable identification, and evidence evaluation may provide additional opportunities to strengthen this competency.

Students' ability to interpret scientific data and evidence also improved, with the experimental group achieving a mean posttest score of 85.77 compared with 73.46 in the control group. The statistical comparison indicated a significant difference between the groups. Interpreting scientific evidence requires students to recognize relationships within information, draw conclusions supported by data, and distinguish evidence-based explanations from unsupported claims (OECD, 2019). The detailed reading stage may have supported this competency by encouraging students to examine information carefully and identify the meaning of relevant scientific statements. Activities involving observation of illustrations, selection of keywords, and reconstruction of explanations may also have provided opportunities to connect textual information with biological processes. Y. Fitria et al. (2022) underscore the importance of literacy-based learning for helping students engage with scientific information in meaningful ways. The findings of the present study are consistent with this perspective, although the available evidence does not establish which particular instructional activity contributed most strongly to students' ability to interpret data. Future classroom activities could incorporate additional tables, graphs, and authentic scientific evidence to develop this competency more explicitly.

Students' responses provide another perspective on the implementation of R2L. The overall questionnaire score reached 78.70%, indicating a good response to the learning experience. Relevance received the highest percentage (80.38%), followed by satisfaction (79.04%), attention (78.08%), and confidence (77.31%). These findings suggest that students generally recognized the usefulness of the reading materials and appreciated learning activities that differed from conventional teacher-centered instruction. The relatively positive responses to relevance and satisfaction may reflect the use of scientific texts connected to familiar biological experiences, allowing students to relate classroom learning to the functioning of their own bodies. Confidence, however, received the lowest percentage, indicating that some students may still have found it difficult to communicate their understanding independently. This result is consistent with the comparatively lower implementation of note-making and suggests that students' ability to organize and express scientific information may require sustained instructional support. The positive questionnaire responses should therefore be understood as evidence of students' acceptance of the learning

experience rather than direct evidence that the model improved their motivation or confidence over time.

The findings have practical implications for science instruction, particularly in classrooms where students have limited experience interpreting scientific texts independently. R2L offers teachers a structured approach for integrating literacy activities with the development of science concepts. Preparing for reading can introduce scientific problems through familiar contexts, detailed reading can support comprehension of complex terminology, and note-making and joint construction can help students organize and communicate their understanding. Teachers may strengthen the implementation of these stages by providing examples of effective note-taking, selecting texts appropriate to students' reading abilities, and gradually increasing opportunities for independent explanation. Collaborative activities should also be accompanied by questions requiring students to evaluate evidence and justify scientific conclusions. From a theoretical perspective, the findings provide additional context-specific support for the application of scaffolded literacy pedagogy to scientific literacy development. Their contribution lies in examining the implementation and outcomes of R2L within another junior secondary school environment rather than establishing R2L as an entirely new approach to learning the human digestive system.

Several limitations should be considered when interpreting these findings. The study involved 52 students from two existing classes at a single junior secondary school, with participants selected through purposive sampling rather than random assignment. Consequently, differences in student characteristics, classroom dynamics, and other uncontrolled factors may have influenced the observed outcomes. Although the pretest comparison did not reveal a statistically significant difference, this result does not establish complete equivalence between the groups. The intervention was also limited to six meetings covering the human digestive system, making it difficult to determine whether the observed improvements would be maintained over a longer period or transferred to other science topics. The scientific literacy test was constructed for the study, and the instrument screening process identified reliability concerns in some items that were excluded from the final assessment. In addition, the questionnaire was administered only to the experimental group, limiting comparisons of students' learning experiences across instructional approaches. Future research could involve larger samples from multiple schools, strengthen the psychometric evaluation of scientific literacy instruments, incorporate longer follow-up

assessments, and examine how individual R2L stages relate to specific scientific literacy competencies. Despite these limitations, the findings provide evidence that R2L is a promising instructional approach associated with improved scientific literacy achievement and generally positive student responses in learning about the human digestive system.

CONCLUSION

Based on the research findings and discussion, the Reading to Learn (R2L) model had a significant positive effect on eighth-grade students' scientific literacy in learning the human digestive system at one of the public junior high schools in Padang City. The implementation of the R2L model was categorized as very good, with average implementation percentages of 91.67% for teacher activities and 82.87% for student activities. Students in the experimental group achieved a higher mean posttest score (86.60) than those in the control group (73.70), with a statistically significant difference ($t = 9.603 > t_{table} = 2.009$). These findings indicate that R2L instruction was associated with better scientific literacy achievement, particularly in explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence. Students also responded positively to the learning experience, with an overall questionnaire score of 78.70%, categorized as good. Of the 26 students in the experimental group, 17 (65.38%) reported good responses, while nine (34.62%) reported very good responses. These results suggest that structured reading, guided information processing, and collaborative knowledge construction can support students in developing scientific understanding.

The findings highlight the potential of R2L as an alternative instructional approach for integrating literacy development into junior secondary science education. Science teachers are encouraged to provide additional guidance during the note-making stage, particularly in helping students identify, organize, and communicate essential scientific information. Schools may support its implementation by providing contextual scientific reading materials and professional development opportunities for teachers. Further research should involve larger and more diverse samples, examine additional science topics, and extend the duration of instructional interventions to evaluate the consistency and sustainability of the observed outcomes. Particular attention should also be given to improving assessment instruments, especially complex multiple-choice items that demonstrated low reliability in the present study (Cronbach's alpha = 0.308). Future

investigations may explore the integration of R2L with complementary instructional media and more extensive inquiry-based activities to better understand its contribution to students' scientific literacy development.

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