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ENHANCING STUDENTS' INFORMATION LITERACY THROUGH RESOURCE-BASED LEARNING IN RESPIRATORY SYSTEM LEARNING

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Abstract

Information literacy is essential for understanding complex biological concepts, yet instructional approaches that effectively support this competency require further examination. This study investigated the effect of resource-based learning on eleventh-grade students' information literacy during respiratory system instruction. A quasi-experimental pretest–posttest non-equivalent control group design was employed with 64 students from two science classes. Students' information literacy was measured using a 30-item multiple-choice test developed according to the Association of College and Research Libraries framework. The instrument was reported as valid and demonstrated acceptable reliability, with a Cronbach's alpha coefficient of 0.82. Post-intervention data were analyzed using analysis of covariance while controlling for initial scores. Students taught through resource-based learning achieved significantly higher information literacy scores than those taught through discovery learning, $F = 5.42$, $p = 0.021$, partial $\eta^2 = 0.08$. These findings indicate that resource-based learning can support students' information literacy in biology instruction by engaging them in locating, comparing, evaluating, and synthesizing information from multiple resources. Its implementation, however, requires appropriate instructional management to address limited teaching time and technical constraints.

INTRODUCTION

In the 21st-century digital era, the rapid development of information technology has fundamentally shifted how students access and utilize information in education. While vast amounts of information are available instantly, this accessibility is frequently unmatched by learners' ability to evaluate and use it effectively. Consequently, information literacy has emerged as an essential competence supporting learning, research, and self-development(Bamgbose, 2024; Nikou et al., 2022). Information literacy encompasses identifying information needs, accessing information, critically evaluating it, and using it ethically. Without adequate proficiency, learners risk utilizing inaccurate sources, encountering misinformation, and engaging in unintentional plagiarism (Ajijola, 2024; Tadeo et al., 2025; UNESCO, 2013; Yu et al., 2024).

Conceptually, the academic information literacy framework formulated by the Association of College and Research Libraries (ACRL, 2000) establishes five core standards: identifying the nature and extent of information needed, accessing required information effectively and efficiently, evaluating information critically, incorporating information effectively to accomplish a specific purpose, and understanding economic, legal, and social issues surrounding information use. Mastery of these standards provides a cognitive foundation fostering students' critical thinking, independent learning, and lifelong educational engagement (Tarbiyati & Riady, 2025). In secondary biology education, particularly regarding complex topics like the respiratory system that intersect with real-world issues such as air pollution, information literacy is vital for validating scientific literature to address health and environmental challenges.

Despite its high urgency, empirical realities indicate that students' information literacy levels remain constrained, driven largely by difficulties in source evaluation and heavy reliance on search engines without verifying credibility (Awasthi & Gulati, 2025). Furthermore, weak awareness of information ethics often leads to frequent academic integrity issues rooted in a lack of proficiency rather than deliberate misconduct (Chiang et al., 2022; Chu et al., 2021; Sozon et al., 2024). These challenges are reflected in preliminary observations at SMA Negeri 4 Tasikmalaya, where pretest assessments indicated low baseline information literacy scores, accompanied by a tendency to passively copy digital texts during task completion (Ramayanti & Iranda, 2023; Saoqillah et al., 2024).

Pedagogically, these gaps are partly reinforced by classroom practices. While Discovery Learning is valuable, its localized implementation in the observed school setting has remained largely teacher-centered, constraining students' opportunities for autonomous exploration within unstructured digital literature (Moreno-Murcia et al., 2024; Newell & Rovegno, 2021). Although recent studies highlight information literacy's importance in biology learning, existing literature—such as Gani et al. (2020) primarily focuses on general online learning conditions or broad literacy challenges without offering structural pedagogical solutions. Most prior research remains fragmented, emphasizing media development or standard cognitive outcomes rather than structured interventions. Consequently, a clear research gap persists regarding the systematic application of the Resource-Based Learning (RBL) model to optimize all ACRL (2000) framework indicators within secondary biology education on complex topics like the respiratory system.

To address this gap, this study applies the RBL model as a structural framework designed to decentralize learning resources and foster learner independence in selecting and evaluating multi-source information (Widodo & Amalia, 2020). Theoretical models suggest that integrating RBL can strengthen digital navigation competencies by encouraging students to access credible academic databases rather than relying solely on surface-level searches (Wang et al., 2024). By requiring students to manage diverse references, synthesize perspectives, and apply proper citation practices, RBL pedagogical designs theoretically support the ethical use of information (Helmita & Sara, 2024; Jannah et al., 2024).

Addressing the identified gap, the novelty of this study lies in empirically examining the effectiveness of the RBL model's syntax in enhancing holistic information literacy indicators among high school students, while observing its broader implications for academic integrity practices. Specifically, this study aims to analyze the effectiveness of implementing the RBL model compared to Discovery Learning in improving the information literacy of eleventh-grade students regarding the respiratory system. The theoretical contribution of this research enriches pedagogical design literature centered on information literacy frameworks. In contrast, its practical contribution offers concrete recommendations for science educators aiming to cultivate autonomous, critical, and ethical learners in the digital era.

METHODS

Research Design

This study uses a quasi-experimental method. Table 1 shows the matching-only pretest-posttest control group design used in this study. The independent variable is the learning model, while the dependent variable is information literacy. This study involves two treatment

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groups, namely the experimental group using the Resource-Based Learning (RBL) model and the control group using the Discovery Learning (DL) model.

Table 1. Research Design

Pretest	Treatment Group	Number of Students	Posttest
O_1	RBL	32	O_2
O_3	DL	32	O_4

Research subjects

The population in this study consisted of all eleventh-grade students at SMA Negeri 4 Tasikmalaya, West Java, Indonesia, studying the Respiratory System material, totaling 150 students. Participant selection was carried out using a purposive sampling technique, which was used exclusively to select two representative classes from the population based on specific criteria: similar average daily test scores, identical class characteristics under the same subject teacher, and recommendations from educators. Meanwhile, the subsequent group assignment using a spin wheel was a random procedure applied after selecting those two qualified classes to fairly determine which class would act as the experimental group (RBL) and which would act as the control group (DL).

The research participants whose data were fully validated and analyzed consisted of 64 students in total (comprising 32 students in class XI-1 as the experimental class [RBL] and 32 students in class XI-11 as the control class [DL]). The entire research process strictly adhered to academic ethical standards by securing formal institutional approval and school authorization from SMA Negeri 4 Tasikmalaya, obtaining written informed consent directly from the participants (alongside formal approval and consent from their parents/guardians), and fully ensuring data confidentiality and anonymity.

Research Instruments

The research instrument used to assess students' information literacy consists of 30 multiple-choice questions developed based on the framework proposed by the Association of College and Research Libraries (ACRL, 2000). The structure of the test covers five main standards: i) determining the nature and scope of information; ii) accessing information effectively and efficiently; iii) evaluating information based on its sources; iv) using information for specific purposes; and v) using information ethically. This final set of 30 items was selected from an initial pool of 50 trial questions, incorporating pedagogical considerations to minimize students' cognitive fatigue.

The instrument was initially reviewed by expert judgment before the researchers evaluated its empirical validity and reliability through trials on 12th-grade students outside the research sample. Validity testing utilizing Pearson Product-Moment correlation via Anates software yielded an item score correlation range between 0.332 and 0.858. At the same time, the reliability test showed a coefficient of 0.97, indicating a very high and consistent category. To maintain strict academic rigor, claims regarding this instrument are limited to measuring cognitive information literacy competencies, rather than capturing direct, authentic behavioral performance.

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Research Procedure

The data collection procedure was carried out face-to-face in the classrooms of SMA Negeri 4 Tasikmalaya during the period from November to December 2025. This study began with the administration of a pretest to students before the treatment to obtain initial data regarding information literacy from the entire group using paper-based written tests.

Following the pretest, the learning models were implemented on the Respiratory System material over three face-to-face meetings, with each meeting lasting 2 x 45 minutes (90 minutes). This implementation aimed to enhance students' abilities to explore, validate various biology/health literature and solve problems independently.

1. Main Activities in the RBL Class: The learning process in the experimental class was student-centered across its specific phases:
    - Teacher role: Acting as a facilitator, resource guide, and mentor who provides learning frameworks and monitors students' independent source exploration.
    - Student role: Actively executing the learning phases: i) identifying questions or problems; ii) planning and gathering information from various credible academic sources; iii) using information; iv) synthesizing information; and v) evaluating results through presentations and dialectics of ideas.
2. Main Activities in the DL Class: The control class followed a more structured and guided conventional flow:
    - Teacher role: Acting as a facilitator, resource guide, and mentor who provides learning frameworks and monitors students' independent exploration of sources.
    - Student role: Engaging in guided phases: i) stimulation; ii) problem identification; iii) data collection; iv) data processing; v) verification; and vi) conclusions.

At the end of all learning sessions, a posttest (using a paper-based written test) was conducted following the research treatment to measure students' final achievement. Across all sections of this manuscript, the codes for the experimental and control classes are consistently written as RBL and DL, respectively.

Data Analysis

All quantitative data from this study were analyzed using SPSS version 26 software. Inferential statistical analysis began with prerequisite testing, including tests of data normality and variance homogeneity. The Kolmogorov-Smirnov test was used to determine the normality of data distribution, while Levene's Test was applied to analyze variance homogeneity with a significance level set at 0.05. After the prerequisites were met, posttest data were analyzed using ANCOVA hypothesis testing, with pretest scores used as covariates to control for initial differences in participants' abilities. (Note: Relevant ANCOVA assumptions, including the homogeneity of regression slopes, were tested and fulfilled prior to final hypothesis reporting in the Results section). This ANCOVA test was conducted to precisely investigate the significant differences in information literacy skills between students in RBL classes and DL classes. In addition to inferential analysis, the improvement in information literacy scores before and after the treatment was analyzed descriptively using the Normalized Gain (N-Gain) test based on the standard equation by Hake (1998) to determine the effectiveness of the treatment. The resulting N-Gain scores were interpreted using standard categorization criteria: High ($g \geq 0.70$), Medium ($0.30 \leq g < 0.70$), and Low ($g < 0.30$).

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RESULT AND DISCUSSION

RESULT

This section presents the quantitative research findings analyzed objectively to answer the problem formulation. The data were extracted from the pretest and posttest assessments of information literacy skills in the experimental group using the Resource-Based Learning (RBL) model ($N = 32$) and the control group using the Discovery Learning (DL) model ($N = 32$).

Students' Information Literacy Improvement

This study evaluates the dynamics of improving information literacy skills using the Normalized Gain (N-Gain) index. Descriptive statistics of the initial and final achievements, as well as the improvement categories in both treatment groups, are comprehensively summarized in Table 2.

Table 2. Recapitulation of Students' Information Literacy Scores

Class (N=32)	Average Pretest	Average Posttest	N-Gain	N-Gain Criteria
RBL	50,94	85,42	0,71	Hight
DL	55,94	84,06	0,58	Medium

Source: Data Processing Results (2026)

As shown in Table 2, the RBL group began with a lower baseline average (50.94) compared to the control group (55.94). Following the treatment implementation, the experimental class achieved a posttest average of 85.42. This improvement is confirmed by an N-Gain score of 0.71, reaching the high category threshold. Conversely, the DL group achieved an N-Gain score of 0.58, which falls into the medium category, with a standard deviation of 0.22, indicating a more varied improvement distribution within the class.

Distribution of Information Literacy Improvement Based on Indicators

To examine performance more comprehensively, information literacy performance was evaluated across its five constituent indicators, as illustrated in Figure 1.

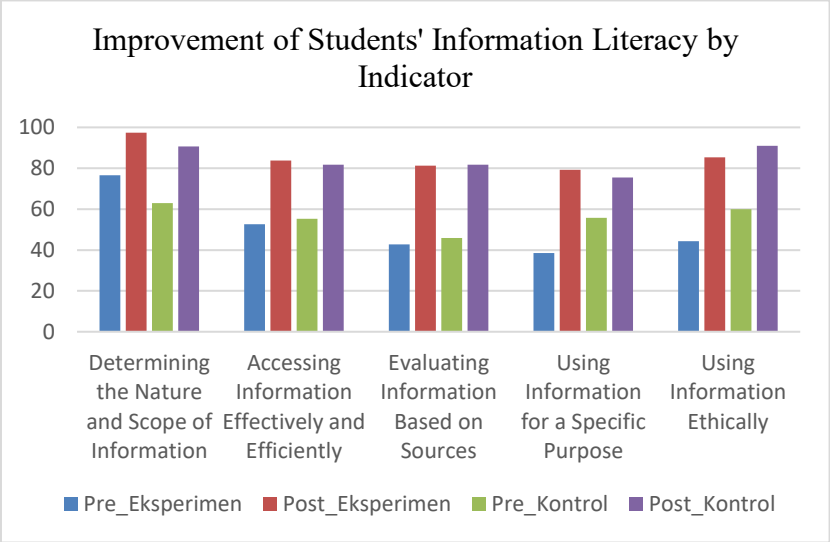

Figure 1. Improvement of Students' Information Literacy Per Indicator
Source: Data Processing Results (2026)

The data in Figure 1 demonstrate that all information literacy indicators increased across both groups. In the experimental class, the highest posttest score was observed in the

indicator of determining the nature and scope of information (97.40). In contrast, the lowest posttest score occurred in the indicator of using information for a specific purpose (79.17), despite the latter showing a substantial point increase from its baseline. In the control class, the lowest posttest score was also recorded in the indicator of using information for a specific purpose (75.52), while the highest achievement was in the indicator of using information ethically (91.00).

Inferential Analysis Prerequisite Testing

Before executing the Analysis of Covariance (ANCOVA) hypothesis test, parametric assumptions were examined. The Kolmogorov-Smirnov normality test confirmed that all data groups achieved significance values greater than 0.05 (p ranging from 0.066 to 0.200), verifying normal data distribution. Furthermore, Levene's test of equality of variances indicated homogeneity for both pretest ($p = 0.211$) and posttest ($p = 0.470$) data. Additionally, the assumption of homogeneity of regression slopes was tested and verified, showing no significant interaction between the covariate (pretest scores) and the treatment groups ($p > 0.05$), thereby validating the suitability of ANCOVA.

Hypothesis Testing Results (ANCOVA)

ANCOVA was conducted to evaluate the significance of differences in information literacy improvement while controlling for pretest scores as a covariate, as detailed in Table 3.

Table 3. Summary of Information Literacy Hypothesis Test Results (ANCOVA)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	564,938	2	282,469	4,308	0,018	0,124
Intercept	6479,087	1	6479,087	98,811	0,000	0,618
Pre_Literasi	365,422	1	365,422	5,573	0,021	0,084
Kelas	367,504	1	367,504	5,605	0,021	0,084
Error	3999,797	61	65,570			
Total	452293,000	64				
Corrected Total	4564,734	63				

Source: Data Processing Results (2026)

The statistical analysis presented in Table 3 indicates that the pretest covariate exerted a significant linear relationship with the posttest outcomes, $F(1,61) = 5.573$, $p = .021$, $\eta_p^2 = .084$. After controlling for initial baseline abilities, the main effect of the learning model treatment was statistically significant, $F(1,61) = 5.605$, $p = .021$, $\eta_p^2 = .084$. These empirical findings lead to the rejection of the null hypothesis (H_0), demonstrating a statistically significant main effect attributable to the implementation of the RBL model. The partial eta squared value indicates that the learning model intervention contributed an effect size of 8.4% to the enhancement of students' information literacy competencies.

DISCUSSION

This study investigated the effectiveness of the Resource-Based Learning (RBL) model compared to Discovery Learning (DL) in enhancing students' information literacy competencies on the respiratory system. The inferential analysis from the ANCOVA demonstrates that the implementation of RBL yields a statistically significant improvement in information literacy compared to DL ($F(1,61) = 5.605$, $p = .021$, $\eta_p^2 = .084$). This overall treatment effect directly addresses the central research objective by providing empirical

evidence that structuring learning around decentralized resources significantly enhances students' ability to navigate and evaluate digital academic literature.

Interpreting this outcome through the lens of student autonomy, the higher N-Gain achievement in the experimental group (0.71, High category) can be attributed to the syntax of RBL, which requires learners to independently explore and select distributed scientific literature (Gündüzalp & Göktaş, 2024). While empirical data confirms the statistical superiority of RBL, theoretical interpretations suggest that this design encourages students to perform cross-reference validation to construct an independent understanding (Rumahlatu et al., 2021). The decentralization of learning resources supports knowledge acquisition (Wei et al., 2026). Conversely, the control group relied on a more teacher-guided discovery process, which, while structured, provided fewer opportunities for autonomous navigation of unstructured literature (Marttunen et al., 2021; Mehler et al., 2020). When compared with previous research by Gani et al. (2020) and Wang et al. (2024), the present findings extend prior work by demonstrating that structured resource decentralization is specifically effective within secondary science classrooms when addressing complex physiological topics.

Examining the findings at the indicator level provides further insight into the cognitive demands of specific RBL phases. The highest posttest score in the experimental class was observed in the indicator of determining the nature and scope of information (97.40). Empirically, this indicates strong baseline performance in initial problem framing. Theoretically, this aligns with the initial phase of RBL, where educators present authentic socio-scientific issues, such as correlating respiratory physiology with air pollution, prompting students to define their information needs. This outcome supports the foundational framework of the Association of College and Research Libraries (ACRL, 2000), which posits that recognizing information requirements is a critical cognitive precursor to effective source evaluation. This finding supports previous studies Tarbiyati & Riady (2025), emphasizing that early-stage framing guides subsequent inquiry.

In contrast, the lowest posttest score in the experimental class occurred in the indicator of using information for a specific purpose (79.17), despite this indicator exhibiting a notable point increase from baseline. Empirically, students scored lower on tasks requiring the synthesis and application of information compared to initial identification. Theoretically, this reflects the cognitive complexity associated with the third phase of RBL (using information), where students must move beyond surface-level paraphrasing to transform textual anatomical and physiological data into spatial representations, such as respiratory gas exchange diagrams. This difficulty in translating textual information into visual formats aligns with findings by Pramudi et al. (2025) and Tikhonova & Grigorieva (2026), who noted that secondary students frequently encounter barriers when converting abstract scientific texts into visual models. These results indicate that higher-order cognitive milestones, such as multi-source synthesis and visual transformation, require more intensive instructional scaffolding than initial information identification (Pramudi et al., 2025; Tikhonova & Grigorieva, 2026).

Addressing the broader context of information ethics, the baseline data indicated low initial information literacy scores (48.9), reflecting vulnerability to unverified digital sources (Awasthi & Gulati, 2025). While the study primarily measured cognitive competencies rather than directly tracking plagiarism behavior, the implementation of RBL structurally

discouraged passive copying by mandating cross-referencing across diverse academic repositories (Helmita & Sara, 2024). By requiring students to manage multiple citations, the instructional design theoretically supports the internalization of information ethics, encouraging proper attribution rather than mechanical text transfer (Firmansyah et al., 2024; Sozon et al., 2024).

These findings offer specific pedagogical implications for secondary science education. Rather than treating RBL as a universal solution, its successful implementation requires specific classroom conditions: teachers must function as active facilitators rather than mere directors; adequate instructional scaffolding must be provided during multi-source synthesis; and reliable access to credible academic repositories is essential (Arifanti et al., 2023; Narahaubun et al., 2020). Furthermore, to address the methodological and operational limitations identified during this study—namely, that reliance on objective multiple-choice tests captures cognitive competence rather than authentic performance, that intense synthesis activities clashed with rigid biology class hour allocations, and that internet instability occasionally hindered real-time database searches—future research should adopt specific adjustments (Dianto et al., 2025; Lestari et al., 2024). Specifically, future studies are recommended to combine objective tests with performance-based rubrics or digital portfolios, integrate blended learning strategies to compensate for limited classroom contact hours, and provide curated offline literature repositories to mitigate infrastructure constraints (Muherdi & Anwar, 2026).

CONCLUSION

This study concludes that implementing the Resource-Based Learning (RBL) model significantly enhances students' information literacy competencies in secondary biology education compared to Discovery Learning (DL). Empirically supported by inferential and descriptive analyses, the RBL group demonstrated superior improvement in navigating, evaluating, and synthesizing digital literature. The primary pedagogical advantage of RBL lies in its structured syntax, which fosters student autonomy in exploring multi-source information and cross-validating credible academic references, thereby structurally discouraging passive copying behaviors and supporting the ethical use of information.

The theoretical contribution of this research extends the application of the ACRL framework within secondary science education, providing empirical evidence on how decentralizing learning resources improves specific information literacy indicators. Methodologically and operationally, however, the study's scope was bounded by reliance on objective cognitive assessments rather than authentic performance rubrics, as well as instructional time constraints and technical infrastructure limitations during real-time database searches.

Addressing these limitations, future research is recommended to integrate performance-based assessments or digital portfolios, adopt blended learning strategies to optimize instructional time, and provide curated offline literature repositories to mitigate connectivity barriers. Ultimately, structured resource decentralization offers a viable pedagogical framework for fostering autonomous, critical, and ethical learners capable of navigating the complexities of the digital era.

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Declarations

Author Contribution Statement

Aulia Qurrotu Aini: Conceptualization, methodology, investigation, data collection, formal analysis, writing original draft.

Liah Badriah: Conceptualization, supervision, methodology, data analysis and interpretation, writing review and editing, critical revision, and final approval of the manuscript.

Egi Nuryadin: Methodology, validation, supervision, writing review and editing, and final approval of the manuscript.

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Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of Interests Statement

The authors declare that they have no known competing financial or non-financial interests that could have appeared to influence the work reported in this paper.

AI Use Statement

During the preparation of this manuscript, the authors used **Grammarly** solely for language editing (grammar, clarity, and readability). The authors reviewed, revised, and verified the final text and take full responsibility for the content of the publication. **SPSS Statistics Version 26** was used exclusively for statistical data analysis and was not used to generate or write the manuscript.

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