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The Effect of Auditory Intellectual Repetition (AIR) Model Assisted by Google Sites on Students' Problem-Solving

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Abstract

Background: Student problem-solving ability often varies and impacts academic performance. This study aims to determine the effect of integrating the AIR model with Google Sites on enhancing problem-solving skills among eighth-grade junior high school students in the context of vibration and wave concepts.
Methods: A quasi-experimental study utilized a Nonequivalent Control Group Design with a purposive sample of 60 eighth-grade students, divided into experimental and control groups. Data were collected using pretest and posttest instruments and analyzed through descriptive and inferential statistics.
Results: A significant improvement in students' problem-solving ability, with the average score increasing from a very low 7.80 before the intervention to a medium 52.60 afterward, and a moderate N-Gain score of 0.48 further suggesting substantial enhancement.
Conclusion: The AIR model significantly enhances students' problem-solving ability at the $\alpha = 0.05$ significance level. This research highlights the potential of technology-integrated instructional models to enhance crucial skills in science education.

INTRODUCTION

Twenty-first-century education has placed growing emphasis on four core competencies: critical thinking, problem-solving, creativity and innovation, and communication and collaboration, collectively known as the 4Cs (Mehadi Rahman, 2019; Ramlawati et al., 2025). Among these competencies, problem-solving is positioned within the domain of learning and innovation skills as an essential capability for engaging with real–world complexity (Anagün, 2018). According to Pinar et al. (2025), problem-solving refers to a systematic process of observing, critical thinking, and determining the most suitable solution when students face a situation where the way forward is not immediately obvious. In addition, the OECD defines problem-solving as the capacity to engage in

cognitive processes through which individuals understand problems and find alternative solutions to issues that lack definite answers, requiring logical and critical thinking to reach the best possible solution (OECD, 2017). Furthermore, problem-solving skills play a vital role in deepening students' understanding of instructional material while encouraging them to articulate the strategies they use, rather than merely memorizing or following predetermined procedures (Szabo et al., 2020).

In fact, Indonesian students' problem-solving skills remain in the low category. Data from PISA show that Indonesia ranked 60th out of 78 countries in problem-solving skills in the 2018 assessment, with an average score of 434 (Amalia et al., 2024). Around 71% of students were unable to meet the minimum standards in mathematical literacy according to OECD measurements (Harefa & Purba, 2020). Indonesian students are particularly weak in solving non-routine problems requiring mathematical reasoning, finding generalizations, and verifying relationships between data-difficulties that arise when problems differ from previously studied examples (Kachchhap & Horo, 2021).

Based on preliminary observations at SMP Negeri 18, students struggled to solve contextual problems. The preliminary survey indicated difficulties in understanding information and learning materials, applying prerequisite concepts, and carrying out the problem-solving process carefully. Interviews with science teachers further revealed that most students could solve routine questions but struggled when the questions differed from previously provided examples. In addition, instruction remains largely dependent on textbooks and teacher explanations, while interactive digital media have not yet been utilized to their full potential. These preliminary findings are supported by previous studies emphasizing the importance of information processing, conceptual understanding, adaptive learning strategies, innovative learning environments, and digital-supported learning in developing students' problem-solving and 21st-century competencies (Hung et al., 2018; Rincon-Flores et al., 2024; Song & Zhu, 2025; Miglani et al., 2024). Therefore, the preliminary study indicates a need for a more adaptive learning approach that provides structured opportunities for students to practice solving contextual and unfamiliar problems while utilizing interactive digital resources.

One learning model aligned with the demands of the digital era is the Auditory-Intellectual-Repetition (AIR) model (Sukasno et al., 2023). This model covers three main stages: Auditory–listening and speaking activities such as presenting, arguing, expressing opinions, and responding; Intellectually-idea development and thinking skills, including reasoning, creating, solving problems, constructing, and applying knowledge; and Repetition–reinforcement of understanding through practice, tasks, or evaluation. The AIR learning model empowers students to build their own knowledge, both individually and in groups, by integrating these three aspects (Suri & Mulyaningrum, 2019). One digital media that can be used is Google Sites, which provides opportunities for teachers and students to build interactive learning spaces by integrating various content, such as text, images, audio, video, and links (Yuniar et al., 2021). Google Sites is widely adopted as a learning medium because it can be created and managed easily without programming skills, as well as its accessibility for students. In line with Aminah et al. (2021), Google Sites is an effective and efficient medium for compiling learning materials. The integration of Google Sites into the AIR model is expected to facilitate students' access to all learning materials in a centralized manner.

Learning also requires appropriate media support to facilitate the delivery of material, particularly in helping students understand abstract or complex concepts. The

use of learning media serves to develop skills, broaden learning experiences, and expand students' knowledge. One digital medium suitable for this purpose is Google Sites, a free and easy-to-use platform launched by Google in 2008 as a web page creation tool (Huyen, 2023). Google Sites provides opportunities for teachers and students to build interactive learning spaces by integrating various content, such as text, images, audio, video, and links. In addition, Google Sites supports multimedia content (audio, visual, and audiovisual) that enables efficient, accessible learning for all students (Wicaksono et al., 2023). With these features, students can learn autonomously and conveniently access study materials repeatedly, anytime and anywhere, without being dependent on teacher presence (Rihatno et al., 2023). The integration of Google Sites in the AIR model's implementation is therefore expected to facilitate students' centralized access to all learning materials.

Research by Suri & Mulyaningrum (2019) demonstrated that AIR model is effective in improving problem-solving in biology learning through Lesson Study for Learning Community, in which problem-solving is defined as the process of eliminating differences between obtained and desired results and is closely tied to decision-making. Furthermore, the use of Google Sites has been shown to help students respond more effectively to teacher-assigned questions because it fulfills three essential dimensions of website quality, namely usability, information quality, and service interaction quality (Wicaksono et al., 2023). Taken together, these findings suggest that combining the AIR learning model with Google Sites may provide a supportive learning environment for developing students' problem-solving skills by integrating structured problem-solving activities with accessible digital learning resources. Therefore, this study aims to investigate the effect of the Auditory, Intellectually, Repetition (AIR) learning model supported by Google Sites on the problem-solving skills of eighth-grade students at SMP Negeri 18 Makassar in learning vibrations and waves.

METHODS

This type of research is *Quasi-Experimental* with *a Nonequivalent Control Group Design* (Table 1), which involves two classes selected without randomization but given different treatments during the learning process.

Table 1. Research Design

Group	***Pretest***	**Treatment**	***Posttest***
Experimental	O_1	X	O_2
Control	O_3	-	O_4

(Creswell, 2016)

O_1, O_3 = *Pre-test*
O_2, O_4 = *Posttest*
X = The AIR learning model assisted by Google Sites
\- = Control class using the discovery learning model

The research population included all 318 eighth-grade students at SMP Negeri 18 Makassar in 2024/2025 academic year. The sample was selected using purposive sampling technique based on the criterion of relatively similar characteristics, namely the learning outcomes of students taught by the same teacher, with class VIII-7 as the experimental group and VIII-9 as the control group. Each class consisted of 30 students, bringing the total sample size in this study to 60. Data collection was conducted by administering a

pretest and posttest to both groups. The research instrument consisted of 10 essay questions designed to measure problem-solving skills in the material on vibrations and waves. The instrument was adapted from previous research and modified by the researchers to suit the learning objectives and the content of vibrations and waves. The instrument was subsequently reviewed by experts to ensure the relevance of the items to the learning objectives, content, and problem-solving indicators. The problem-solving skill indicators, their descriptions, and the corresponding test items are presented in Table 2.

Table 2. Problem-Solving Skill Indicators, Descriptions, and Test Items

Indicator	Description	Item
Understanding the problem	The subject is able to understand what is known and what is being asked in the given problem	1–10
Planning completion	The subject is able to determine the formula, approach, or method that can be used to solve the given problem	1–10
Completing the plan	The subject is able to apply the planned formula, approach, or method to solve the given problem	1–10
Re-check	The subject reviews the answers provided when solving the problem to ensure they are correct	1–10

Polya (Ramdani & Suryaningsih, 2023)

Table 3. Scoring Criteria for Problem-Solving Skills

Indicator	Description	Score
Understanding the problem	Students write down what they know from the question	
	Did not answer at all	0
	Write down what they know but misunderstand the information	1
	Write down what they know but incompletely	2
	Write down what they know completely and correctly	3
	Students write down what is asked in the question	
	Did not answer at all	0
	Write down what is asked but misunderstand the information	1
	Write down what is asked but incompletely	2
	Write down what is asked completely and correctly	3
Planning completion	Did not answer at all	0
	Write down a solution strategy, but it is not quite correct	1
	Write down a solution strategy with a correct and complete answer	2
Completing the plan	Did not answer at all	0
	Write down the steps to solve the problem, but they are incorrect, leading to a wrong answer	1
	Write down the steps to solve the problem, but the procedure is incomplete, leading to a correct answer but an incorrect solution	2
	Provides a complete set of solution steps, leading to the correct answer but an incorrect solution process	3
	Provides a complete set of solution steps and arrives at the correct result	4
Re-check	Did not answer at all	0
	Performs the verification incorrectly	1
	Performs the verification correctly	2

(Astutiani et al., 2019)

Based on the scores obtained, the problem-solving ability score is then calculated using the following formula:

$$\text{Grade} = \frac{Score\ earned}{Maximum\ score} \text{ x } 100$$

The categorization of problem-solving skills was determined according to Table 4.

Table 4. Problem-Solving Ability Score Categories

Interval	Category
81 – 100	Very High
61 – 80	High
41 – 60	Moderate
21 – 40	Low
0 – 20	Very Low

(Rodiah et al., 2023)

The *N-Gain* results were then classified according to the categories in Table 5.

Table 5. *N-Gain* Categories

N-Gain Score	N-Gain Criteria
N-gain ≥ 0.7	High
0.3 ≤ N-gain < 0.7	Moderate
N-gain < 0.3	Low

(Hake & Reece, 1999)

Normality data was assessed using the Shapiro-Wilk test at a significance level of 0.05, and homogeneity was assessed using analysis of variance. Next, the hypothesis was tested using an Independent Samples T-Test, and all data analyses were conducted using SPSS version 29.0 for Windows.

RESULT AND DISCUSSION

Descriptive Statistical Analysis

Descriptive statistical analysis provides an overview of the results of the problem-solving ability test of eighth-grade students at SMP Negeri 18 Makassar. The complete data are shown in Table 6.

Table 6. Results of Descriptive Analysis of Students' Problem-Solving Ability

Descriptive Statistics	Experimental Class		Control Class	
	Pre-test	*Posttest*	*Pre-test*	*Posttest*
Lowest Score	1	15	2	9
Highest Score	17	98	16	65
Average	7.80	52.60	7.57	29.27
Standard Deviation	4.16	25.66	4.11	15.36
Sample Size	30	30	30	30

The table shows that scores increased from the pretest to the posttest in both groups, but the increase was greater in the experimental group. This is evident in the higher average score of the experimental group compared to the control group.

Table 7. Average Problem-Solving Ability Scores of Students

	Experimental Class		**Control Class**	
	Average Score	Category	Average Score	Category
Pre-test	7.80	Very Low	7.57	Very Low
Posttest	52.60	Moderate	29.27	Low

Based on Table 7, the same problem-solving test instrument was administered to both the experimental and control classes during the pretest and posttest. The average pretest scores for both the experimental and control classes were very low. This finding indicates that students' initial problem-solving abikmarin lities were still weak and relatively equal across both classes before the treatment. Following the treatment, the experimental group's mean score advanced to the moderate category, whereas the control group only progressed to the low category. In other words, although both classes experienced an increase, the change that occurred in experimental class was more significant categorically than in control class.

Table 8. Average *N-Gain* Scores for Problem-Solving Skills

Class	**Average *N-Gain* Score**	**Category**
Experimental	0.48	Moderate
Control	0.23	Low

Based on Table 8, the average *N-Gain* score in the experimental class was in the moderate category, while in the control class it was still in the low category. This confirms that the treatment given in the experimental class had a greater impact on improving problem-solving skills.

Table 9. Average *N-Gain* Scores of Each Problem-Solving Ability Indicator

Indicator	**Value**				**Experimental**		**Control**	
	Pre-test		*Posttest*		*N-Gain*	Category	*N-Gain*	Category
	E	C	E	C				
Understanding the problem	122	120	914	545	0.47	Moderate	0.25	Low
Planning completion	27	22.5	387	135	0.63	Moderate	0.19	Low
Completing the plan	70	67.5	711	359.5	0.57	Moderate	0.26	Low
Re-check	105	102	199	188	0.19	Low	0.17	Low

Table 9 shows that in the experimental class, the indicators of problem comprehension, planning solutions, and completing plans were in the moderate category, while the indicator of rechecking was still low. In the control group, all indicators, including problem comprehension, solution planning, plan completion, and rechecking, remained low.

Inferential Statistical Analysis

A normality test was conducted to determine whether the research data were normally distributed. The normality test result of eighth-grade students' problem-solving abilities are shown in Table 10.

Table 10. Normality Test of Students' Problem-Solving Abilities

Problem Solving	**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test Experimental	0.134	30	0.177	0.955	30	0.231
Post-test Experimental	0.131	30	0.198	0.938	30	0.078
Pre-test Control	0.141	30	0.131	0.941	30	0.097
Post-test Control	0.158	30	0.053	0.934	30	0.064

Based on the table, all significance values for both the pretest and posttest data in the experimental and control classes were greater than 0.05. This indicates that the students' problem-solving ability data is normally distributed. Once the normality test confirmed that the data were normally distributed, a homogeneity test was subsequently performed on the research sample. This statistic aims to determine whether the data from each group has the same variance (homogeneous) or not. The results of the homogeneity test of the problem-solving abilities of eighth-grade students are presented in Table 11.

Table 11. Homogeneity Test of Students' Problem-Solving Ability

Tests of Homogeneity of Variances					
		Levene Statistic	**df1**	**df2**	**Sig**
Problem-Solving Ability	Based on Mean	0.027	1	58	0.871
	Based on Median	0.022	1	58	0.884
	Based on Median and with adjusted df	0.022	1	57.997	0.884
	Based on trimmed mean	0.029	1	58	0.866

Based on the results of the homogeneity test for problem solving in Table 11, a significance value of 0.871 was obtained. Because this value is greater than 0.05, it can be concluded that the variance in problem-solving ability between the experimental and control classes is homogeneous. Statistical hypothesis testing was used to determine the effect of using the AIR model assisted by Google Sites on problem-solving ability. Hypothesis testing was conducted using the Independent Sample T-Test statistic.

Table 12. Hypothesis Test of Students' Problem-Solving Ability

Variable		***Independent Samples Test***				
		Lavene's Test for Equality of Variances		***t-test for Equality of Means***		
		F	***Sig.***	***t***	***df***	***Sig. (2-tailed)***
Problem Solving (*Posttest*)	*Equal variances assumed*	12.533	< 0.001	4.274	58	< 0.001
	Equal variances not assumed			4.274	47.424	< 0.001

The hypothesis test results illustrate the significance value (2-tailed) is < 0.001), which is below the 0.05 level. Therefore, H_0 is rejected, and H_1 is accepted, indicating a significant difference in the mean posttest scores for problem-solving skills between the experimental class and the control class. Therefore, it can be concluded that the use of the Auditory-Intellectual-Repetition (AIR) learning model, assisted by Google Sites, has a significant effect on improving the problem-solving skills of eighth-grade students at SMP Negeri 18 Makassar.

Discussions

The data analysis shows that the problem-solving skills of students who learn using the AIR model are better than those of students who follow the Discovery Learning model. As shown in Table 7, there was an increase in the average problem-solving skill scores from the pretest to the posttest in both the experimental and control classes. Before the treatment, both classes had relatively comparable average scores. The increase in scores in the experimental group was due to students' active participation in learning activities that emphasized problem-solving exercises. At each meeting, students were given problem-based questions aligned with problem-solving ability indicators, which were then discussed in groups and presented publicly. This activity provided an opportunity for students to practice critical thinking in both the sequential problem-solving process and the final results. The increase in scores in the experimental group can be attributed to the implementation of the Auditory, Intellectually, and Repetition (AIR) learning model integrated with a website-based learning medium. Meanwhile, in the control class, learning was conducted using the Discovery Learning model without the support of website-based learning media. Students did not have access to supporting digital media such as videos, simulations, and reinforcement quizzes, so learning tended to be less than optimal in training problem-solving skills.

The structured AIR model emphasizes three stages of learning (auditory, intellectual, and repetition) that directly support the development of problem-solving skills, especially when combined with Google Sites as a learning support medium. Google Sites serves as a learning resource center, providing learning materials, interactive videos, student worksheets, and neatly organized exercises and evaluations so students can access them easily at any time. In the first stage, the auditory stage, students are directed to listen to the teacher's explanations and study the material provided as learning videos via links on Google Sites. This stage facilitates students in listening to explanations of the material, asking questions about material they do not understand, and ensuring a comprehensive understanding of the concepts. The question-and-answer activity at this stage plays an important role in providing initial stimuli that support students in designing and carrying out the next investigative process (Hasanuddin & Arif, 2023).This is aligned with Darwis (2024) research, which indicates that the auditory stage can improve understanding and develop listening and active questioning skills. With the auditory stage, students play a greater role in the learning process (Xie et al., 2019).

The second stage, the *intellectual*, students are directed to think critically and engage in problem-solving through group discussions as they work on the LKPD. In this stage, Google Sites provides instructions for completing LKPD and contains problem-solving questions. Although this stage is designed to develop problem-solving skills, its application in this study has not fully trained all indicators of problem-solving competence. In line with research by Al-Thani & Ahmad (2025), the intellectual stage of the learning

model encourages students to develop logical, structured thinking patterns through exercises that solve challenging problems. After the students complete the assigned problems, group representatives are randomly selected to present their discussion results to the class.

The next stage is repetition, where students review the material through quizzes available on Google Sites. This stage serves to deepen their understanding through individual evaluation exercises. This activity is related to the indicator of rechecking, as students review the solutions they have made. At this stage, the use of Google Sites as a quiz medium proved to be less interactive. Although it functions as a means of reinforcing material, Google Sites does not provide comprehensive automatic feedback features. According to (Hidayati et al., 2021), repetition in the AIR model can train students to solve problems by developing independent solution strategies. The N-Gain results indicate that the average problem-solving ability of students in the experimental class falls within the moderate category, with a score of 0.48. This indicates a significant improvement, although it has not yet reached the optimal level. A more in-depth analysis of each indicator, as presented in Table 9, shows a moderate improvement in understanding the problem, planning the solution, and completing the plan. Meanwhile, the rechecking indicator is still in the low category. This is because students are not yet accustomed to working on essay-type questions used as research instruments. This finding is supported by the analysis of student answers, as explained below.

The first indicator, understanding the problem, showed that students in the experimental class were able to identify important information in the questions, such as known and unknown variables, but their scores were lower than those of the control class. The ability to identify data is the initial stage in the problem-solving process, and this is supported by the Auditory and Intellectual steps in the AIR model, in which students are exposed to concepts through explanations and discussions before practicing problem-solving (Adiani & Rini Kristiantari, 2020). Therefore, in the understanding the problem indicator, students performed better than the control class, which was taught using the discovery learning model. In the second indicator, planning the solution, the experimental class students wrote down the sequence of formulas correctly, while the control class tended to leave it blank or was less systematic. This achievement indicates that learning through the Intellectually stage helps students build a logical thinking structure before solving problems, where students are guided to compile the stages of solution that are relevant to the problems presented, so that they are able to design a precise and focused plan for solving problems (Todingan et al., 2026; Ling et al., 2024). After being guided and trained to break down problems into problem-solving steps, students were able to work on the problems well (Hobri et al., 2021).

In the third indicator, namely completing the plan, the experimental class students generally completed the calculation steps, including using formulas, substituting numbers, and using correct units. Meanwhile, students in the control class wrote down only some of the calculation steps, without a systematic explanation. This condition indicates that the Intellectually stage, designed through group problem-solving activities, supports students in developing a structured thinking process (Huang et al., 2020). In addition, the AIR model encourages students to actively engage in solving problems in stages (Sukasno et al., 2023). The fourth indicator, rechecking, occurs when students provide conclusions based on the results of solving the problems. However, this indicator remained relatively low because, during the learning process, students were not sufficiently trained to rewrite the

results obtained and immediately write down their conclusions. As a result, when working on the problems, many students did not perform optimally in providing answers to the rechecking indicator. These findings indicate that reflection on the results of the work has not become part of the learning routine in either the experimental or control group. This is aligned with research (Aswir et al., 2025; Sinaga et al., 2023), which found that students are not accustomed to systematically rewriting their results and reflecting on their answers before drawing conclusions.

As a result, when working on problems, many students are not careful when reviewing their answers, leading to low scores on this indicator. To analyze the results, inferential statistics were used to test the research hypothesis. The normality and homogeneity test results showed that the data were normally distributed and had homogeneous variance, thus meeting the requirements to proceed to the hypothesis testing stage. Furthermore, the independent samples t-test yielded a significance value of 0.001 (< 0.05), indicating a significant difference between the experimental and control classes. Thus, it can be concluded that the use of the Auditory-Intellectual-Repetition (AIR) learning model, assisted by Google Sites, has a significant effect on improving the problem-solving skills of eighth-grade students at SMP Negeri 18 Makassar. These results supported by the research of Sukasno et al. (2023), which shows that the application of the AIR model can improve problem-solving skills by providing an active, understanding-oriented learning experience and strengthening thinking skills through repetition. Therefore, the AIR model, combined with Google Sites, is suitable for implementation in learning, especially for improving problem-solving skills in science subjects.

CONCLUSION

Based on the research results and data analysis, it can be concluded that the AIR model assisted by Google Sites has an effect on the problem-solving abilities of eighth-grade junior high school students. The average problem-solving abilities in experimental class after treatment were 52.60, and in control class were 29.27. This research highlights the potential of technology-integrated instructional models to enhance crucial skills in science education. The limitations of this research are the specificity of the participant context and study background, which limits generalization, and the short duration, which hinders evaluation of long-term impacts. Future research should explore the effectiveness of the Google Sites-assisted AIR model in a broader, longer-term context, including student characteristics and Google Sites features that support problem-solving.

DECLARATION OF GENERATIVE AI

The author used Jenni.ai for paraphrasing, grammar checking, and clarity improvements, and Grammarly for grammar and language editing. The author subsequently reviewed and edited all content and takes full responsibility for the content of the publication.

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

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Ramlawati: Conceptualization, Methodology, Supervision, Writing – Review & Editing. **Andi Umdatul Hasanah**: Collecting data, Investigation, Writing – Original Draft, Data Curation, Data Analysis, **Rifda Nur Hikmawati Arif**: Validation, Supervision, Writing – Review & Editing. **Nur Indah Sari**: Resources, Visualizartion, Writing – Review & Editing.

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