

Assessing Learning Attainment Through the AIR Model: A Mathematics and Gender Differences Study

Della Permata Sari, Fida Rahmantika Hadi, Lingga Nico Pradana 

Della_2102101120@mhs.unipma.ac.id, fida@unipma.ac.id, nicopgsd@unipma.ac.id
Faculty of Teacher Training and Education, Universitas PGRI Madiun, Madiun, Indonesia

Article Info

Article history:

Submission Jul 31, 2025
First Revised Nov 11, 2025
Accepted Dec 5, 2025
Published Dec 31, 2025

Keywords:

AIR learning model
elementary education
gender differences
mathematics learning
students' attainment

ABSTRACT

Mathematics education in the 21st century compels educators to not only instruct on procedures and formulas but also to create learning experiences that foster contextual problem modelling, critical reasoning, collaboration, and the effective use of digital technology to cultivate adaptive and advanced cognitive skills in students, particularly in elementary schools. This study aims to examine the effectiveness of the Auditory, Intellectuality, Repetition (AIR) learning model in improving the mathematics learning outcomes of fifth-grade elementary students. Using a quantitative approach with an Interrupted Time Series design, this study involved 28 students who completed a pre-test prior to the AIR-based learning intervention and a post-test afterward. The Number-Test was used to measure students' mathematics achievement. Data obtained from both tests were analyzed quantitatively. A paired sample t-test was conducted to compare students' pre-test and post-test scores. The normalized gain (N-gain) score was also calculated to determine the degree of improvement. The average pre-test score was 64.46, while the post-test average increased to 85. The results of paired sample t-test analysis showed a significant improvement in students' achievement ($p < 0.001$). The normalized gain (N-gain) score was 0.57, indicating a moderate level of improvement. Further analysis using an independent sample t-test revealed no significant difference in learning outcomes between male and female students ($p = 0.685$), suggesting that the AIR model was equally effective across gender. Overall, the AIR learning model positively contributed to enhancing students' mathematical understanding, particularly in least common multiple (LCM) and greatest common factor (GCF) topics.

© 2025 Authors.

This is an open-access article distributed under the terms of
the [Creative Commons Attribution License \(CC BY-SA\)](https://creativecommons.org/licenses/by-sa/4.0/)



Corresponding Author:

Lingga Nico Pradana
Department of Primary Education, Faculty of Teacher Training and Education
Universitas PGRI Madiun
Jl. Setiabudi No. 85, Madiun City, East Java, Indonesia
Email: nicopgsd@unipma.ac.id

How to cite:

Sari, D. P., Hadi, F. R., & Pradana, L. N. (2025). Assessing Learning Attainment Through the AIR Model: A Mathematics and Gender Differences Study. *Pedagogia: Jurnal Ilmiah Pendidikan*, 17(2), 229–240.
<https://doi.org/10.55215/pedagogia.v17i2.75>

Introduction

Mathematics learning outcomes represent the achievements attained by students after undergoing a learning process, reflecting the extent of their understanding of the material taught, and are generally demonstrated through test scores (Fadillah, 2016; Murphy, 2016). Teachers' understanding of these learning outcomes enables effective evaluation of students' mastery of concepts, facilitating targeted instructional decisions. Learning outcomes signify students' accomplishments in accordance with predetermined criteria, which can be seen through knowledge absorption and observable behavior (Dakhi, 2020; Ayadat et al., 2020; Caspersen et al., 2017). Moreover, learning outcomes encompass cognitive, affective, and psychomotor domains, which form a comprehensive framework for assessing students' academic performance (Anand et al., 2024; Zainudin & Ubabuddin, 2023; Hoque, 2016).

Despite the structured delivery of mathematics lessons, learning often fails to meet instructional goals. Students frequently struggle to master specific indicators of competence, particularly in the cognitive domain. In mathematics learning, especially on the topics of Least Common Multiple (LCM) and Greatest Common Factor (GCF), many students face difficulties in identifying the prime factors of a number and determining LCM and GCF using prime factorization (Muthmainnah, 2024; Pratiwi, 2023; Netson & Ain, 2022). In contrast, students tend to demonstrate better understanding when identifying prime numbers below 100. These gaps in indicator mastery are reflected in students' learning outcomes, underscoring the importance of selecting appropriate learning models that support the development of conceptual understanding.

Numerous studies have attempted to identify effective instructional approaches for improving mathematics achievement. Recent evidence shows that mathematics education in Indonesia continues to require substantial instructional innovation, reinforcing the relevance of models such as AIR. According to the 2022 Programme for International Student Assessment (PISA), Indonesian students achieved an average mathematics score of 366, significantly below the OECD average of 472, indicating persistent weaknesses in reasoning and problem-solving skills (OECD, 2023). Furthermore, only 18% of Indonesian students reached Level 2 proficiency or higher in mathematics, a threshold associated with basic conceptual understanding. These data collectively suggest that traditional instructional practices in mathematics have not yet succeeded in developing students' higher-order thinking and conceptual mastery. Several approaches emphasize multisensory engagement, allowing students to process information through physical, auditory, visual, and intellectual channels, which has been shown to enhance understanding in geometric concepts (Nainggolan et al., 2021; Volta et al., 2018).

Other approaches focus on collaborative learning, encouraging students to work together through structured group discussions to solve mathematical problems such as those involving LCM and GCF (Lahann & Lambdin, 2020; Asshofi et al., 2019). Additionally, some studies highlight individualized learning strategies that support students' mastery at their own pace while still maintaining academic rigor (Dewi, 2018). While these approaches promote active participation and meaningful learning experiences, their implementation often relies on group dynamics or classroom structures that may not be feasible or effective in every instructional context. Consequently, implementing structured and student-centered learning innovations such as the AIR model is essential to enhance students' engagement, cognitive processing, and sustained reinforcement in mathematics learning.

Recent research highlights the promise of more structured models like Auditory, Intellectually, Repetition (AIR), which focus on individual engagement through listening, critical thinking, and repetition. For instance, AIR improved student performance in integrated thematic learning (Tryas & Hashim, 2025; Mustofa et al., 2020). Furthermore,

AIR encourages student participation and supports retention through repeated exposure and intellectual engagement (Ekasari & Trisnawati, 2021). However, most existing studies focus on general or thematic subjects rather than on specific mathematical topics like LCM and GCF, and the targeted indicators used in prior studies often differ. Hence, there remains a gap in applying the AIR model to support students' mastery of these more abstract arithmetic concepts.

The Auditory, Intellectuality, Repetition (AIR) learning model is designed to enhance student engagement and conceptual understanding through three interrelated components: auditory processes that involve listening, articulating, and exchanging ideas; intellectual engagement that emphasizes higher-order thinking and problem-solving; and systematic repetition that strengthens retention through structured reinforcement. While prior studies have demonstrated the model's effectiveness in promoting active participation and improving factual mastery (Agustiana et al., 2018; Ekasari & Trisnawati, 2021), its application has predominantly been situated in language learning or general instructional contexts. The novelty of this study lies in extending the AIR framework into elementary mathematics instruction, particularly in teaching abstract number theory concepts such as LCM and GCF, where students frequently encounter difficulties in conceptualization and procedural accuracy. By positioning AIR within the domain of mathematics, this research addresses a clear empirical gap and offers a pedagogical innovation tailored to strengthening conceptual depth and cognitive processing in numeracy learning.

Based on this rationale, the study aims to examine the effectiveness of the AIR learning model in improving fifth-grade students' mathematics learning outcomes on LCM and GCF topics. Beyond measuring achievement gains, the research seeks to analyze how the integration of auditory interaction, structured intellectual engagement, and deliberate repetition contributes to improved conceptual retention and procedural fluency. The contribution of this study is twofold: theoretically, it enriches the discourse on active learning models in mathematics education by validating AIR within a quantitative reasoning context; practically, it provides evidence-based guidance for elementary teachers in designing mathematics instruction that is cognitively engaging and systematically reinforcing. Consequently, this research not only tests the effectiveness of AIR but also advances an alternative instructional framework capable of addressing persistent challenges in elementary mathematics learning.

Method

Participant

The participants in this study were fifth-grade students from a public elementary school, comprising a total of 28 individuals. Of these, 11 were male and 17 were female. The entire class participated in the learning intervention designed to examine the impact of a specific instructional approach on mathematics achievement. These students were actively involved in classroom activities and assessments focused on the mathematical concepts of LCM and GCF. The demographic composition of the group reflects a typical classroom setting at the elementary level, providing a balanced perspective on the effectiveness of the learning model across both genders. All participants engaged in the same sequence of pre-instructional assessments, learning activities, and post-instructional evaluations, allowing for a comprehensive analysis of changes in learning outcomes.

Instruments

The primary instrument used in this study was a mathematics achievement test titled Number-Test, developed to measure students' learning outcomes on the topic of LCM and

GCF. The Number-Test consisted of 20 multiple-choice items aligned with key indicators such as identifying the prime factors of a number and determining LCM and GCF using prime factorization. Students were given 60 minutes to complete the test (**Table 1**).

The Number-Test was administered in two phases: a pre-test before the instructional intervention to determine students' prior knowledge, and a post-test after the intervention to assess the learning outcomes. The results from both tests were compared to evaluate the effectiveness of the instructional approach implemented in the study. To ensure its validity, the instrument was reviewed and validated by two experts in mathematics education. Revisions were made based on their feedback to enhance content relevance and clarity. After validation, a reliability test was conducted through a pilot study involving students outside the study group. The result showed that the Number-Test achieved a Cronbach's Alpha coefficient of 0.896, indicating a high level of internal consistency and reliability.

Table 1. Indicators of the Number-Test Instrument for Subtopics: Prime Factorization, GCF, and LCM

Sub-topic	Indicators (Expanded – English)
Determining Prime Factors	Identify the prime factors of a given whole number. Perform prime factorization for two or more whole numbers.
Determining Greatest Common Factor (GCF)	Determine the GCF of two or more numbers using their prime factors. Solve contextual problems involving GCF in everyday situations.
Determining Least Common Multiple (LCM)	Determine the LCM of two or more numbers using their prime factors. Solve contextual problems involving LCM in everyday situations.

Procedure

This study employed a quantitative approach because the data collected were in the form of interval-scale numerical scores representing students' mathematics learning outcomes. The design used was time series with an interrupted time series design, focusing on a single group observed at two time points: before and after the intervention. This design does not involve random sampling or control groups. The class studied served as both the control (during the pre-test) and the experimental group (during the post-test), with comparisons made between their performances across these two phases (**Figure 1**).

At the beginning of the study, students were administered a pre-test using the Number-Test instrument to assess their prior knowledge of LCM and GCF. Following the pre-test, students received mathematics instruction through the AIR learning model. The instructional sessions were integrated into regular classroom teaching and emphasized active listening, mental engagement, and reinforcement of concepts through repetition. The learning content focused specifically on problem-solving related to prime factorization and determining LCM and GCF. After the instructional period, students completed a post-test using the same Number-Test to evaluate the knowledge gained through the intervention.

The collected data from both the pre-test and post-test were analyzed to determine the effectiveness of the AIR learning model. The comparison of scores provided quantitative evidence of learning progress and the impact of the instructional strategy implemented within the same group over time.

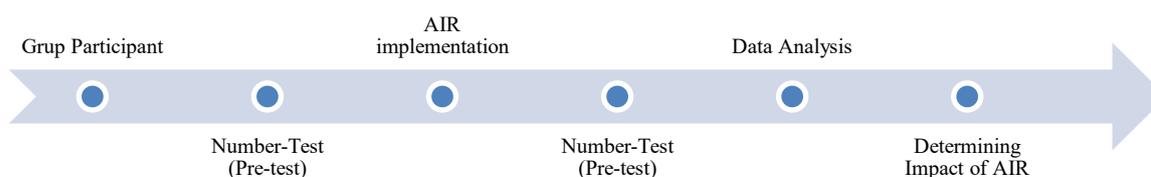


Figure 1. Research Procedure for Evaluating the Impact of AIR Learning Model Using the Number-Test

Data Analysis

Data obtained from the pre-test and post-test using the Number-Test instrument were analyzed quantitatively to assess the effectiveness of the AIR learning model in improving fifth-grade students' mathematics learning outcomes on the topics of Least Common Multiple (LCM) and Greatest Common Factor (GCF). The analysis process began with calculating descriptive statistics, including the mean, standard deviation, minimum, and maximum scores of students' performance on both tests. To test the effectiveness of the intervention, a paired sample t-test was conducted using SPSS version 26. This statistical test was chosen because it allows for comparison of two related means. In this case, the same group of students measured before and after the implementation of the instructional model. The significance level was set at $\alpha = 0.001$. If the p-value obtained was less than 0.05, the result was considered statistically significant, indicating that the AIR learning model had a meaningful effect on students' learning outcomes. Additionally, the normalized gain (N-gain) score was calculated to examine the degree of improvement in students' learning. The N-gain score helps categorize learning gains into low, medium, or high, providing a more nuanced interpretation of the instructional impact. Through this combination of statistical methods, the data analysis aimed to provide robust evidence regarding the AIR model's contribution to enhancing mathematics achievement in the specific content areas addressed.

Results and Discussion

Learning Profile Before and After AIR Implementation

This study aimed to measure the effectiveness of the AIR learning model on the mathematics learning outcomes of fifth-grade students. Data were collected through two tests—pre-test and post-test—administered before and after the implementation of the AIR model. The pre-test aimed to assess the students' initial understanding of the material before the learning intervention. The results showed that the average mathematics achievement score was 64.46. After the implementation of the AIR learning model, students were given a post-test to assess their understanding after the learning process. The average post-test score was 85. A comparison of pre-test and post-test results is illustrated in **Table 2**. The descriptive statistics reveal a substantial increase in student performance following the implementation of the AIR learning model, indicating its potential effectiveness in improving mathematics achievement.

In addition to the increase in mean scores, the statistical analysis further confirms the significance of this improvement. The mean difference between the pre-test and post-test scores was 20.54, with a standard deviation of 10.63, indicating a consistent gain among students. The paired-samples t-test result showed a t-value of 10.55 with 27 degrees of freedom and a significance value of 0.000 ($p < 0.05$), demonstrating that the difference between pre-test and post-test scores was statistically significant. Furthermore, the minimum score increased from 30 in the pre-test to 65 in the post-test, while the maximum score rose from 85 to 100. This shift suggests not only an overall improvement in average performance

but also a meaningful enhancement across different levels of student ability, strengthening the evidence that the AIR learning model contributed positively to students' mathematics learning outcomes.

Table 2. Descriptive Statistics of Pre-Test and Post-Test Scores

Data	N	Mean	Median	Min	Max	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Pre-test	28	64.46	65	30	85					
Post-test	28	85.00	85	65	100	20.54	10.63	10.55	27	0.000

The Effectiveness of AIR Learning Model

To examine the effectiveness of the AIR (Auditory, Intellectually, Repetition) learning model on students' mathematics learning outcomes, a paired-sample t-test was conducted. This statistical test compared the mean scores of the students' pre-test and post-test results to determine whether the difference was statistically significant. The analysis results in Table 2 show a significant increase in the students' scores after implementing the AIR learning model. The mean difference between the pre-test and post-test scores was 20.54, with a significance value of 0.000, which is less than the threshold of 0.05. This indicates that the improvement in scores is statistically significant. The findings demonstrate that the AIR learning model had a substantial and positive effect on student learning outcomes in mathematics. The model's focus on auditory engagement, intellectual stimulation, and repeated reinforcement appears to have contributed effectively to students' understanding of the material, particularly in the topic of LCM and GCF. This result aligns with the theory that multimodal strategies, especially those that integrate repetition and cognitive involvement, enhance long-term retention and conceptual understanding.

Additionally, the normalized gain (N-gain) score was calculated to measure the degree of improvement in students' mathematics learning outcomes. The average N-gain for the class was found to be 0.58, which falls into the moderate category (low: <0.3; medium: 0.3–0.7; high: >0.7). This result indicates a substantial improvement in student understanding after the implementation of the AIR learning model. The moderate gain suggests that the AIR model significantly enhanced students' conceptual grasp and procedural fluency, particularly in solving LCM and GCF problems. These findings strengthen the conclusion that the AIR model is not only statistically effective—as shown by the t-test—but also pedagogically impactful in improving learning retention and conceptual comprehension. Through this combination of statistical analysis and normalized gain assessment, the study provides strong and multidimensional evidence for the effectiveness of the AIR instructional model in improving mathematics achievement among elementary school students.

Gender Differences

The participants in this study were fifth-grade students from a public elementary school, comprising a total of 28 individuals—11 male and 17 female students. To investigate whether there were statistically significant differences in post-test mathematics achievement between male and female students following the implementation of the AIR learning model, an independent sample t-test was conducted. The results indicated that the mean post-test score for male students was 84.18 (SD = 9.91), while the mean score for female students was 85.59 (SD = 9.58). The independent sample t-test yielded $p = 0.685$, which is greater than the significance level of 0.001 (**Table 3**). This suggests that there was no statistically significant difference in mathematics learning outcomes between male and female students.

Thus, the AIR learning model appeared to be equally effective across genders in improving student achievement in the given mathematical content.

Further analysis of the statistical output strengthens this conclusion. The independent samples t-test produced a t-value of 0.412 with 26 degrees of freedom, indicating that the observed mean difference of 1.41 points between male and female students was minimal. The relatively comparable standard deviations (SD = 9.91 for males and SD = 9.58 for females) also suggest a similar distribution and variability of scores within both groups. This homogeneity of variance reflects that both male and female students responded similarly to the AIR learning model. Therefore, the findings imply that the AIR model promotes equitable learning opportunities and supports mathematics achievement consistently, regardless of gender differences in the classroom context.

Table 3. Independent Sample t-Test on Post-Test Scores by Gender

Gender	N	Mean	Std. Deviation	t	df
Male	11	84.18	9.91	0.412	26
Female	17	85.59	9.58		

Discussion

This study highlights the role of the AIR learning model in supporting students' comprehension during mathematics learning on the topics of LCM and GCF. The results showed a noticeable development in student understanding, which was reflected in the improvement of students' cognitive learning outcomes. This improvement was attributed to the systematic and structured learning process implemented through the AIR model.

In line with previous research, it is stated that changes in student behavior during learning can be observed through the implementation of appropriate learning models, which encourage active participation and optimal contribution from students, potentially enhancing learning outcomes (Wilujeng, 2013). This is supported that the AIR learning model integrates three main aspects—Auditory, Intellectual, and Repetition—which promote active student participation during the learning process (Mustamin & Kusumayanti, 2019). Through this model, students are trained to develop listening skills, express opinions confidently, solve problems creatively, recall previously learned material, and express their ideas. The “Repetition” component of the AIR model can be supported by the theory of spaced repetition, which posits that structured and interval-based review strengthens students' understanding and retention of mathematical concepts (Lindquist et al., 2024; Lyle et al., 2022; Muzsnay et al., 2025; Voice & Stirton, 2020). The “Intellectuality” component of the AIR model—which encompasses critical thinking, discussion, and problem-solving—aligns with findings that active pedagogies foster intellectual engagement, thereby exerting a positive influence on students' cognitive outcomes (Karjanto & Acelajado, 2022). In contrast, SAVI learning model emphasizes four main stages—preparation, delivery, practice, and performance—designed to engage students' sensory and physical activities (Nainggolan et al., 2021). However, this model does not focus on material repetition at the end of the learning process, as it emphasizes exploration and direct application through somatic, auditory, visual, and intellectual interactions.

The present study demonstrated that the AIR model was effective in improving students' learning outcomes, as indicated by their test scores. During the implementation, students showed great enthusiasm and active engagement in each phase of the learning process. This was evident in the well-managed discussions, where students exchanged ideas, and during material repetition sessions, where they eagerly volunteered to answer quizzes. These findings align with the AIR model cultivates habits of active participation and builds students' confidence in expressing opinions, while the repetition phase helps reinforce learning and memory (Hayyun & Duri, 2019). This is further supported that the repetition

stage enhances students' understanding and deepens knowledge through exercises and skills-based tasks that support effective learning (Bego et al., 2024; Lindquist et al., 2024; Mahmudah & Respati, 2022; Nazari & Ebersbach, 2019). Unlike discovery learning, as studied by Kristin (2016), where students are encouraged to perform observations, experiments, and scientific actions to draw conclusions, or the direct instruction model explored by Lase and Tangkin (2022), which relies heavily on teacher-centered communication and leads to passive student involvement, the AIR model requires active student engagement throughout all stages. In direct instruction, students simply receive information from the teacher, with limited opportunities for discussion.

The implementation of the AIR learning model in this study significantly improved students' learning outcomes and collaborative skills, as students actively engaged in classroom discussions. This is consistent with findings from Elinawati et al. (2018), who emphasized that the AIR model enhances cognitive outcomes and student activeness by creating dynamic, student-centered learning. Manurung (2016) further supports this, highlighting that the AIR model promotes the use of all sensory organs in learning, making it more effective and improving student achievement. The model encourages students to participate by listening, thinking, and repeating material, resulting in new and enriching learning experiences. This differs from the Problem-Based Learning (PBL) model discussed by Wardani (2023), which focuses more on exploring and solving real-world problems collaboratively while developing students' skills.

This study integrated the AIR learning model effectively to improve the mathematics achievement of fifth-grade students in the cognitive domain. The AIR model's focus on auditory, intellectual, and repetition aspects encouraged student participation and better material comprehension, enhancing engagement throughout the learning process. This integration created a meaningful and structured learning process that led to increased learning achievement in the topics of LCM and GCF. The findings are in line with research by Suryanda et al. (2023), who combined the AIR model with other digital tools and found that integrating learning models with interactive platforms enhanced learning outcomes, encouraged student participation, built confidence in expressing opinions, and supported creative problem-solving. In contrast, Suryantari et al. (2019), who implemented a guided inquiry model with concrete media, emphasized direct problem-solving without structured content reinforcement. Their model required students to independently discover information and solve problems, which resulted in different dynamics compared to the systematic approach of the AIR model.

The analysis of gender-based differences in mathematics achievement revealed no statistically significant disparity between male and female students following the implementation of the AIR learning model. Although descriptive data indicated that female students achieved slightly higher average post-test scores than their male counterparts, the results demonstrated that this difference was not significant. This suggests that the AIR model contributed positively to the learning outcomes of both male and female students in a relatively equitable manner. These findings are consistent with prior research indicating that, while gender gaps in mathematics performance may exist in certain contexts, well-designed instructional interventions can help bridge these differences (Verdugo-Castro et al., 2022). The structured nature of the AIR learning model, which emphasizes active listening, cognitive engagement, and material repetition, appears to create a learning environment that supports diverse learners regardless of gender. This reinforces the importance of instructional strategies that are inclusive and responsive to the needs of all students. Moreover, the equitable impact of the AIR model may be attributed to its balanced focus on auditory processing, intellectual stimulation, and reinforcement, which are essential for deep

learning and benefit all students regardless of gender. The claim that the AIR model is “equally effective for male and female students” can be supported by international literature indicating that well-designed instructional interventions—particularly those emphasizing repetition and cognitive engagement—can reduce gender disparities or, at the very least, avoid exacerbating them. (Qushem et al., 2025; Giofrè et al., 2020; Mejía-Rodríguez et al., 2021). The result underscores that gender should not be viewed as a limiting factor in student achievement when effective and inclusive pedagogical approaches are employed.

The findings of this study have important pedagogical and practical impacts, particularly for elementary mathematics instruction. By demonstrating that the AIR learning model significantly improves students’ cognitive achievement, engagement, collaborative skills, and conceptual retention in LCM and GCF topics, this research provides empirical evidence for a structured yet active instructional alternative to both teacher-centered and purely exploratory models. The integration of auditory interaction, intellectual engagement, and systematic repetition not only strengthens mathematical understanding but also promotes equitable learning outcomes across gender, reinforcing the model’s inclusivity. Practically, the study offers a replicable instructional framework that teachers can adopt to address persistent challenges in mathematics learning, such as low retention and passive participation. At a broader level, the research contributes to the development of evidence-based, student-centered mathematics pedagogy by highlighting the importance of structured reinforcement alongside active learning processes in achieving sustainable academic improvement.

Conclusion

This study examined the effectiveness of the AIR learning model in enhancing mathematics learning outcomes among fifth-grade elementary students and demonstrated a significant increase from pre-test to post-test scores, supported by a moderate N-gain and robust statistical evidence. The absence of gender-based differences further indicates that the AIR model offers equitable benefits across student groups. These findings imply that integrating auditory engagement, intellectual processing, and structured repetition can strengthen students’ conceptual understanding and performance in key mathematics topics such as LCM and GCF. The study contributes to the growing body of literature emphasizing innovative instructional models in mathematics education by providing empirical evidence of AIR’s effectiveness in elementary settings, reinforcing its potential as a pedagogically sound approach to improving learning outcomes. Several limitations should be acknowledged in this study. First, the sample size was limited to 28 students from a single school, which may affect the generalizability of the results. Second, the study focused on a specific mathematics topic, limiting its applicability across broader subject areas. Third, the intervention period was relatively short, which may not capture long-term retention or transfer of learning. Additionally, external variables such as teacher differences, classroom environment, and student motivation were not controlled in this study. Future research could consider expanding the sample size and including students from diverse school settings to enhance the generalizability of the findings. Longitudinal studies are also recommended to assess the long-term effects of the AIR model on students’ learning and retention. Moreover, investigating the model’s impact on different mathematical concepts or other subject areas could provide a more comprehensive understanding of its instructional potential. Teachers and curriculum developers are encouraged to adapt and integrate structured and interactive elements of the AIR model into classroom practices to support inclusive and effective learning for all students.

References

- Agustiana, E., Putra, F. G., & Farida, F. (2018). Penerapan model pembelajaran auditory, intellectually repetition (AIR) dengan pendekatan lesson study terhadap kemampuan pemecahan masalah matematis peserta didik. *Desimal: Jurnal Matematika*, 1(1), 1–6.
- Anand, B., Mishra, I., Beri, G., & Chaudhary, K. L. (2024). Types of learning: Domains of learning—cognitive, affective, and psychomotor, learning theories, experiential learning. *Extension methods, ICT and educational technology*, 53-82.
- Asshofi, M. P. D., Damayani, A. T., & Rofian. (2019). Peningkatan hasil belajar matematika materi faktor persekutuan besar dan kelipatan persekutuan kecil melalui model NHT berbantu media papan puzzle berbintang. *Jurnal Ilmiah Sekolah Dasar*, 3(4), 511–518.
- Ayadat, T., Ahmed, D., Chowdhury, S., & Asiz, A. (2020). Measurable performance indicators of student learning outcomes: A case study. *Global Journal of Engineering Education*, 22(1), 40-50.
- Bego, C. R., Lyle, K. B., Ralston, P. A. S., Immekus, J. C., Chastain, R. J., Haynes, L. D., Hoyt, L. K., Pigg, R. M., Rabin, S. D., Scobee, M. W., & Starr, T. L. (2024). Single-paper meta-analyses of the effects of spaced retrieval practice in nine introductory STEM courses: Is the glass half full or half empty? *International Journal of STEM Education*, 11(1), 9.
- Caspersen, J., Smeby, J. C., & Olaf Aamodt, P. (2017). Measuring learning outcomes. *European journal of education*, 52(1), 20-30.
- Dakhi, A. S. (2020). Peningkatan hasil belajar siswa. *Jurnal Education and Development*, 8(2), 468–470.
- Dewi, R. M. L. K. (2018). The effect of think pair share in social science learning activity. *Advances in Social Science, Education and Humanities Research*, 212, 649–651.
- Ekasari, E. R. R., & Trisnawati, N. (2021). Pengaruh model pembelajaran auditory intellectually repetition (AIR) terhadap hasil belajar siswa kelas X OTKP di SMK N 2 Buduran. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, 9(1), 236–245.
- Elinawati, W., Duda, H. J., & Julung, H. (2018). Penerapan model pembelajaran auditory intellectually repetition (AIR) terhadap hasil belajar kognitif siswa. *SAINSMAT: Jurnal Ilmiah Ilmu Pengetahuan Alam*, 7(1), 13–24.
- Fadillah, A. (2016). Analisis minat belajar dan bakat terhadap hasil belajar matematika siswa. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, 1(2), 113–122.
- Giofrè, D., Cornoldi, C., Martini, A., & Toffalini, E. (2020). A population level analysis of the gender gap in mathematics: Results on over 13 million children using the INVALSI dataset. *Intelligence*, 81, 101467.
- Hayyun, M., & Duri, B. A. (2019). Pengaruh model pembelajaran auditory intellectually repetition (AIR) terhadap hasil belajar matematika siswa Sekolah Dasar (SD). *Jurnal Holistika*, 3(2), 127–130.
- Hoque, M. E. (2016). Three domains of learning: Cognitive, affective and psychomotor. *The Journal of EFL Education and Research*, 2(2), 45-52.
- Karjanto, N., & Acelajado, M. J. (2022). Sustainable learning, cognitive gains, and improved attitudes in college algebra flipped classrooms. *Sustainability*, 14(19), 12500.

- Kristin, F. (2016). Analisis model pembelajaran discovery learning dalam meningkatkan hasil belajar siswa SD. *Jurnal Pendidikan Dasar PerKhasa*, 2(1), 90–98.
- Lahann, P., & Lambdin, D. V. (2020). Collaborative learning in mathematics education. In *Encyclopedia of mathematics education* (pp. 94-95). Springer International Publishing.
- Lase, R. K., & Tangkin, W. P. (2022). Model pembelajaran langsung untuk meningkatkan kemampuan memahami instruksi pada siswa SD dalam pembelajaran daring. *Jurnal Cakrawala Pendas*, 8(3), 564–572.
- Lindquist, D. S., Sparrow, B. E., & Lindquist, J. M. (2024). Spaced recall reduces forgetting of fundamental mathematical concepts in a post high school precalculus course. *Instructional Science*, 52(5), 859–878.
- Lyle, K. B., Bego, C. R., Ralston, P. A. S., & Immekus, J. C. (2022). Spaced retrieval practice imposes desirable difficulty in calculus learning. *Educational Psychology Review*, 34(3), 1799–1812.
- Mahmudah, H. N., & Respati, R. (2022). Pengenalan model pembelajaran AIR dalam pembelajaran pola irama. *PEDADIDAKTIKA: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 9(2), 261–270.
- Manurung, S. H. (2016). Upaya meningkatkan kreativitas dan hasil belajar matematika siswa dengan menggunakan model AIR (Auditory, Intellectually, Repetition) pada siswa kelas VIII MTs Negeri Rantauprapat T.P 2014/2015. *EduTech (Jurnal Ilmu Pendidikan dan Ilmu Sosial)*, 2(1), 97–107.
- Mejía-Rodríguez, A. M., Luyten, H., & Meelissen, M. R. M. (2021). Gender differences in mathematics self-concept across the world: An exploration of student and parent data of TIMSS 2015. *International Journal of Science and Mathematics Education*, 19(6), 1229–1250.
- Murphy, P. E. (2016). Student approaches to learning, conceptions of mathematics, and successful outcomes in learning mathematics. In *Success in Higher Education: Transitions to, within and from University* (pp. 75-93). Springer Singapore.
- Mustamin, S. H., & Kusumayanti, A. (2019). Kemampuan pemahaman konsep matematika melalui model pembelajaran auditory intellectually repetition (AIR) pada siswa. *Alauddin Journal of Mathematics Education*, 1(2), 90–97.
- Mustofa, S. B., Listyarini, I., & Untari, M. F. A. (2020). Keefektifan model pembelajaran AIR (Auditory Intellectually Repetition) terhadap hasil belajar Tema 6 siswa kelas V. *Jurnal Sinektik*, 3(2), 180–187.
- Muthmainnah, M. (2024). Analysis of mathematics learning difficulties in material greatest common factor class VII. *Tarbiyah: Jurnal Ilmiah Kependidikan*, 13(2), 125-135.
- Muzsnay, A., Szabó, C., Zábó, C., Szabó, G., & Szeibert, J. (2025). Retrieval practice—A tool to narrow the achievement gap in learning higher mathematics. *International Journal of Science and Mathematics Education*, 23, 3875–3901.
- Nainggolan, M., Tanjung, D. S., & Simarmata, E. J. (2021). Pengaruh model pembelajaran SAVI terhadap hasil belajar matematika siswa di Sekolah Dasar. *Jurnal Basicedu*, 5(4), 2617–2625.

- Nazari, K. B., & Ebersbach, M. (2019). Distributed practice in mathematics: Recommendable especially for students on a medium performance level? *Trends in Neuroscience and Education*, 17, 100122.
- Netson, B. P. H., & Ain, S. Q. (2022). Factors causing difficulty in learning mathematics for elementary school students. *International Journal of Elementary Education*, 6(1), 134-141.
- OECD. (2023). *PISA 2022 Released Main Survey New Mathematics Items* (pp. 1–53).
- Pratiwi, I. M. (2023). Learning obstacles analysis of lowest common multiple and greatest common factor in primary school. *Jurnal Elemen*, 9(2), 440-449.
- Qushem, U. B., Christopoulos, A., Kaliisa, R., Khalil, M., Salakoski, T., & Laakso, M.-J. (2025). Technology-enhanced learning and learning analytics for personalized STEM learning: A scoping review. *International Journal of Educational Research*, 134, 102827.
- Suryanda, I., Sukardi, S., Nursaptini, N., & Suryanti, N. M. N. (2023). Penerapan model pembelajaran AIR (Auditory, Intellectually, Repetition) berbantuan aplikasi Quizizz terhadap hasil belajar siswa di SMAN 7 Mataram. *Jurnal Ilmiah Profesi Pendidikan*, 8(3), 1745–1752.
- Suryantari, N. M. A., Pudjawan, K., & Wibawa, I. M. C. (2019). Pengaruh model pembelajaran inkuiri terbimbing berbantuan media benda konkret terhadap sikap ilmiah dan hasil belajar IPA. *International Journal of Elementary Education*, 3(3), 316–326.
- Tryas, I., & Hashim, E. (2025). The Influence of integrated thematic learning method on the academic achievement of primary school students in Indonesia. *Zabags International Journal of Education*, 3(1), 13-21.
- Verdugo-Castro, S., García-Holgado, A., & Sánchez-Gómez, M. C. (2022). The gender gap in higher STEM studies: A systematic literature review. *Heliyon*, 8(8), e10300.
- Voice, A., & Stirton, A. (2020). Spaced repetition: Towards more effective learning in STEM. *New Directions in the Teaching of Natural Sciences*, 15(1).
- Volta, E., Alborn, P., Gori, M., Ghisio, S., Piana, S., & Volpe, G. (2018). Enhancing children understanding of mathematics with multisensory technology. In *Proceedings of the 5th International Conference on Movement and Computing*, 50, 1-4.
- Wardani, D. A. W. (2023). Problem based learning: Membuka peluang kolaborasi dan pengembangan skill siswa. *Jurnal Jawa Dwipa*, 4(1), 1–17.
- Wilujeng, S. (2013). Peningkatan aktivitas dan hasil belajar siswa melalui model Team Games Tournament (TGT). *Journal of Elementary Education*, 2(1), 45–53.
- Zainudin, Z., & Ubabuddin, U. (2023). Ranah kognitif, afektif dan psikomotorik sebagai objek evaluasi hasil belajar peserta didik. *ILJ: Islamic Learning Journal*, 1(3), 915–931.