JUSTEK : JURNAL SAINS DAN TEKNOLOGI
http://journal.ummat.ac.id/index.php/justek
ISSN 2620-5475
Vol. 9, No. 3, September 2026, pp. 367-375

Kahoot-Assisted Discovery Learning and Students' Learning Outcomes in Human Respiratory System Instruction: A Quasi-Experimental Study

Mikhaela Fransiska Bulu Doren[1], Rikardus Herak*[2], Florentina Yasinta Sepe[3]
[123]Department of Biology Education, Faculty of Teacher Training and Education, Universitas Katolik Widya Mandira Kupang, Indonesia
[1]dorenmikhaela@gmail.com, [2]evikaherak@gmail.com, [3]florentinayasinta1@gmail.com

ARTICLE INFO

Article History:

Received : 04-08-2026
Revised : 10-09-2026
Accepted : 13-09-2026
Online : 17-09-2026

Keywords:
Discovery Learning;
Kahoot;
Learning Outcomes;
Human Respiratory System;
Science Learning.

ABSTRACT

This study examined the effect of Kahoot-assisted Discovery Learning on eighth-grade students' science learning outcomes in human respiratory system material. It extends earlier local pre-experimental evidence by employing a nonequivalent control group design, incorporating a direct-instruction comparison class, and using ANCOVA to account for baseline achievement. The study was conducted at SMPN 16 Kupang in April 2026 with 56 students selected through purposive sampling. Class VIII E (n = 28) received Discovery Learning integrated with Kahoot as an immediate formative-feedback and concept-verification tool, whereas class VIII F (n = 28) received direct instruction. Learning outcomes were measured using a 20-item multiple-choice test administered before and after instruction; expert content validation of the test yielded 72/80 (90.00%), supporting its content suitability for use. Student activity and teacher learning management were observed to provide process evidence supporting the achievement data. Descriptive analyses included mean scores, classical mastery, and normalized gain, while inferential analyses included normality, homogeneity, and ANCOVA tests using SPSS 26 at a significance level of 0.05. The experimental class improved from a pretest mean of 51.25 to a posttest mean of 80.00, with an N-Gain of 0.60 and classical mastery of 85.71%. The control class improved from 49.29 to 66.25, with an N-Gain of 0.34 and mastery of 46.43%. ANCOVA yielded F = 11.615 and p = 0.001, indicating a significant difference in posttest achievement after accounting for baseline scores. Student activity was also higher in the experimental class (79.48%) than in the control class (74.60%), while teacher learning management was rated very good in both groups. These findings indicate that Kahoot contributes most meaningfully when used not merely as a game platform, but as immediate formative feedback and concept verification within a structured Discovery Learning cycle.

A. INTRODUCTION

Science education is expected to help students build conceptual understanding, scientific reasoning, and the ability to connect biological phenomena with everyday life. This expectation is difficult to achieve when classroom instruction is dominated by teacher explanation and students have limited opportunities to explore evidence, discuss ideas, and receive timely feedback. Contemporary empirical studies show that technology-supported gamification and active learning can strengthen engagement and

academic performance when digital tools are embedded within purposeful pedagogy rather than used as isolated add-ons (Ab. Rahman et al., 2018; Álvaro-Tordesillas et al., 2020; Çakıroğlu et al ., 2017; Campillo-Ferrer et al., 2020; Pertegal-Felices et al., 2020).

Preliminary observations and interviews with a science teacher at SMPN 16 Kupang indicated that eighth-grade students' learning outcomes on human respiratory system material remained below expectations. The teacher described students as often passive during discussion, easily distracted, and less attentive when instruction relied mainly on explanation and routine exercises. The study pretest subsequently quantified this weak baseline achievement, with mean scores of 51.25 in class VIII E and 49.29 in class VIII F. Because the preliminary interview was not designed as a formal misconception diagnostic, it was used to characterize classroom learning difficulties rather than to infer specific misconceptions. Limited variation in learning models and interactive media can reduce attention and participation, whereas technology-supported active learning can strengthen engagement when instructional tools are purposefully integrated into the learning design (Çakıroğlu et al., 2017; Bawa, 2019; Chernov et al., 2021). These conditions indicate a need for learning that actively involves students in discovering concepts while also giving rapid information about whether their emerging understanding is accurate.

Discovery Learning offers such an opportunity by guiding students through stimulation, problem identification, data collection, data processing, verification, and generalization. Rather than receiving a complete explanation at the beginning, students are supported to construct concepts through guided exploration and evidence-based reasoning. This orientation is consistent with Brunerian discovery learning, in which learners actively organize evidence and derive conceptual relationships with appropriate instructional guidance (Ozdem-Yilmaz & Bilican, 2020).

Kahoot can complement the discovery process because it provides game-based questions, immediate feedback, and visible response patterns that can be used for formative verification. Empirical studies across different educational settings have reported that Kahoot can support engagement, motivation, formative assessment, and academic performance when it is aligned with instructional goals (Bawa, 2019; Bicen & Kocakoyun, 2018; Göksün & Gürsoy, 2019; Ismail & Mohamad, 2017; Licorish et al., 2018; Plump & LaRosa, 2017; Tóth et al., 2019; Turan & Meral, 2018). Similar findings have been reported in engineering, health sciences, business education, and other higher-education contexts, demonstrating the value of gamified response systems for feedback and active participation while also showing that effects depend on implementation quality and learning context (Aras & Çiftçi, 2021; Chernov et al., 2021; Coveney et al., 2022; Martínez-Jiménez et al., 2021; Özaras Oz & Ordu, 2021; Sumanasekera et al., 2020; Zainuddin et al., 2020).

The novelty of the present study lies not simply in using Kahoot as a digital gamification tool, but in positioning it pedagogically as immediate formative feedback and concept verification within the Discovery Learning cycle. In particular, Kahoot was embedded in the verification process to help students check their emerging understanding before formulating conceptual generalizations. Previous research has

shown that Kahoot-assisted Discovery Learning can improve students' learning interest and achievement in science instruction, particularly when game-based feedback is integrated into the discovery process (Widiadnyani et al., 2025). International empirical evidence likewise indicates that Kahoot-based learning can enhance science achievement, although the magnitude of its effects may vary according to learner characteristics, task design, competition, feedback, and classroom conditions (Cvjetićanin et al., 2024; Janković & Lambić, 2022). Recent studies further emphasize that Kahoot can strengthen participation and academic performance when its use is supported by appropriate pacing, interaction, and pedagogical integration (Ebadi et al., 2023; Marín-Vinuesa & Rojas-García, 2024; Martínez López et al., 2022; Rojabi et al., 2022; Tandiono, 2024). However, evidence remains limited for biology-specific topics at the junior high school level using a concurrent control group and baseline-adjusted inferential analysis. The present study addresses this gap by comparing Kahoot-assisted Discovery Learning with direct instruction in two intact eighth-grade classes, using ANCOVA to control for pretest differences and observation data to examine student activity and teacher learning management.

Accordingly, this study aimed to determine whether Kahoot-assisted Discovery Learning significantly affects students' learning outcomes in human respiratory system material and to describe the accompanying patterns of student activity and teacher learning management. The findings are expected to provide context-specific evidence for biology and science teachers who seek to integrate discovery-oriented pedagogy with game-based formative feedback.

B. METHODS

1. Research Design

This study used a quantitative quasi-experimental approach with a nonequivalent control group design. Two intact classes were used without random assignment. The experimental class received Discovery Learning assisted by Kahoot, while the control class received direct instruction. Both groups completed a pretest before instruction and a posttest after the learning intervention. The independent variable was the learning model, and the dependent variable was students' cognitive learning outcomes in human respiratory system material.

2. Population and Sample

The research was conducted at SMPN 16 Kupang in April 2026 during the 2025/2026 academic year. The population consisted of all eighth-grade students at the school. Purposive sampling was used to select two classes with comparable instructional conditions. The sample consisted of 56 students: class VIII E (n = 28) as the experimental class and class VIII F (n = 28) as the control class.

3. Research Instruments and Procedure

The main instrument was a 20-item multiple-choice achievement test administered as pretest and posttest. Before use, the test underwent expert content validation, which yielded a score of 72 out of 80 (90.00%), indicating strong content suitability for the

intended assessment. The available study records did not include a separate internal-consistency reliability coefficient; therefore, no reliability coefficient is reported. Supporting instruments included student-activity observation sheets and teacher learning-management observation sheets. Learning devices comprised teaching modules, learning materials, student worksheets, and achievement-test items. In the experimental class, Discovery Learning activities followed the stages of stimulation, problem identification, data collection, data processing, verification, and generalization. Kahoot was integrated specifically as an immediate formative-feedback and concept-verification tool during the learning cycle, helping students check emerging understanding before generalization. The control class studied the same topic through direct instruction.

4. Data Analysis

Data were analyzed descriptively using pretest and posttest means, mean gain, classical mastery, and normalized gain (N-Gain). Normality was examined using the Kolmogorov-Smirnov test, and homogeneity of variance was examined using Levene's test. The effect of the learning model on posttest achievement was tested using analysis of covariance (ANCOVA), with pretest score treated as a covariate. All inferential analyses were conducted using SPSS version 26.0 at a significance level of 0.05.

C. RESULT AND DISCUSSION

1. Students' Learning Outcomes

The pretest and posttest results showed improvement in both groups, but the experimental class achieved a larger gain and substantially higher classical mastery. A descriptive summary is presented in Table 1.

Table 1. Descriptive Summary of Students' Learning Outcomes

Class	N	Pretest Mean	Posttest Mean	Gain Mean	N-Gain	Mastery
Kahoot-assisted Discovery Learning	28	51.25	80.00	28.75	0.60 (medium)	85.71%
Direct instruction	28	49.29	66.25	16.97	0.34 (medium)	46.43%

The experimental class increased from a pretest mean of 51.25 to a posttest mean of 80.00, producing a mean gain of 28.75, an N-Gain of 0.60, and classical mastery of 85.71%. The control class increased from 49.29 to 66.25, with a mean gain of 16.97, an N-Gain of 0.34, and mastery of 46.43%. Although both N-Gain values were in the medium category, the experimental class demonstrated a stronger improvement and exceeded the control class by 19.68 points on the posttest mean.

2. Assumption Tests and Hypothesis Testing

Normality testing showed that all pretest and posttest distributions met the normality assumption, and Levene's test indicated homogeneous variance. ANCOVA was then used to compare posttest achievement while accounting for pretest scores. The results are summarized in Table 2.

Table 2. Summary of Assumption Tests and ANCOVA

Analysis	Result	Sig.	Decision
Normality: pretest experimental	Kolmogorov-Smirnov	0.106	Normal
Normality: posttest experimental	Kolmogorov-Smirnov	0.200	Normal
Normality: pretest control	Kolmogorov-Smirnov	0.083	Normal
Normality: posttest control	Kolmogorov-Smirnov	0.087	Normal
Homogeneity	Levene statistic = 0.077	0.782	Homogeneous
ANCOVA	$F = 11.615$; $R^2 = 0.177$	0.001	Significant

The ANCOVA significance value was 0.001, which is below 0.05. Thus, the null hypothesis was rejected, indicating a statistically significant difference in posttest achievement between the learning conditions after accounting for baseline performance. The ANCOVA model explained 17.7% of the variance in posttest scores, indicating that the learning condition contributed meaningfully to achievement while other student and contextual factors also remained relevant.

3. Student Activity and Teacher Learning Management

Observation data provided process evidence that complemented the achievement results. Student activity in the experimental class reached 79.48% and was categorized as good, whereas student activity in the control class reached 74.60% and was categorized as fairly good. Teacher learning management was categorized as very good in both classes, as shown in Table 3.

Table 3. Summary of Observation Results

Observed Aspect	Kahoot-assisted Discovery Learning	Category	Direct Instruction	Category
Overall student activity	79.48%	Good	74.60%	Fairly good
Teacher learning management	89.60	Very good	86.60	Very good

4. Discussion

The findings demonstrate that Kahoot-assisted Discovery Learning produced stronger learning outcomes than direct instruction in human respiratory system material. The difference is evident not only in the higher posttest mean but also in the larger N-Gain and the much higher proportion of students reaching classical mastery. The result is theoretically consistent with Discovery Learning, which positions students as active constructors of conceptual relationships through guided exploration and verification (Ozdem-Yilmaz & Bilican, 2020). It is also consistent with international evidence showing that game-based response systems can strengthen academic achievement when they are connected to active learning processes and clear instructional purposes (Göksün & Gürsoy, 2019; Janković & Lambić, 2022; Martínez-Jiménez et al., 2021; Tóth et al., 2019).

The contribution of Kahoot is best interpreted as pedagogical support for the discovery process rather than as a stand-alone game. Immediate questions and feedback

can help students check whether concepts constructed during exploration are consistent with scientific explanations. This interpretation is supported by studies describing Kahoot as an effective formative assessment and engagement tool when feedback is connected to subsequent learning actions (Ismail & Mohammad, 2017; Ismail et al., 2019; Licorish et al., 2018; Zainuddin et al., 2020). Evidence from nursing and professional education similarly shows that Kahoot-supported assessment can support knowledge, skills, and motivation, although superiority over alternative reinforcement methods is not always observed (Aras & Çiftçi, 2021; Coveney et al., 2022; Özaras Öz & Ordu, 2021; Sumanasekera et al., 2020).

The present result also extends earlier context-specific evidence. Doren and Nau (2025) reported improvement after Kahoot-assisted Discovery Learning using a one-group pretest-posttest design at the same school context. The current study strengthens the evidentiary basis by using a separate comparison class and ANCOVA, thereby reducing the likelihood that improvement is explained only by repeated testing or general classroom progression. Similarly, positive effects of Kahoot-assisted Discovery Learning on elementary students' science learning interest and outcomes have been reported (Widiadnyani et al., 2025). The present findings also align with international science-education studies in which Kahoot-supported game learning produced higher or improved achievement under well-structured classroom conditions (Cvjetićanin et al., 2024; Janković & Lambić, 2022).

Higher student activity in the experimental class supports the interpretation that the treatment changed the learning process as well as the final scores. Discovery activities required students to interact with problems and evidence, while Kahoot added rapid feedback and a visible challenge structure. Similar effects on participation, motivation, and engagement have been reported across university and technology-enhanced learning settings (Ab. Rahman et al., 2018; Bawa, 2019; Campillo-Ferrer et al., 2020; Chernov et al., 2021; Pertegal-Felices et al., 2020; Plump & LaRosa, 2017; Rojabi et al.,2022). At the same time, the very good teacher-learning-management ratings in both classes suggest that the outcome difference was unlikely to be caused simply by weak implementation in the control class.

The ANCOVA model explained 17.7% of posttest variance, which cautions against attributing achievement exclusively to the learning model. Prior knowledge, motivation, learning discipline, technology readiness, peer interaction, and home support may also contribute to performance. Empirical studies indicate that gamified response systems can produce different levels of benefit depending on pacing, competition, learner preferences, feedback quality, and how the platform is integrated with the instructional design (Bicen & Kocakoyun, 2018; Ebadi et al., 2023; Marín-Vinuesa & Rojas-García, 2024; Martínez López et al., 2022; Tandiono, 2024; Turan & Meral, 2018). Therefore, teachers should use Kahoot strategically, ensure that questions represent the intended concepts, provide adequate scaffolding during discovery, and use feedback to clarify misconceptions rather than allowing competition to become the main learning goal. The preliminary teacher interview was not a structured misconception diagnostic, and the retained dataset did not include a separate internal-consistency estimate for the achievement test. Future studies

should therefore incorporate explicit misconception diagnostics and report KR-20 or an equivalent reliability coefficient alongside content validation.

D. CONCLUSION AND SUGGESTIONS

Kahoot-assisted Discovery Learning had a significant positive effect on eighth-grade students' science learning outcomes in human respiratory system material at SMPN 16 Kupang. The experimental class improved from a pretest mean of 51.25 to a posttest mean of 80.00, with an N-Gain of 0.60 and classical mastery of 85.71%, whereas the direct-instruction class improved from 49.29 to 66.25, with an N-Gain of 0.34 and mastery of 46.43%. ANCOVA confirmed a significant difference after accounting for baseline scores ($F = 11.615$, $p = 0.001$). Student activity was higher in the experimental class (79.48%) than in the control class (74.60%), while teacher learning management was rated very good in both groups (89.60 and 86.60, respectively). The achievement test also showed strong content suitability in expert validation (72/80; 90.00%). These findings extend earlier pre-experimental evidence and indicate that Kahoot is most valuable not merely as a game platform but as immediate formative-feedback and concept-verification support within a structured Discovery Learning cycle. The findings remain limited to two classes, one school, and one biology topic, and an internal-consistency reliability coefficient was not available in the retained dataset. Further studies should test the approach across broader samples and topics, include explicit misconception diagnostics, and report reliability estimates alongside additional outcomes such as conceptual understanding, motivation, critical thinking, and scientific reasoning.

ACKNOWLEDGEMENT

The authors express their appreciation to the principal, science teacher, and eighth-grade students of SMPN 16 Kupang for their support and participation during the research process.

DECLARATIONS

The authors declare no conflict of interest. This research did not receive specific funding from any public, commercial, or not-for-profit funding agency.

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