INTERNATIONAL JOURNAL OF SOCIAL SCIENCE, EDUCATIONAL, ECONOMICS, AGRICULTURE RESEARCH AND TECHNOLOGY (IJSET) | ISSN (E): 2827-766X
Website: https://ijset.org/ | Volumes 5 No. 7 (2026)

IMPLEMENTATION OF LEARNING MODELS *PBL- REDIPPER* FOR INCREASE ABILITY THINK CRITICAL AND COLLABORATION STUDENTS ON ATOMIC STRUCTURE MATERIAL

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Received: 01/04/2026 | **Revised** : 10/04/2026 | **Accepted:** 15/05/2026 | **Published** : 24/05/2026

Abstract

Study This aim For analyze influence application of learning models *Problem-Based Learning* integrated REDIPPER (PBL-REDIPPER) against ability think critical (KBK) and ability collaboration (KOL) participants educate on the material atomic structure . Type of research used is experiment quasi - experimental with design *pretest-posttest control group design* . Subject study involving 72 participants educate class XI in one of the senior high schools in Cirebon Regency which is divided into to in two groups , namely class experiments (n = 36) with the PBL-REDIPPER model and class control (n = 36) with the *Direct Instruction* (DI) model . Research data collected use instrument test essay ability think critical and sheet observation skills collaboration that has been validated . Data analysis techniques using analysis *Multivariate Analysis of Variance* (MANOVA) assisted by IBM SPSS Statistics 26. Analysis results statistics multivariate show that the PBL-REDIPPER model provides influence very significant simultaneity to ability think critical and collaborative participant educate in a way simultaneously ($p = 0.007 < 0.01$) with contribution practical as big as **13.4% of which is included in category effect moderate .** Univariate test results partial also confirms significant differences in each variable bound , where the learning model give contribution effect as big as **13.1% (category currently)** to variation ability think critical ($p = 0.002$), and as big as **11.5% (category currently)** to variation ability collaboration participant educated ($p = 0.004$). With Thus , the implementation PBL-REDIPPER syntax is proven effective in facilitate reconstruction draft abstract chemistry at a time optimize competence sociocognitive 21st century participants educate .

Keywords: Problem-Based Learning, REDIPPER, Thinking Critical , Collaboration , Atomic Structure

INTRODUCTION

Development knowledge knowledge and technology in the 21st century drives the world of education For produce participant capable students think critical , collaborative , and solving problem in a way effective . Skills the become part important in learning Because needed For face global challenges and developments in the modern workplace . The implementation of the Independent Curriculum also emphasizes importance development ability reasoning critical and mutual cooperation through Profile Pancasila students . However , the practice learning at school Still dominated teacher-centered approach so activity Study participant educate tend passive and not optimal in develop skills 21st century (Binkley et al., 2012; Liu & P´asztor, 2022; Trilling & Fadel, 2009) . These conditions show that the learning process at school Still need directed at more learning active and participant - centered educate .

Problems was also found in learning chemistry , especially in materials atomic structure . Atomic structure material has characteristics abstract Because involving draft particle subatomics , atomic models, and configurations electrons that are not can observed in a way live . Taber (2020) explain that concepts chemical properties abstract often cause confusion conceptual on participants educate Because involving representation microscopic and symbolic in a way simultaneously . Research conducted by Zarkadis et al. (2020) also shows that participant educate Still experience misconceptions about the concept of atoms and atomic structure . In addition , research Herdien & Bahriah (2024) find that participant educate experience difficulty understand draft atomic structure because learning chemistry Still

dominated memorization and less involving visualization draft in a way deep . This condition show that a capable learning model is needed help participant educate understand draft abstract at a time involving they in a way active in the learning process . One of approach assessed learning capable overcome problem the is Problem-Based Learning (PBL). The application of PBL in learning chemistry give chance to participant educate For do investigation , discussion , and problem solving problem through context problem real . Some study show that the implementation of PBL provides influence positive to ability think critical and collaborative participant Didik . Liu & P´asztor (2022) report that PBL has an effect significant to improvement ability think critical participant educate in learning science . Research conducted by Arsyad et al. (2024)that implementation of PBL in learning chemistry capable increase involvement , motivation learning and ability think critical participant students . In addition , Putri et al. (2023) also showed that implementation of PBL is capable increase ability think critical participant educate in learning chemistry through activity investigation and analysis solution problem . Although Thus , the application of PBL in learning chemistry Still face a number of obstacles , such as not enough directed exploration process concept , low involvement all over member group in discussion , as well as Not yet optimally stage reflection learning so that the construction process knowledge participant educate Not yet ongoing in a way maximum . This condition show that required development of learning models that are not only based problem , but also able to give stages more learning structured and systematic .

Therefore that , in study This PBL model is integrated with REDIPPER stages include Read, Explore, Discussion, Investigation, Presentation, and Reflection. The Read and Explore stages help participant educate understand draft abstract atomic structure through activity reading and exploration draft in a way independent , whereas Discussion and Investigation stages encourage participant educate For collaborate in analyze and solve problem . In addition , the Presentation and Reflection stages provide chance to participant educate For communicate results thinking as well as do evaluation regarding the learning process that has been carried out done . Integration of PBL with REDIPPER stages are expected capable create a more effective learning process active , structured , and participant - centered educate so that can increase ability think critical and collaborative on the material atomic structure . Therefore that , research This aim For analyze influence application of the PBL-REDIPPER learning model to ability think critical and collaborative participant educate on the material atomic structure .

METHOD

Research Design and Participants

This study employed a quasi-experimental design with a pretest–posttest control group. The research was conducted at a senior high school in Cirebon Regency during the 2025/2026 academic year. The participants consisted of 72 Grade XI students selected using purposive sampling based on academic equivalence. The participants were divided into two classes, namely the experimental class (n = 36) taught using the PBL-REDIPPER model and the control class (n = 36) receiving conventional instruction.

Learning Implementation

Table 1. presents the implementation stages of the PBL-REDIPPER model in the experimental class.

Stage	Learning Activities
Read	Students identify contextual problems related to atomic structure through reading activities and problem orientation.
Explore	Students explored concepts using learning resources, digital media, and teacher guidance.
Discussion	Students discussed and analyzed problems collaboratively in groups.
Investigation	Students conduct investigations and analyze concepts to solve the given problems.
Presentation	Students presented the results of group discussions and investigations.
Reflection	Students reflected on learning activities, evaluated understanding, and identified learning difficulties.

Meanwhile, the control class received conventional teacher-centered instruction.

Research Instruments

The instruments used in this study consisted of a critical thinking test and a collaborative observation sheet. The critical thinking test was administered in the form of essay questions developed based on indicators of interpretation, analysis, inference, explanation, and evaluation. Collaboration skills were assessed through observation sheets covering participation, communication, responsibility, cooperation, and contribution during group activities. All instruments were validated by experts prior to implementation.

Data Analysis

Data were collected through pretest and posttest administered to both groups. The improvement in students' critical thinking skills was analyzed using the normalized gain (N-gain) test. Furthermore, prerequisite tests consisting of normality and homogeneity tests were conducted before hypothesis testing. Hypothesis testing was performed using an independent sample t-test at a significance level of 0.05 with the assistance of IBM SPSS Statistics 26. Meanwhile, collaboration data were analyzed descriptively using percentage scores obtained from classroom observations.

RESULTS AND DISCUSSION

Validity Instrument

Before testing hypothesis done , instrument study moreover formerly validated in a way theoretical and empirical . Validity construct instrument analyzed use *Exploratory Factor Analysis* (EFA) and *Confirmatory Factor Analysis* (CFA), meanwhile reliability instrument determined through analysis coefficient reliability . Analysis results show that all over instrument fulfil valid and reliable criteria so that worthy used in research data collection .

Prerequisite Test Analysis

Before it is done MANOVA analysis , especially formerly prerequisite tests were carried out For ensure data meets assumptions analysis multivariate which includes normality , homogeneity , multicollinearity and linearity tests .

Normality test results show that mark significance ability think critical and collaborative more big from 0.05 so that the research data stated normally distributed . Furthermore , homogeneity matrix covariance tested use *Box's M Test* . Analysis results presented in Table 2.

Table 2. Results of Homogeneity Test

Test	F	Sig.	Information
Box's M	0.325	0.807	Homogeneous

Based on Table 2, the value significance *Box's M Test* more big from 0.05 to matrix covariance variables dependent stated homogeneous . In addition , the results of the multicollinearity test show VIF value is less from 10 to No happen multicollinearity intervariable dependent . The linearity test also shows existence linear relationship between ability think critical and collaborative demonstrated through pattern data distribution on a scatterplot graph . With Thus , all necessary assumptions in MANOVA analysis .

The Influence of the PBL-REDIPPER Model on Ability Think Critical and Collaborative

After all prerequisite tests fulfilled Analysis *Multivariate Analysis of Variance* (MANOVA) then implemented For test influence simultaneous and partial from the learning model to ability think critical (KBK) and collaboration (KOL) participants educate on the material atomic structure at Cirebon Regency High School. Test results statistics multivariate in a way simultaneous summarized in Table 3.

Table 3. Multivariate Test Results

Effect	Statistical Test	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared (ηp2)
Model	Pillai's Trace	0.134	5,319	2	69	0.007	0.134
	Wilks' Lambda	0.866	5,319	2	69	0.007	0.134
	Hotelling's Trace	0.154	5,319	2	69	0.007	0.134
	Roy's Largest Root	0.154	5,319	2	69	0.007	0.134

Based on results analysis multivariate analysis focusing on the **MODEL** row (Table 3), obtained mark consistent significance of p = 0.007 in all four metric statistics (*Pillai's Trace, Wilks' Lambda, Hotelling's Trace* , and *Roy's Largest Root*). Because the value significance This is at far below alpha threshold ($p < 0.01$) with the F value is 5.319, then hypothesis null (H_0) is rejected and the hypothesis alternative (Ha) is accepted . Statistical facts This prove existence very significant difference in ability think critical and ability collaboration in a way simultaneous between participant students who are taught with the PBL-REDIPER model compared with the *Direct Instruction* (DI) model .

If reviewed from significance in practice , value *The Partial Eta Squared* (η_p^2) obtained was 0.134. This indicates that the application of this problem-based learning model was able to contribute 13.4% to the simultaneous variation in students' cognitive (critical thinking) and social (collaboration) outcomes. Based on the criteria of Cohen (1988) and Field (2013) where$\eta_p^2 \approx 0.01$ is effect small , $\eta_p^2 \approx 0.06$ effect moderate , and $\eta_p^2 \geq 0.14$ effect big , then size impact simultaneous PBL-REDIPER model enter in **category moderate** . This result show that model intervention provides meaningful influence in a way substantive in environment instructional . For understand how the learning model influence each variable bound in a way specific , analysis to be continued with univariate test through *Tests of Between-Subjects Effects* are presented in Table 4.

Table 4. Results of Tests of Between-Subjects Effects

Source	Variables	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared (ηp2)
MODEL	Thinking (KBK)	2,990,222	1	2,990,222	10,541	0.002	0.131
	Collaboration (KOL)	2,346,125	1	2,346,125	9,074	0.004	0.115

On the variable **Ability Think Critical (KBK)** , Table 4 shows very significant influence from the learning model with F value = 10.541 and p = 0.002 ($p < 0.01$). Findings This confirm that ability think critical participant educate in class different experiments (PBL-REDIPER) in a way significant and more superior than class control (DI). A value η_p^2 of 0.131 indicates that the learning model independently explains 13.1% of the variation in students' critical thinking scores, which are classified into **category effect currently** .

Superiority reasoning critical in class experiment This rooted in characteristics the problem presented in PBL-REDIPER syntax . Remembering material atomic structure will concepts abstract at the sub- microscopic level , methods lecture or transmission knowledge in line with *Direct Instruction* tend limit involvement cognitive students . In contrast , PBL-REDIPER confronts students on the problem real nature open - *ended* and not structured (*ill-structured*). Uncertainty from problem This push student For active explore information , analyzing connection inter-concept , as well as evaluate argument scientifically in order to formulate solution in a way independent . This process in a way consistent practice sharpness think critical they . This result in line with findings Xu et al. (2023) and Liu & P´asztor (2022) who concluded that intervention based problem give influence strong positive to disposition and skills think critical students at the level education medium and tall .

Temporary that , the results of the univariate test For **Ability Collaboration (KOL)** in Table 4 also shows very significant difference between groups , F = 9.074, p = 0.004 ($p < 0.01$). This prove that dynamics Work same and interaction participant educate in class based problem Far more superior than class with learning directly . A value η_p^2 of 0.115 indicates that the learning model contributes 11.5% to the variation in collaboration ability, which is also included in **category effect currently** .

Improvement performance social This happen Because structure PBL-REDIPER syntax requires existence Work group For solve problems . Tasks complex in module chemistry No can completed individually , but rather need distribution role , negotiation conceptual , and drafting argument group in a way collective . Activities discursive this is what triggered it interaction intense and productive social interaction among participant educate .

Phenomenon growth double This prove that development cognitive (thinking) critical) and skills social (collaboration) are not two separate things , but rather a reciprocal process that can accommodated in a way simultaneously through environment Study based designed problem with good . Success synergistic This validate results studies Trisdiono (2019) who found trend consistent and significant improvement in scores think critical and work The same student after its implementation module learning active .

In a way general , magnitude consistent effect be in the category moderate (13.4% simultaneous , 13.1% for KBK, and 11.5% for KOL) confirmed that the usefulness of the PBL-REDIPER model is not only looks its significance in a way mathematically above paper , but also provide impact real practical in the classroom . Findings This strengthen map literature education chemistry moment This . Zahra et al. (2025) and Islawati et al. (2024) report that integration framework based problems on the topic chemistry abstract proven powerful deepen understanding conceptual at a time hone skills think level tall .

In dimension social , research the latest also validates that learning model based combined problems with context local and interactive media capable increase quality coordination groups and interdependence positive participant educate compared to with approach conventional (Hardianti et al., 2022; Nugraha & Setiawan, 2024) . With Thus , integration results and Discussion in study This emphasize that shift from learning one-way (*Direct Instruction*) towards a problem - centered model such as PBL-REDIPER is a highly recommended instructional strategy For optimize competence sociocognitive participant educate in learning modern chemistry .

CONCLUSION

In a way overall , research This show that the application of the PBL-REDIPPER learning model provides significant influence in a way simultaneous to ability think critical and collaborative participant educate on the material atomic structure ($p = 0.007 < 0.01$). Based on size effect practical , this model give contribution by 13.4% against combination second variables dependent with category effect moderate . In general partial , learning model this also shows influence significant to ability think critical with contribution by 13.1% ($p = 0.002$; category medium) and to ability collaboration by 11.5% ($p = 0.004$; category moderate). Findings This indicates that the PBL-REDIPPER model is effective in increase competence sociocognitive participant educate on the material chemical properties abstract , so that potential used as alternative learning models in learning science .

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