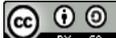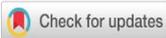# IMPLEMENTATION OF STEAM-BASED PROBLEM BASED LEARNING (PBL) LEARNING MODEL TO IMPROVE STUDENTS' CRITICAL THINKING ABILITIES

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ABSTRACT

This classroom action research aims to improve students' critical thinking skills through the implementation of the STEAM-based Problem Based Learning (PBL) model at SMA Negeri 15 Medan. The research subjects were 32 eleventh-grade students. The study was conducted in two cycles, each consisting of planning, action, observation, and reflection stages. The research instruments included observation sheets, critical thinking skill tests, and documentation. The results show that the implementation of STEAM-based PBL significantly improved students' critical thinking skills. In the pre-action stage, the percentage of students achieving mastery in critical thinking was only 37.5%. After the first cycle, it increased to 65.6%, and by the second cycle, it further increased to 87.5%. This improvement was supported by more active and collaborative learning activities, as well as students' better ability to analyze problems systematically through the STEAM approach. Therefore, the STEAM-based PBL model is effective in enhancing students' critical thinking skills in the learning process at SMA Negeri 15 Medan.

ABSTRAK

Penelitian tindakan kelas ini bertujuan untuk meningkatkan kemampuan berpikir kritis siswa melalui penerapan model pembelajaran Problem Based Learning (PBL) berbasis STEAM di SMA Negeri 15 Medan. Subjek penelitian adalah siswa kelas XI yang berjumlah 35 orang. Penelitian dilaksanakan dalam dua siklus, setiap siklus meliputi tahapan perencanaan, pelaksanaan tindakan, observasi, dan refleksi. Instrumen penelitian terdiri atas lembar observasi, tes kemampuan berpikir kritis, dan dokumentasi. Hasil penelitian menunjukkan bahwa implementasi PBL berbasis STEAM mampu meningkatkan kemampuan berpikir kritis siswa secara signifikan. Pada pra-tindakan, persentase ketuntasan berpikir kritis hanya mencapai 37,5%. Setelah siklus I, terjadi peningkatan menjadi 65,6%, dan pada siklus II meningkat lebih lanjut hingga 87,5%. Peningkatan ini ditunjang oleh aktivitas belajar yang lebih aktif, kolaboratif, serta kemampuan siswa dalam menganalisis masalah secara sistematis melalui pendekatan STEAM. Dengan demikian, penerapan PBL berbasis STEAM efektif dalam meningkatkan kemampuan berpikir kritis siswa pada mata pelajaran di SMA Negeri 15 Medan.

Kata kunci: Problem Based Learning, STEAM, Berpikir Kritis.

INTRODUCTION

21st century education demands participant educate For own ability think level High (Higher Order Thinking Skills/HOTS), one of which is ability think critical. Ability think critical become competence important things to do owned student in face complexity problems in the global era, especially in context learning at school intermediate. Thinking critical allows student For analyze information in a way in-depth, evaluating arguments, and take decision in a way logical based on evidence (Setyawan et al., 2023). Therefore that, teachers are required For presenting a learning model that is capable facilitate development ability think critical through a meaningful, creative and contextual approach (As'ad Badar, Zaifatur Ridha, Erna Sari, 2022).

However in fact, the results observation the beginning at State Senior High School 15 Medan showed that ability think critical student Still is in the category low. This is seen from low ability student in identify problem, lack ability evaluate the information provided, as well as difficulty in formulate solution in a way logical. When given problem contextual, partial big student tend wait teacher's instructions and less capable Work The same For finish problem in a way independent (Herawati, 2022). Students also demonstrate limitations in put forward arguments supported by data, so that the learning process ongoing not enough active and still dominated by methods lecture. Condition This need quick repaired through application of learning models innovative (Aithal & Aithal, 2019).

One of the learning models that is assessed capable increase ability think critical student is Problem Based Learning (PBL). PBL focuses on providing problem authentic For completed student in a way collaborative so that push they analyze situations, develop ideas, and evaluate alternative solution (Susanto et al., 2024). This model No only train ability think critical, but also fosters creativity, curiosity know, and ability communication in group. Although Thus, the implementation of PBL will more optimal if combined with STEAM (Science, Technology, Engineering, Art, and Mathematics) approach. The STEAM approach provides room for student For apply draft science, technology, and design engineering in a way integrated, at the same time bring up element creativity and art in finish Problem. Integration of PBL and STEAM becomes a powerful learning strategy For produce experience learn more real, holistic, and challenging.

The implementation of relevant STEAM- based PBL For increase ability think critical student Because combination second approach the emphasize investigation, exploration, creation solutions, as well as reflection. Through STEAM activities such as experiments, design prototypes and visualizations creative, students pushed For evaluate every step settlement problem in a way logical and based evidence. With Thus, learning No only focus on understanding concept, but also on the thinking process level height that becomes foundation important in Independent Learning curriculum (Zaid et al., 2022).

Based on problems found at State Senior High School 15 Medan, are needed something capable actions answer need improvement ability think critical student in a way direct. Research action class (PTK) becomes the right approach For repair quality learning in a way sustainable through cycle planning, implementation, observation, and reflection. The implementation of the STEAM- based PBL learning model is expected capable increase activity Study student as well as give impact significant to ability think critical they (Wang & Wang, 2023).

Therefore that, research This done with objective For know to what extent can the implementation of the STEAM- based Problem Based Learning (PBL) learning model be increase ability think critical students at State Senior High School 15 Medan. Research results

This expected become references for teachers in develop more effective learning strategies effective and innovative as well as give contribution for improvement quality education at school medium (Izzania, 2021).

Theoretical Review

Problem Based Learning (PBL) Learning Model

Problem Based Learning (PBL) is a learning model that emphasizes the problem-solving process problem authentic as means For build knowledge and skills students. In PBL, participants educate No only accept material from the teacher, but in a way active involved in analyze, explore, and solve relevant issues with context life real. This model rooted in a paradigm constructivism, which places knowledge as results construction active student through experience meaningful learning (Zulvira & Desyandri, 2022).

According to theory constructivism, learning will more effective If student involved in a way direct in the discovery process (Pardimin, 2022). PBL facilitates matter the through stages like identification problem, collection information, development alternative solutions, and reflection (Gultom et al., 2020). In the context of this, the role of the teacher shifts from giver information become guiding facilitator students to be able to think critical, working same, and found solution in a way independent (Fauziah, 2022). PBL also emphasizes collaborative processes in group, so that student can discuss, convey ideas, and evaluate argument in a way scientific. Some The advantages of PBL include :

1. Encourage ability think level tall,
2. Develop skills communication and collaboration,
3. Connect learning with life real, and
4. Increase motivation and independence learn. With characteristics Therefore, PBL is considered very relevant. For support strengthening competence 21st century, especially ability think critical.

In general, PBL is run through steps following (Rachmah et al., 2022):

a. Orientation problem – The teacher presents problem authentic as trigger learning.

b. Organizing group – Students Work in group small For analyze problem.

c. Collection information and investigation – Students search for data and perform exploration For understand problem in a way deep.

d. Development alternative solution – Students formulate various ideas and solutions based on the data collected (Wahyuningsih et al., 2020).

e. Presentation and discussion results – Group presenting solutions and accept bait come back.

f. Reflection – Students evaluate effectiveness of problem-solving strategies problems that are done.

Stages This create cycle dialogic, exploratory, and reflective learning so it is very supportive improvement ability think critical.

Approach (Science, Technology, Engineering, Art, and Mathematics)

STEAM is approach integrated learning discipline Science, Technology, Engineering, Arts, and Mathematics in a way integrated For produce comprehensive and creative learning. Approach This develop method think interdisciplinary that allows student see connection between concept, solving problem through various perspective, as well as produce innovative solutions (A. Hasanah et al., 2021).

Arts integration in STEAM differentiates it from traditional STEM approach. Arts plays a role in develop creativity, aesthetics, and ability design, which is very important in

development products and solutions problem (Pratiwi & Syarifin, 2020). Meanwhile that, the components of science and technology hone ability analytical as well as utilization digital tools ; engineering development ability designing and evaluating ; and mathematics strengthen ability quantitative and logical. The STEAM approach emphasizes learning through practices, projects, experiments, and activities exploratory others. In the context of this, students pushed For produce product or prototype which is results analysis problems and integration various discipline. Because it emphasizes the process of investigation, creativity, and reflection, STEAM has the potential big support improvement ability think critical student (Nurfadillah & Rakhman, 2020).

The STEAM approach aims For :
a. Develop ability think critical and creative through solution problem complex.
b. Increase science and technology literacy in context life real.
c. Growing ability design, evaluate, and improve prototype
d. Encourage collaboration, communication, and innovation.
e. Integrate aspect analytical (STEM) and aesthetic-creative (Art) in the learning process.

Implementation of STEAM in schools usually done through :
a. Project based problem-solving (STEAM- based PBL), where students finish problem real in a way interdisciplinary (Rosydiana et al., 2023).
b. Project design engineering, such as designing mini bridge, ecosystem model, or tool simple.
c. Integrated science experiments, which involve calculation mathematics and utilization technology.
d. Activity manufacturing work art, such as science posters, 3D models, or creative data visualization.

STEAM approach is also often combined with other learning models such as Problem Based Learning (PBL), Project Based Learning (PjBL), or Inquiry Learning for produce more learning effective and collaborative.

Integration of PBL and STEAM in Learning

STEAM -based PBL integration is approach integrated learning strength second concept, namely settlement problem authentic in PBL and integration interdisciplinary in STEAM. Combination This make learning more comprehensive, creative, and challenging Because student No only sued find solutions, but also visualize, design, and apply draft technology and art in the process of completion problem (Handayani & Koeswanti, 2021).

In practice, STEAM- based PBL is carried out through steps as following :
a. Giving problem authentic in need implementation concepts of science, technology, engineering, art, and mathematics ;
b. Discussion group For analyze problems and determine required information ;
c. Exploration and investigation For collect data or do test ;
d. Design prototype or solution creative that reflects integration STEAM aspects ;
e. Presentation and evaluation, where students convey results solution problem with logical argument ;(Saputra et al., 2019).
f. Reflection, for evaluate effectiveness of resolution strategies problem used.

Through integration this, students No only develop ability think critical, but also skills creative, collaborative, and communicative.

Ability Students' Critical Thinking

Think critical is a mental process that involves ability analyze, evaluate, create inference, and taking decision in a way logical based on evidence. In the context curriculum modern

education, thinking critical be one of competence the main thing that must be developed For face global challenges and developments rapid technology.

Indicator ability think critical student includes (Serevina et al., 2018):

a. Ability identify problem,
b. Ability analyze information and arguments,
c. Ability evaluate proof,
d. Ability interesting conclusion logical, and
e. Ability develop the right solution.

Effective learning process must capable activate all over indicator STEAM - based PBL facilitates all aspect ability think critical through activity observation, experiment, discussion, compilation arguments, and reflection. Activities the demand student For think analytical at a time creative in solve problem, so that ability think critical can develop optimally (Alfianiawati et al., 2019).

The Relevance of STEAM -Based PBL to Improvement Think Critical

Relatedness between PBL, STEAM, and skills think critical very strong and mutual support. PBL provides framework activity based problem, while STEAM enriches the problem-solving process. problem with approach creative and interdisciplinary. Through integration both of them, students No only train analyze problems and evaluate data, but also do exploration scientific and design innovative solutions (Puspitasari et al., 2020).

Characteristics demanding learning analysis in-depth, idea testing, collaboration, and drafting argument logical in a way direct develop ability think critical. With Thus, STEAM-based PBL is effective, relevant and appropriate approach need learning 21st century in increase ability think critical student (Ilić et al., 2021)

METHOD

Location and Time of Research

This research was conducted at State Senior High School 15 Medan. The research was conducted during the odd semester of the 2025/2026 academic year.

Population and Sample

The population in this study is all student Class XI Science, State Senior High School 15 Medan Whereas The sample in this study were students class XI-A SMA Negeri 15 Medan, totaling 35 people.

Types and Design of Research

In accordance with problems that will examined, then type research used This classified as in Classroom Action Research in effort improve and enhance processes and results learning in the classroom as well as applying learning theory.

Data Collection Techniques and Research Instruments

Data collection technique

The data collection technique in this study was obtained by conducting observation direct observation done For observe activity Study student during the learning process using the STEAM- based PBL model. Observation focused on indicators activity students, abilities Work same, ability submit questions, and skills student in analyze and evaluate problem. Observation sheet arranged in form a column containing category evaluation in accordance indicator think critical and activity study. Observation done on every cycle to see development of the learning process from actions applied (Fauzia, 2018)..

Data Collection Instruments

Instrument study is tools used For collect data in a systematic, accurate, and relevant with

objective research. In research action class this instrument arranged For measuring processes and results improvement ability think critical student after implementation of the STEAM-based Problem Based Learning (PBL) learning model. The following is instruments used in study This (Khotimah et al., 2019).

a. Student Activity Observation Sheet. Observation sheet used For evaluate activity student during the learning process at each cycle. Instrument This shaped a column containing indicator activity relevant learning with STEAM- based PBL model and skills think critical. Observed indicators includes :
   1. Activity student in identify problem.
   2. Ability submit question critical.
   3. Skills Work The same in group.
   4. Ability analyze data or information.
   5. Ability evaluate solutions and create decision logical.
   6. Involvement students in STEAM activities (experimentation, design, prototype, analysis).

Every indicator assessed use scale categories (for example : very good, good, sufficient, less) that are provided description behavior specific. Observation sheet make it easier researchers For see development of the learning process from pre-action until every cycle.

b. Test Critical Thinking Skills Test used For measure improvement ability think critical student in a way quantitative. Instrument This shaped test compiled description based on indicator think critical which includes : Identification problem, analysis information and evidence, argument evaluation, and drafting logical and creative solutions. Every grains question designed based STEAM context and use solution problem authentic in accordance PBL characteristics. Assessment rubric made For evaluate quality answer student based on level ability think critical test shown. given to three stages : pre-action, final cycle I, and the end cycle II (M. Hasanah & Fitria, 2021).

c. Observation Sheet. In addition to observations students, sheets observation for teachers to use For know to what extent has the STEAM- based PBL model been implemented ? in accordance plan.

Data Analysis Techniques

Data analysis in study This done in a way qualitative and quantitative, adjusted with characteristics of each data obtained in each cycle study.

Qualitative Data Analysis. Qualitative data obtained from observation activity students, notes field, as well as documentation. Analysis done through three stages, namely :

1. Data Reduction : Collected data selected, simplified, and arranged in a way systematic For focus on aspects relevant like development involvement students, patterns interactions, and thinking processes critical during STEAM -based PBL learning takes place.
2. Presentation : : Data that has been reduced served in form narrative, tables, and findings descriptive For show change behavior Study student from pre-action until each cycle.
3. Drawing : Researcher interpret data based on pattern findings during action ongoing For determine effectiveness implementation of STEAM- based PBL in increase ability think critical student (Rahman & Latif, 2020).

Quantitative Data Analysis. Quantitative data obtained through results test ability think critical analysis done with step following :

1. Count mark individual based on score answer student in accordance rubric evaluation.
2. Count percentage completeness Study

3. Analyze improvement ability think critical between cycle with compare average value of pre-action, cycle I, and cycle II.
4. Criteria success action set if : Minimum 80% of students reach KKM value,
5. Happen improvement quality of the learning process based on results observation.

With combine analysis qualitative and quantitative research This capable give description comprehensive about effectiveness implementation of the STEAM -based PBL model in increase ability think critical students at State Senior High School 15 Medan.

RESULT AND DISCUSSION

Description of Research Results Cycle I

In cycle I, learning implemented in two meetings. The teacher started learning with to explain problem related contextual with STEAM theme, then student pushed Work in group For identify problem, collecting information, and designing solution beginning (Idris et al., 2019).

During the learning process, some student seen active in discussion, but part other Still passive and waiting teacher's instructions (Marasabessy et al., 2021). Some group difficulty linking science and technology concepts in settlement problem, so that discussion Not yet running optimally. Although Thus, involvement student Already start increase compared to phase pre-action (Simanjuntak et al., 2024).

Observation Results Activity Students in Cycle I

Activity student during cycle I experienced improvement compared to pre-action, although Not yet evenly throughout indicator think critical (Wau, 2017). Average score activity obtained as following :

Table 1. Observation Results Activity Students in Cycle I

Activity Indicator	Max Score	Average Score	Category
Identification problem	4	2.9	Enough
Submit question critical	4	2.5	Enough
Information analysis	4	2.7	Enough
Solution Evaluation	4	2.4	Enough
Group collaboration	4	3.1	Good
Argumentative communication	4	2.6	Enough

In a way general, average activity students in cycle I achieved **66.5**% or **category Enough**

Test Results Critical Thinking Skills Cycle I

Test results think critical show existence improvement after action. Completion data served following :

Table 2. Test Results Critical Thinking Skills in Cycle I

Stage	Average Value	Number of Students Who Completed	Percentage of Completion
Pre-Action	58	12 of 35	34.2%
Cycle I	72	21 of 35	60%

Improvement completeness from pre-action to cycle I was 25.8%. Although show

improvement, completion Not yet achieve a minimum target of 80%, so that action need to be continued to cycle II (M. Januar Ibnu Adham, 2021).

Reflection Cycle I

Reflection results show that :

1. Student Still experience difficulty connect STEAM elements in solution problem.
2. Discussion group Not yet effective Because domination a number of student.
3. Teachers need to give visual guides and modules step solution STEAM issues.
4. Strengthening concept and delivery example analysis problem need improved (Doyan et al., 2025).
5. Findings This become base repair actions in cycle II (Hadi et al., 2022).

Description of Research Results Cycle II

Repair done with adding scaffolding in the form of :

1. use *worksheet* STEAM structured,
2. explanation step analysis more problems systematic, (Konstantakis et al., 2022).
3. affirmation distribution role in group,
4. giving example prototype simple For trigger creativity.

Learning cycle II is underway more dynamic and collaborative. Students more independent in identify problems and more capable integrate concepts of science, technology, and design technique in solution they (Kania et al., 2023).

Observation Results Activity Students in Cycle II

Activity student show improvement significant, shown in the table following.

Table 3. Observation Results Activity Student Cycle II

Activity Indicator	Max Score	Average Score	Category
Identification problem	4	3.6	Good
Submit question critical	4	3.4	Good
Analysis information	4	3.5	Good
Solution Evaluation	4	3.3	Good
Collaboration group	4	3.7	Very good
Communication argumentative	4	3.4	Good

Average activity students in cycle II reached 84.2%, category Good.

Test Results Critical Thinking Skills Cycle II

Test results cycle II shows quite an improvement significant (Dwi Oktavia & Kusumawati, 2019).

Table 4. Test Results Critical Thinking Skills in Cycle II

Stage	Average Value	Number of Students Who Completed	Percentage of Completion
Cycle I	72	21 of 35	34.2%
Cycle II	82	28 of 35	80%

Completeness Study experience improvement as big as **21.9%** from Cycle I. Success target (>80% of students) complete) is achieved, so that action stopped in cycle II.

Reflection Cycle II

In cycle II:

1. Student more independent and critical in identify and analyze problem.
2. Integration of STEAM aspects is evident in prototypes and solutions group
3. Discussion ongoing more productive and all member play a role active.
4. The teacher succeeded optimally implement STEAM -based PBL (Kartono, 2021).

This result show that actions in cycle II were successful repair deficiencies in cycle I and improve ability think critical student in a way significant (Puspita et al., 2020).

Improvement results from pre-action until cycle II shows that the STEAM- based PBL model is effective in increase ability think critical students (Burgess & Matar, 2020). PBL provides problem real that spurs analysis students, while STEAM enriches the problem-solving process. problem through approach interdisciplinary (Suprihadi & Ma rifah, 2022). Combination both of them push student think analytical, evaluating information, designing creative solutions, and communicating in a way argumentative. Activity Study increase in line with improvement completeness learn, signify that involvement student in the STEAM -based PBL process contributes directly on the increase ability think critical they (Festiawan et al., 2021).

CONCLUSION

Based on results study action classes that have been done through two cycles learning, can concluded that The implementation of the STEAM- based Problem Based Learning (PBL) learning model has been proven effective in increase ability think critical students at State Senior High School 15 Medan. Through implementation of STEAM- based PBL, students get chance For identify problem in a way independent, analyzing information, evaluate solutions, and compile argument in a way logical. Involvement student in activity learning increase in a way significant, visible from results observation activities that show improvement from category enough in cycle I to become category good in cycle II.

Improvement ability think critical is also reflected from results test students. Percentage completeness Study increase from 34.2% in pre-action to 60% in cycle I, and reached 80% in cycle II. With Thus, the minimum completion target that has been determined (≥ 80%) successful achieved at the end cycle II. This is show that integration of PBL and STEAM is capable create a more effective learning process meaningful, collaborative, and supportive development skills think level tall (Padilah et al., 2025).

In a way overall, research This confirm that the STEAM- based PBL model is approach relevant and effective learning For increase ability think critical students at the level school medium, at the same time can become alternative innovative for teachers in develop appropriate learning with demands curriculum 21st century.

Suggestion

Based on findings research, some suggestions that can be given is as following :

a. **For Teachers.** Teachers are advised For implementing the STEAM -based PBL model as one of the variation learning that can be increase ability think critical students. Careful planning, development problem authentic, and proper scaffolding will help student more active and creative in the process of solving problem.

b. **For Schools.** Schools need give support in form provision facility learning, STEAM supporting media, and training for teachers to understand optimal implementation of STEAM- based PBL. Support very influential institutions in success implementation approach learning innovative in class.

c. **For Further Research.** Research This can developed more carry on with expand coverage eye lessons, levels education, or add other variables such as creativity,

collaboration, or ability solution problem. In addition, the use of instrument further evaluation deep will enrich findings study.

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