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Analysis of Deep Learning Implementation's Factors through Growth Mindset Optimization: A Structural Equation Modelling (SEM) Approach

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ABSTRACT

Deep learning and growth mindset are two concepts that are becoming increasingly important in the world of education. The implementation of deep learning, which focuses on conceptual understanding and knowledge transfer, is a priority in contemporary education. Deep learning focuses on comprehensive conceptual understanding, not just memorization, while a growth mindset is the belief that abilities and intelligence can be developed through dedication and hard work. The integration of these two concepts has great potential to improve learning effectiveness. This study aims to comprehensively analyze the influence of three key factors mindset, the quality of the teacher-student relationship, and the learning framework applied on the implementation of deep learning optimized through a growth mindset. The main problem identified is the lack of research that holistically examines the interaction and combined impact of these three factors. Many previous studies tend to focus on one variable separately, leaving a gap in understanding how an integrated learning environment facilitates profound understanding and the formation of an adaptive mindset. The purpose of this study is to develop a theoretical model that illustrates the causal relationship between mindset, teacher-student relationships, learning frameworks, and the effectiveness of deep learning implementation supported by a growth mindset. Research data was collected using a mixed-methods approach. Quantitative data analysis used multiple regression analysis techniques to identify which variables most significantly influenced the implementation of deep learning using Structural Equation Modelling (SEM). The benefits of this research are expected to provide practical guidance for teachers, curriculum developers, and policymakers to design a more supportive and effective learning environment. Based on 1,200 respondents who were willing to fill out the questionnaire, the results showed that the optimization of a growth mindset mediated the improvement in the effectiveness of deep learning implementation with a standardized value of 0.21. Another finding is the causal relationship between mindset, teacher-student relationships, learning frameworks, and the effectiveness of deep

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learning implementation supported by a growth mindset. These findings can help optimize deep learning strategies that focus not only on material but also on psychological and social aspects that are essential to student learning success.

1. Introduction

The Indonesian government has made major changes through the implementation of a deep learning approach across all levels of education. This is based on the low PISA scores for reading literacy, mathematical literacy, and scientific literacy. The government has high hopes for an increase in PISA scores in the next assessment [30]. Massive collaboration between the government and all levels of schools has required teachers to undergo deep learning training. Deep learning will have a direct impact on students' if teachers and students understand and apply a growth mindset to the fullest. The essence of deep learning [18] lies in the growth mindset that stems from the process. Deep learning as applied in Indonesia differs from deep learning as applied in various other countries. Indonesia applies deep learning starting from the eight dimensions of graduate profiles, followed by the three principles of deep learning, namely awareness, meaning, and enjoyment. That is not enough, with the addition of three learning experiences, namely understanding, applying, and reflecting.

Deep learning focuses on comprehensive conceptual understanding, not just memorization, while a growth mindset is the belief that abilities and intelligence can be developed through dedication and hard work. The integration of these two concepts has great potential to improve learning effectiveness [1]. The implementation of deep learning, which focuses on conceptual understanding and knowledge transfer, is a priority in contemporary education. Various studies have identified psychological and pedagogical factors that are crucial to its success. This review specifically describes research findings on the influence of mindset, the quality of teacher-student relationships, and learning framework design on the implementation of deep learning. The main focus is on how these three elements work together to optimize a growth mindset as a central mechanism, with reference to the contributions of key researchers in the field.

Researchers such as Jeni L. Burnette [4] have explored the relationship between mindset and goal setting and learning strategies. Their findings show that individuals with a growth mindset are more likely to adopt mastery goals, which encourage them to use more in-depth learning strategies such as elaboration and metacognition, rather than the superficial memorization strategies often associated with performance goals. This research confirms that a growth mindset serves as a psychological foundation, equipping students with the perseverance and strategic tools necessary to engage in deep learning processes [2]. This research confirms that a growth mindset serves as a psychological foundation, equipping students with the perseverance and strategic tools necessary to engage in deep learning processes.

Recent literature continues to confirm Dweck's theory that a growth mindset in teachers and students' is the foundation of deep learning. Teachers with a growth mindset are more likely to design complex challenges and provide constructive feedback [35]. Meanwhile, interventions targeting students' mindsets show improvements in academic resilience and the use of more deep learning strategies [43]. The psychological safety that comes from supportive teacher-student relationships is recognized as a crucial catalyst. This trust allows students to take the intellectual risks necessary for deep learning. Studies indicate that these positive relationships mediate the success of learning frameworks such as inquiry-based learning [5] and are particularly important in culturally diverse learning environments [15].

Research by Ernesto Panadero and colleagues [33] has highlighted the important role of formative assessment and reflection in promoting self-regulated learning. A learning framework rich in formative assessment (such as continuous feedback), self-evaluation, and peer evaluation shifts the focus from summative (judgmental) assessment to assessment for learning. This practice makes the growth process visible, thereby strengthening students' belief that they can improve their abilities. There is a clear shift from knowledge transmission models to constructivist frameworks. Frameworks such as Project-Based Learning (PBL) and Inquiry-Based Learning have proven effective in promoting higher-order thinking, especially when supported by appropriate scaffolding [13]. In addition, the principles of Universal Design for Learning (UDL) are increasingly recognized for their role in providing equitable access to deep learning for all students' [29]. This framework, popularized by Carol Ann Tomlinson, implicitly conveys the message of a growth mindset. By adapting the content, process, and products of learning to meet individual needs, teachers acknowledge that students are at different points in their learning journey and that everyone is capable of growing from their respective starting points [20].

Literature in recent years has converged on a model of integrated deep learning implementation. This model is not a simple sum of the three factors, but rather a synergy: A well-designed learning framework provides a structure for challenging tasks; supportive teacher-student relationships provide security and feedback that nurture mindsets within that structure; and the systematic interaction of the two optimizes students' growth mindset. It is this mindset that ultimately unlocks students' willingness and ability to engage deeply with the material [27]. Research led by experts such as Yeager, Burnette, and Panadero confirms that efforts to implement deep learning must go beyond curricular interventions alone. Success depends on the deliberate engineering of the classroom ecosystem, where pedagogical frameworks and relational practices align to actively foster the belief in each student that they are capable learners who can grow.

Several studies indicate that these three factors do not operate independently. Teachers with a growth mindset are more likely to invest in building strong relationships with their students'. These strong relationships, in turn, create the foundation of trust necessary to successfully implement challenging learning frameworks such as PBL or inquiry. Effective implementation of deep learning is not simply the application of new techniques but rather a comprehensive shift in classroom culture supported by belief, relationships, and appropriate pedagogical structures.

Research gaps identified for future exploration include further study of teachers own mindsets and how they influence their practices, the need for longitudinal studies to track the impact of these interventions over time, and more in-depth research in non-Western cultural contexts to understand how these variables interact in different value systems. Most existing research only measures impact over short periods. There is a gap in understanding the long-term impact of this integration on students' academic achievement and character development. Based on the above studies, new research is needed to analyze the factors involved in implementing deep learning through the optimization of a growth mindset so that the causal relationship between mindset, teacher-student relationships, learning frameworks, and the effectiveness of implementing deep learning through a growth mindset can be understood.

Amidst the national education transformation agenda, the successful implementation of deep learning is a fundamental benchmark, but its realization is often hampered by challenges that go beyond curriculum and infrastructure. The successful adoption of this approach is highly dependent on the psychological and pedagogical ecosystem in schools, a domain whose interactions have not yet been comprehensively unraveled. The gap between potential and practice leads to a series of essential research questions: (1) What are the key factors that significantly influence the successful implementation of deep learning in the context of education in Indonesia? (2) To what extent can a growth mindset serve as an effective mediator? (3) How exactly is the map of causality between these various determining factors formed?

To answer this series of complex questions, the main objective of this study is to develop a theoretical model capable of describing the causal relationship between mindset, the quality of teacher-student relationships, and the learning framework on the effectiveness of deep learning implementation, supported by a growth mindset. This study proposes a layered hypothesis: first, that the factors influencing the implementation of deep learning are mindset, teacher-student relationships, and learning frameworks, with a highly significant level of influence. Second, the growth mindset is postulated to play a crucial role as a mediating variable. Finally, it is hypothesized that there is a network of interrelated causal relationships between all variables' mindset, teacher-student relationships, learning frameworks, the implementation of deep learning, and the growth mindset itself.

2. Methodology

2.1 Participant and Data Collection

This study sample consisted of 1,200 respondents who were given a questionnaire after attending an online seminar on Optimizing Learning through Deep Learning held on June 30, 2025. Among them were 181 elementary school teachers, 839 middle school teachers, 170 college students', and 10 members of the general public. Table 1 shows the respondent data.

Table 1
Respondent profile of participant

Description	Frequency	(%)
Kindergarten	13	1.08
Elementary School	138	14.00
Junior High School	211	17.58
Senior High School/Vocational School	628	52.33
College	170	14.17
General	10	0.83

2.2 Research Design and Instruments

This study uses a mixed-method approach, where quantitative methods are applied through online questionnaires using Google Forms and qualitative methods are applied through interviews with Google Form entries and documentation [21]. The analysis of factors in the implementation of deep learning through the optimization of growth mindset involves understanding mindset, student-teacher relationships, and the learning framework. Participants responded to mindsets and their impact, teacher-student relationships accompanied by awareness of a safe and comfortable environment for students', learning frameworks with learning strategies and learning environments, learning partnerships and digital utilization, growth mindsets as the foundation for deep learning implementation accompanied by fostering students' confidence to continue to grow and develop in order to create a mindful, meaningful, and joyful learning atmosphere and learning process through intellectual, ethical, aesthetic, and kinesthetic thinking in a holistic and integrated manner, through a questionnaire with a 1-5 Likert scale provided in the form of a Google Form.

The instruments used in this study analyze the factors of deep learning implementation related to thinking patterns and growth mindsets, student-teacher relationships, and learning frameworks to be effective and successful in classroom learning. Table 2 displays the distribution of the instruments.

Table 2
Instruments used in research according to specified variables

Variable	Total
Mindset	5
Student-Teacher Relationships	5
Learning Framework	4
The Growth Mindset	6
Implementation of Deep Learning	5

2.3 Analysis Technique

The data were analyzed using an integrative approach, in which various data sources were integrated through observation or literature to find relationships and to participate in relevant theories through a reflective and collaborative process. The Structural Equation Modeling (SEM) approach was used to perform path analysis. SEM utilized LISREL version 8.8 and SPSS version 25 for three tasks at once. This was carried out in order to make the interpretation results more lucid and in line with the actual outcomes. LISREL assisted in the structural equation modeling (SEM) analysis of the study data [39]. Confirmatory factor analysis (CFA) was combined with regression analysis through SEM; this also allowed for the integration of CFA and path analysis, as well as the combination of measurement and structural models [17]. In addition to looking at measurement errors, SEM can look at the relationship patterns between latent variables and their indicators. As long as the hypothetical model is constructed as a diagram consisting of a structural model and a measurement model based on theoretical justification, SEM can analyze the relationship patterns between latent variables and their indicators, as well as measurement errors. These are the steps of data analysis:

i. Validity and Reliability Test Analysis. The LISREL application version 8.8 was used to analyze the validity test of each indicator item in the questionnaire used. An indicator is said to be valid if the standardization value between the indicator and the variable is above 0.50. Reliability tests were carried out on questionnaires that met the validity test using the results of the LISREL application. It is said to be reliable if the Construct Reliability (CR) value is > 0.50 or Variance Extracted (VE) > 0.50, the following equation:

$$CR = \frac{(\sum Standardized\ Loading)^2}{(\sum Standardized\ Loading)^2 + (\sum Measurenment\ Error)} \text{And} VE = \frac{(\sum Std.Loading\ g)^2}{(\sum Std.Loading\ g)^2 + (\sum e)} \quad (1)$$

ii. Heteroscedasticity, multicollinearity, and normality tests are all part of the classical assumption test analysis. If the RMSEA value in SEM is less than 0.05, the model is considered fit.

iii. Direct and indirect impacts. The LISREL application's confirmatory factor analysis (CFA) output was used to obtain simultaneous and indirect influence tests. The following equation must satisfy the regression equation:

Structure 1:

$$Z = a X1 + b X2 + c X3 + \delta \quad (2)$$

Structure 2:

$$Y = a X1 + b X2 + c X3 + \delta \quad (3)$$

Structure 3:
$$Y' = a' X1 + b' X2 + c' X3 + d Z + \delta \quad (4)$$

3. Results

The validity and reliability test results were obtained for each variable (CR = construct reliability and VE = variance extracted) using LISREL 8.8 as part of SEM (structural equation modelling), with the summary shown in Table 3.

Table 3
Validity and reliability testing for 1,200 respondents using LISREL 8.8

Variable	Total	Valid	CR	Result	VE	Result
Mindset	5	5	0.916944	Reliable	0.688691	Reliable
Student-Teacher Relationships	5	5	0.898523	Reliable	0.643308	Reliable
Learning Framework	4	4	0.938909	Reliable	0.793591	Reliable
The Growth Mindset	6	6	0.956575	Reliable	0.785978	Reliable
Implementation of Deep Learning	5	5	0.941939	Reliable	0.802253	Reliable

The results in Table 3 show that all indicators are >0.50, so all are valid. The results of CR>0.70 and VE>0.500 show that all variables are reliable. The results in Table 2 are proven to be valid and reliable according to the goodness of fit statistical output in the following LISREL 8.8 application:

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The following lines were read from file H:\dataPM\analisPM.spj:
Sample Size = 1200
Latent Variables MS STR LF GM IDL
X1-X5=MS
X6-X10=STR
X11-X14=LF
Z1-Z6=GM
Y1-Y4=IDL
Relationships
Path Diagram
End of Problem
Sample Size = 1200

Goodness of Fit Statistics
Degrees of Freedom = 242

Minimum Fit Function Chi-Square = 817.81 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 846.83 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 604.83
90 Percent Confidence Interval for NCP = (519.96 ; 697.29)
Minimum Fit Function Value = 0.68
Population Discrepancy Function Value (F0) = 0.50
90 Percent Confidence Interval for F0 = (0.43 ; 0.58)
Root Mean Square Error of Approximation (RMSEA) = 0.046
90 Percent Confidence Interval for RMSEA = (0.042 ; 0.049)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.98
Expected Cross-Validation Index (ECVI) = 0.80
90 Percent Confidence Interval for ECVI = (0.73 ; 0.88)
ECVI for Saturated Model = 0.50
ECVI for Independence Model = 127.04
Chi-Square for Independence Model with 276 Degrees of Freedom = 152273.52
Independence AIC = 152321.52
Model AIC = 962.83
Saturated AIC = 600.00
Independence CAIC = 152467.68
Model CAIC = 1316.06
Saturated CAIC = 2427.02
Normed Fit Index (NFI) = 0.99
Non-Normed Fit Index (NNFI) = 1.00
Parsimony Normed Fit Index (PNFI) = 0.87
Comparative Fit Index (CFI) = 1.00
Incremental Fit Index (IFI) = 1.00
Relative Fit Index (RFI) = 0.99
Critical N (CN) = 435.12
Root Mean Square Residual (RMR) = 0.0077
Standardized RMR = 0.019
Goodness of Fit Index (GFI) = 0.94
Adjusted Goodness of Fit Index (AGFI) = 0.93
Parsimony Goodness of Fit Index (PGFI) = 0.76
Time used: 0.078 Seconds

As illustrated in Figure 1, the outcomes of the fitted model were further examined to determine the relationship between mindset, learning frameworks, teacher-student relationships, and the efficacy of implementing deep learning with a growth mindset acting as a mediator.

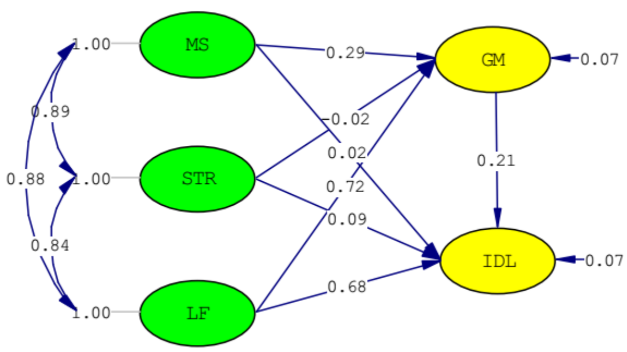

Fig. 1. Final Structural Equation Modelling (SEM) model results from LISREL 8.8

Based on Figures 1 and 2, confirmatory factor analysis (CFA) with the LISREL tool demonstrates that the variables exhibit causal links, which are corroborated by the syntactic output results. The results of the final SEM model in Figure 1 showed that mentality, teacher-student connections, learning frameworks, and the success of deep learning implementation backed by a growth mindset are all related. The article's opening hypotheses are that mindset, teacher-student relationships, and learning frameworks are the factors influencing the implementation of deep learning in Indonesia; that a growth mindset mediates these factors toward the implementation of deep learning; and that there is a causal relationship between these factors, as well as between the implementation of deep learning, learning frameworks, mindset, and a growth mindset. The model is in line with RMSEA (0.046) and NFI (0.99), indicating that the proposed relationship between these variables is supported by empirical data, according to the analysis and computation of the model derived from the LISREL application in Figures 1 and 2. Figure 2 shows that mindset, teacher-student relationships, and learning frameworks are the main factors in the application of deep learning through a growth mindset. For further details, see Figure 2.

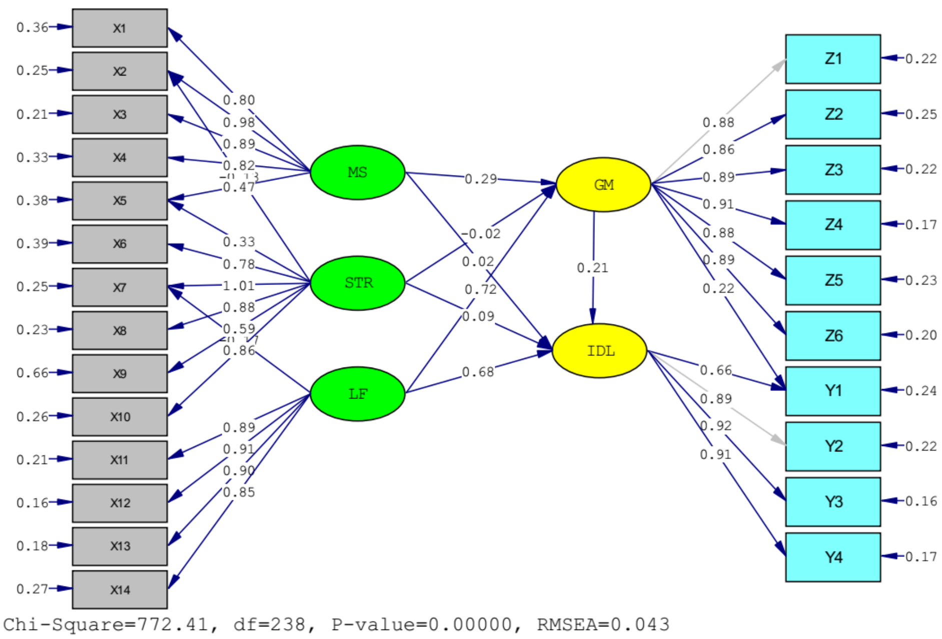

Fig. 2. Final Structural Equation Modelling (SEM) standard solution from LISREL 8.8

The results show the effect of the mindset variable (0.02) on the direct application of deep learning, the teacher-student relationship variable (0.09) on the direct application of deep learning, and the learning framework variable (0.68) on the direct application of deep learning. Thinking patterns grew to become a good mediator (0.21) of several factors that influenced the application of deep learning, namely mindset, teacher-student relationships, and learning frameworks. The teacher-student relationship variable had a negative impact on growing thinking patterns. Other variables were thinking patterns (0.29) and learning frameworks (0.78).

These results show that the growth mindset variable becomes a mediator in accordance with the calculations in the goodness of fit statistical output in the LISREL 8.8 application. The indirect effect is on the variables of mindset (0.061), teacher-student relationship (-0.004), and learning framework (0.143).

The results of Figure 1 and Figure 2 are in accordance with the goodness of fit statistic output in the LISREL 8.8 application as follows:

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The following lines were read from file  H:\dataPM\analisisPM.spj:
Sample Size = 1200
Latent Variables  MS STR LF GM IDL
X1-X5=MS
X6-X10=STR
X11-X14=LF
Z1-Z6=GM
Y1-Y4=IDL
IDL=MS STR LF
GM=MS STR LF
IDL=MS STR LF GM
Set Error Covariance of Y1 to GM Free
Set Error Covariance of X2 to STR Free
Set Error Covariance of X5 to STR Free
Set Error Covariance of X7 to LF Free
Relationships
Path Diagram
End of Problem
Sample Size =  1200

     Structural Equations
    GM = 0.29*MS - 0.023*STR + 0.72*LF, Errorvar.= 0.067  , Rý = 0.93
       (0.040)   (0.034)    (0.034)          (0.0066)
        7.35     -0.66      20.89             10.25

   IDL = 0.21*GM + 0.015*MS + 0.088*STR + 0.68*LF, Errorvar.= 0.066  , Rý = 0.93
       (0.069)   (0.045)   (0.035)   (0.065)          (0.0073)
        3.01      0.34      2.54      10.42             9.04

Reduced Form Equations
    GM = 0.29*MS - 0.023*STR + 0.72*LF, Errorvar.= 0.067, Rý = 0.93
       (0.040)   (0.034)    (0.034)
        7.35     -0.66      20.89

   IDL = 0.076*MS + 0.083*STR + 0.82*LF, Errorvar.= 0.069, Rý = 0.93
       (0.042)    (0.036)    (0.038)
        1.80       2.32       21.78

Goodness of Fit Statistics
```

Degrees of Freedom = 238
Minimum Fit Function Chi-Square = 744.99 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 772.41 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 534.41
90 Percent Confidence Interval for NCP = (454.08 ; 622.34)
Minimum Fit Function Value = 0.62
Population Discrepancy Function Value (F0) = 0.45
90 Percent Confidence Interval for F0 = (0.38 ; 0.52)
Root Mean Square Error of Approximation (RMSEA) = 0.043
90 Percent Confidence Interval for RMSEA = (0.040 ; 0.047)
P-Value for Test of Close Fit (RMSEA < 0.05) = 1.00
Expected Cross-Validation Index (ECVI) = 0.75
90 Percent Confidence Interval for ECVI = (0.68 ; 0.82)
ECVI for Saturated Model = 0.50
ECVI for Independence Model = 127.04
Chi-Square for Independence Model with 276 Degrees of Freedom = 152273.52
Independence AIC = 152321.52
Model AIC = 896.41
Saturated AIC = 600.00
Independence CAIC = 152467.68
Model CAIC = 1273.99
Saturated CAIC = 2427.02
Normed Fit Index (NFI) = 1.00
Non-Normed Fit Index (NNFI) = 1.00
Parsimony Normed Fit Index (PNFI) = 0.86
Comparative Fit Index (CFI) = 1.00
Incremental Fit Index (IFI) = 1.00
Relative Fit Index (RFI) = 0.99
Critical N (CN) = 470.43
Root Mean Square Residual (RMR) = 0.0066
Standardized RMR = 0.016
Goodness of Fit Index (GFI) = 0.95
Adjusted Goodness of Fit Index (AGFI) = 0.94
Parsimony Goodness of Fit Index (PGFI) = 0.75
Time used: 0.094 Seconds

Eq. (2), Eq. (3) and Eq. (4) by entering the values in figure 2, and outputting goodness of fit statistics in LISREL 8.8. its application, for mindset variables (X1), student-teacher relationships (X2), and learning framework variables (X3), growth mindset variables (Z) and implementation of deep learning variables (Y) becomes:

Structure 1:

$$Z = 0.290\ X1 - 0.023\ X2 + 0.720\ X3 + \delta \tag{5}$$

Structure 2:

$$Y = 0.076\ X1 + 0.083\ X2 + 0.820\ X3 + \delta \tag{6}$$

Structure 3:

$$Y' = 0.015\ X1 + 0.088\ X2 + 0.680\ X3 + 0.210\ Z + \delta \tag{7}$$

LISREL Structural Equation Estimation Calculation (Maximum Likelihood): mindset variables, student-teacher relationships, learning framework variables, growth mindset variables, and implementation of deep learning variables. The results of structural Eq. (5) show that mindset influences growth mindset (29%), teacher-student relationships negatively influence growth mindset (2.3%), and learning framework (72%). Using mediation according to equation (7), it was found that mindset affects the implementation of deep learning (1.5%), teacher-student relationships affect the implementation of deep learning (8.8%), the learning framework affects the implementation of deep learning (68%), and growth mindset affects the implementation of deep learning (21%). As seen in Figures 1 and 2, which are backed by LISREL Estimates (Maximum Likelihood) output, the use of SEM in confirmatory factor analysis (CFA) facilitates the identification of causal linkages or relationships between two variables that impact one another. The findings of the independent variable correlation matrix indicate that the learning framework has an influence of 0.88 and the teacher-student relationship variable has an influence of 0.89 on mentality. The teacher-student relationship variable is influenced by the learning framework by 0.84 with a significant effect.

The findings of this study indicate that deep learning is influenced by mindset, teacher-student relationships, and learning frameworks through a growth mindset. This study reveals the important finding that a growth mindset has a significant influence on the implementation of deep learning [31]. These findings are based on empirical data collected through various methods, including observation, interviews, and analysis of mindsets, teacher-student relationships, learning frameworks, and growth mindsets.

The mindset theory pioneered by Carol Dweck [7] remains the main foundation. Recent research continues to strengthen and expand her theory, showing that students' beliefs about the nature of their intelligence directly influence their engagement in high-level cognitive tasks. A large-scale study conducted by David Yeager and colleagues [42] provides strong evidence that brief interventions to foster a growth mindset can improve students' academic performance, especially when they encounter challenging material. Students' who believe that intelligence can be developed show greater resilience, an essential prerequisite for deep learning that often involves failure and iteration [32]. A study by Aulia and Prabowo (2021) highlights how PBL in science lessons allows students to face challenges, which in turn strengthens their growth mindset. When students are given complex projects, they are forced to learn deeply, overcome failure, and keep trying until they succeed. Growth mindset principles are organically ingrained in frameworks like PBL. According to PBL specialists' study, students learn that success is the outcome of a process and ongoing progress because of the iterative nature of project work, the focus on drafting and editing, and the normality of constructive failure.

Positive relationships between teachers and students are recognized as a vital factor. Contemporary research not only confirms this but also identifies specific relational practices that actively shape students' mindsets. Building on Dweck's work, recent research consistently demonstrates the power of process feedback. Studies in educational psychology, for example by researchers such as Brandi C. O'Keefe (2021), show that teachers who provide feedback that praises effort, strategy, and persistence (rather than innate intelligence) explicitly teach students' that ability can be developed. This feedback is most effective when delivered in the context of a relationship based on trust. The concept of psychological safety, originally developed by Amy Edmondson in the context of work teams, is increasingly being applied in classroom settings. Strong teacher-student relationships create an environment where students' feel safe to ask questions, admit mistakes, and try unconventional solutions, all behaviours that are essential for deep learning [3]. When students' feel supported and non-judged, they are more likely to take the intellectual risks necessary to go beyond surface-level understanding. The successful implementation of deep learning [25] in the context of education in Indonesia is a multifaceted phenomenon that is significantly influenced by the dynamic interaction of several key psycho pedagogical factors, going beyond mere curriculum or infrastructure aspects.

The first and most fundamental factor is mindset, particularly the growth mindset embraced by educators and learners. Teachers with a growth mindset tend to view intelligence as something that can be developed, making them more persistent in adopting innovative pedagogy and providing constructive feedback. This mindset provides the psychological foundation for students to develop resilience and intrinsic motivation in the face of challenges, a concept that continues to be validated as central to learning success [8,44].

Second, the quality of the teacher-student relationship is a crucial relational foundation. A relationship based on trust and psychological safety has been shown to be a key catalyst for student engagement. In a supportive environment, students' feel safe to take intellectual risks, which is a prerequisite for deep learning. Recent research highlights how these positive relationships, when combined with a growth mindset, significantly promote student engagement [26].

The third factor is a deliberately structured learning framework. Instructional designs such as inquiry-based or project-based learning provide an arena for students to apply their knowledge in complex and authentic contexts. This framework demands persistence and the ability to learn from failure. This is where the growth mindset plays a vital role, enabling students to persevere and thrive in challenging learning processes [36].

These three factors do not operate in isolation but are interrelated within a learning ecosystem. Studies show that teachers mindsets directly influence the instructional practices (learning frameworks) they choose, which in turn have a direct impact on the achievement of deep learning in students [45]. Thus, the synergy between the right mindset, healthy relationships, and relevant frameworks is the key formula for the successful implementation of deep learning in Indonesia. A growth mindset serves as both a determining element and an important mediating variable in the process of deciphering the complexity of deep learning implementation. It functions as a psychological bridge that connects and strengthens the influence of other factors (such as general mindset), the quality of teacher-student relationships, and the learning framework (on the success of implementation of deep learning).

The growth mindset effectively mediates the influence of the general mindset of teachers and students. When educators have a fundamental belief that abilities can be developed (a growth mindset), they are more likely to interpret pedagogical challenges not as obstacles, but as opportunities to learn. This belief then spreads to students', changing their perceptions of difficulties and failures. Thus, a growth mindset becomes an active mechanism that transforms abstract beliefs into resilient and productive learning behaviours [8].

Furthermore, a growth mindset becomes a channel for effective teacher-student relationships. Positive relationships, characterized by trust and support, create a fertile emotional foundation. However, it is the growth mindset that transforms this foundation into bold learning actions. Students' who believe that effort will lead to improvement (and see that belief validated by their teachers) will be more willing to take intellectual risks and engage in deep dialogue. Conversely, without a growth mindset, even supportive relationships can be less effective because students' may still be reluctant to step outside their comfort zone [24].

Finally, this mediating role is particularly evident in the context of learning frameworks. Frameworks such as project-based or inquiry-based learning require students to face uncertainty and iterative processes. A growth mindset serves as a mental engine that enables students to persevere and thrive within these frameworks. Without the belief that their abilities will grow through the process, students' can quickly become frustrated and give up when faced with the complex tasks that characterize deep learning. A growth mindset ensures that sophisticated pedagogical frameworks do not remain empty structures but are truly brought to life by students' persistence and internal motivation [36].

Overall, a growth mindset is not merely an additional variable but rather a core mechanism that amplifies and channels the potential of other pedagogical elements, transforming them from mere supporting conditions into active drivers for the realization of authentic and effective deep learning [28]. To understand the success of deep learning implementation, an analysis of each determining factor—mindset, teacher-student relationships, and learning frameworks—is not enough. A map of the causal relationships between these factors reveals a dynamic ecosystem model, in which the growth mindset acts as a central catalyst that drives and strengthens the other elements.

This causal relationship begins with an educator's fundamental mindset, namely, their basic beliefs about the nature of intelligence and the learning process. This mindset is a latent variable that is the main predictor for the adoption of a more specific and actualizable growth mindset [8]. A teacher who believes that abilities can be developed inherently will find it easier to internalize and practice a growth mindset in their pedagogy [23].

Once established, a growth mindset does not operate in a vacuum. It causally influences two crucial domains simultaneously: Selection and Implementation of Learning Frameworks: A growth mindset directly encourages teachers to select and implement challenging, student-centered learning frameworks, such as project-based learning (PBL) or inquiry-based learning (IBL). These teachers see these frameworks not as a burden, but as a vehicle for maximizing student potential. Research consistently shows a strong correlation between teachers' mindsets and the instructional practices they implement in the classroom [45].

Quality of Teacher-Student Relationships: In parallel, a growth mindset shapes the quality of teacher-student relationships. Teachers who believe in the growth potential of each student will tend to build relationships based on trust, empathy, and psychological safety. This safe environment is a prerequisite for students to dare to take intellectual risks, which is the essence of deep learning [11].

Furthermore, the learning framework and teacher-student relationships do not operate independently but rather interact and mediate each other. Strong relationships act as social-emotional lubricants that enable students to engage fully and productively in challenging learning frameworks. Without a sense of security and support from teachers, even the best learning frameworks will feel intimidating and ineffective [14].

Ultimately, the synergistic interaction between relevant learning frameworks and supportive teacher-student relationships (both motivated by teachers' growth mindsets) creates optimal conditions for authentic deep learning [9]. This is not a linear chain but a mutually reinforcing cycle. Student success in a project (facilitated by the framework and relationship) will provide positive feedback that further strengthens the teacher's growth mindset, which will then continue to improve the quality of practice and relationships in the future [38].

This is in line with research showing that teachers and students' mindsets have a significant impact on the adoption and effectiveness of deep learning [10]. Teachers with a growth mindset tend to be more open to experimenting with new teaching methodologies and see challenges as opportunities for growth [7]. Smith and Jones [40] emphasize that teachers who demonstrate resilience and persistence in the face of technological or curricular difficulties are more successful in facilitating deep learning [40]. On the other hand, students with a growth mindset are more likely to engage actively, take cognitive risks, and collaborate on complex tasks that are characteristic of deep learning. Research in the fields of educational neuroscience and social-emotional learning (SEL) highlights that trust-based relationships reduce student stress levels and increase cognitive engagement [12]. When students' feel valued and understood by their teachers, they are more willing to step outside their academic comfort zone. Teachers who successfully build these relationships can provide challenging feedback without making students' feel threatened, thereby encouraging reflection and metacognition.

One essential requirement for establishing a secure and encouraging learning environment is the caliber of the teacher-student interaction. This is in line with a study conducted by Johnson *et al.*, [19], which found that positive and trusting relationships increase students' intrinsic motivation and their willingness to engage in discussions or projects that require critical thinking and problem solving. When students' feel supported and valued by their teachers, they are more courageous in taking the initiative in deep learning and are not afraid of failure. Strong relationships also facilitate more effective constructive feedback, which is important for continuous improvement in the learning process. Strong relationships enable teachers to understand the needs, interests, and backgrounds of each student more deeply. This understanding is crucial for differentiating instruction and providing personalized support, which allows each student to access learning materials at a level of depth appropriate to their zone of proximal development.

A well-structured learning framework provides clear guidance for teachers and students' on how to navigate the deep learning process. Research by Lee and Kim [22] identifies that the systematic use of frameworks such as The Six C's (Creativity, Critical thinking, Communication, Collaboration, Citizenship, and Character) or similar models helps teachers integrate these competencies into their curriculum. Effective frameworks focus not only on end results but also on the process, emphasizing the importance of open-ended questions, collaborative inquiry, and reflection. Implementing these frameworks transforms the role of teachers from information deliverers to facilitators and mentors, which is essential for supporting student self-directed learning.

One such framework, PBL, is explicitly designed to foster 21st-century competencies such as collaboration, creativity, and critical thinking. Through PBL, students apply conceptual knowledge to solve authentic and relevant problems. They must carry out research, compile data, and produce valuable products as a result of this process, which naturally encourages in-depth comprehension. By encouraging students to research, ask questions, and create their own understanding, inquiry-based learning, another framework, puts students at the center of the learning process. Teachers now play the role of facilitator rather than information provider. Curiosity and a sense of ownership over learning are naturally sparked by this method and are strong motivators for mastering the subject matter. Strong relationships with pupils are more likely to be invested in by teachers who have a growth mentality. These strong relationships, in turn, create the foundation of trust necessary to successfully implement challenging learning frameworks such as PBL or inquiry. Effective implementation of deep learning is not simply the application of new techniques but rather a comprehensive shift in classroom culture supported by belief, relationships, and appropriate pedagogical structures.

4. Conclusions

The data consistently shows that the learning framework (e.g., project-based/inquiry-based learning) is the factor with the most dominant causal influence. This factor is not only the main driver of growth mindset (72% influence) but also contributes most significantly to the direct application of deep learning (68% influence). This implies that the most impactful intervention to encourage deep learning lies in the design of structured learning activities and environments. This study affirms the vital role of growth mindset as a mediating variable. With a significant influence of 21% on the implementation of deep learning, growth mindset has been proven to function as an essential psychological bridge. It effectively channels and amplifies the impact of other factors (such as initial mindset and learning framework), transforming them from supporting conditions into active drivers. The correlation matrix showing a very strong relationship (values of 0.84 to 0.89) between mindset, teacher-student relationships, and learning frameworks confirms that these factors do not operate independently. Instead, they form a synergistic pedagogical ecosystem, in which a teacher's fundamental mindset will causally influence the quality of the relationships they build and the type of learning framework they apply. The results of the study present complex and counterintuitive findings: although teacher-student relationships have a positive effect on the implementation of deep learning (8.8%), they have a small negative effect on the formation of a growth mindset (-2.3%). This anomaly implies that a positive relationship alone is not enough. The quality of interactions within the relationship—such as the type of feedback (praising process vs. results) and the level of challenge provided—becomes a more critical determinant in fostering a growth mindset.

The suggestions provided require further investigation to answer the questions: “Under what conditions can positive teacher-student relationships actually hinder or fail to foster a growth mindset? What specific relational practices distinguish supportive-productive relationships from supportive-permissive relationships?” The text hypothesizes the existence of a “mutually reinforcing cycle.” Further research could empirically test this hypothesis with the question, “Does student success in deep learning over time create positive feedback that reinforces teachers’ growth mindset, which then improves the quality of their pedagogical practices in the next teaching cycle?”

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