



Epistemological Beliefs, Classroom Climate and Deep Learning: The Role of Metacognitive Awareness

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ABSTRACT

This research aims to determine whether epistemological beliefs, classroom climate, and metacognitive awareness directly influence deep learning, and whether metacognitive awareness mediates the influence of epistemological beliefs and classroom climate on deep learning. The study population included all students at Madrasah Aliyah (Senior High School) in Central Java. This study used convenience sampling. The study obtained 418 samples. Data were collected using a questionnaire in the form of a scale. The study used four scales: deep learning, epistemological beliefs, classroom climate, and metacognitive awareness. This study used a Structural Equation Model analyzed with the AMOS program. The results showed that epistemological beliefs significantly influenced metacognitive awareness ($\beta = -0.107$, $p < 0.05$) and deep learning ($\beta = -0.156$, $p < 0.05$). Class climate variables significantly influenced metacognitive awareness ($\beta = 0.206$, $p < .05$) and deep learning ($\beta = 0.238$, $p < .05$). The metacognitive awareness variable had a significant influence on deep learning ($\beta = 0.435$, $p < 0.05$).

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■ INTRODUCTION

Minister of Primary and Secondary Education Abdul Mu'ti emphasized using learning approaches, including deep learning (Puspapertiwi, 2024). On another occasion, Abdul Mu'ti introduced the concept of Deep Learning to improve education quality, in which the learning process begins by building attention through the five senses. This method aims to ensure that students not only master the material but also find meaning and joy in learning, so education can honor each individual and their different abilities. Through this learning approach, it is hoped that learning can increase students' capacity.

The perspective of deep learning provides an antithesis to rote learning, which fails to foster higher-order thinking skills and creativity. Massive Open Online Courses (MOOCs) can support deep learning by encouraging the creation of new concepts, conceptualization and critical thinking, and the development of higher-level metacognitive skills.(Elbyaly & Elfeky, 2022).

According to Li, Burke & Plunkett (2022), Saljo first introduced the concept of deep learning in 1979, Marton et al. developed it

in 1993, and Hattie and Marsh expanded it in 1996 into hierarchical categories. Marton then categorized five (later expanded to six) "qualitatively different" learning concepts that learners were assumed to move from lower to higher levels during their university studies, then arranged the hierarchy from (1) increasing knowledge, (2) memorizing and reproducing, and (3) applying, which these three hierarchies belong to the reproductive or surface approach category. Then (4) understanding, (5) seeing things differently, and (6) changing personally. The fourth to sixth hierarchies are the constructive, or deep, approach categories.

Based on Li, Burke & Plunkett (2022), the concept of learning was further reduced into two categories by Van Rossum and Schenk as "reproductive approach" and "constructive approach" (Dart & Boulton-Lewis, 1998, p. 225), and further identified as 'surface learning' and 'deep learning', which aligns with the framework of learners' approaches to learning. Marton and Saljo (1976) initially identified two approaches to learning: deep and surface, attempting to distinguish learning for meaningful understanding from learning for reproductive purposes. Biggs (1987) emphasized that the

learning approach is a “complex motivation” in learning, along with the selection of “appropriate strategies” by learners for learning. According to Marton and Saljo (1976), the deep approach encourages the learner’s intrinsic intention to understand the meaning of the learning task, while the surface approach encourages the learner’s extrinsic intention towards the task itself.

Literature Review

Supporting theories

Establishing a deep learning ecosystem is not simple; it is shaped by complex, multidimensional factors, both internal and external. From students’ perspective, the success of deep learning depends heavily on varying learning motivations, cognitive readiness levels, literacy skills in understanding complex academic texts, and the confidence to actively engage in intellectual discourse. From the teacher’s perspective, teaching style, classroom interaction patterns, the types of provocative questions asked, and scaffolding strategies determine the extent to which meaningful learning can be realized. Furthermore, the learning environment, both physical and digital, also plays a vital role. Adequate learning resources, an academic culture, a supportive environment, egalitarian communication patterns, and institutional policy support can catalyze or hinder the learning process that demands deep analytical thinking (Anugraheni, 2020; Faridli et al., 2024; Yuwono et al., 2020).

Epistemological beliefs and deep learning

Various studies show that epistemological beliefs influence the learning process (Mason & Bromme, 2010; Soleimani, 2020; Cashew, 2023), use of approaches in learning (Cano, 2005; Chan, 2003; 2004; 2007; Phan, 2006; 2008; Tsai, 2000; Tsai & Chuang, 2005; Bra’ten & Strømsø, 2006; Barnard, Lan, Crooks, Paton, 2008; ete, 2026) The results of a meta-analysis of 52 studies of epistemological beliefs related to learning approaches conducted by Ghufon and Suminta (2020) concluded that epistemological beliefs per dimension (certain knowledge, simple knowledge, authority/expert knowledge, fixed/innate ability, and effort/process/quick learning) and epistemological beliefs which have unidentified dimensions, caused an individual predictor in choosing the learning approach to be used.

Ghufon (2020) claimed that epistemological beliefs play an important role in academic behaviors, such as influencing the use of learning techniques; for example, students who believe that knowledge consists

of unrelated pieces of information may use memorization techniques rather than comprehension techniques. This study also concluded that students who view knowledge as the same, unchangeable, and stable tend to use memorization techniques for scientific facts. However, students who view knowledge as dynamic prioritize understanding information (Davis, 1997). Moreover, students who believe comprehension techniques are the best strategy for learning will perform better on the final exam than those who believe memorization techniques are best (Davis, 1997).

Research by Schiefer et al. (2022) found that epistemological beliefs refer to one’s beliefs about the nature of knowledge (e.g., whether it is fixed or developing), the source of knowledge (authority vs. evidence), and the process of acquiring knowledge (effortless vs. reflective effort). These beliefs influence how one interprets tasks, sets learning goals, and chooses strategies, which in turn shape whether one tends to use deep learning strategies (e.g., elaboration, concept integration, problem solving) or surface strategies (rote learning, reproduction). More sophisticated epistemological beliefs (e.g., viewing knowledge as complex, developing, and reasonable) encourage one to: (a) adopt understanding-oriented learning goals, (b) use reflective and elaborative strategies, and (c) be more tolerant of uncertainty and failure, all of which are characteristics of deep learning. Meanwhile, beliefs that view knowledge as fixed and authority-derived tend to trigger a surface learning approach (Schiefer et al., 2022).

Classroom climate and deep learning

In addition to epistemological beliefs, classroom climate is also a main factor in selecting a deep learning approach (Sucheri, Connie, & Kartiwi, 2026). The success of the teaching and learning process often depends on the patterns of relationships and interactions between teachers and students in the classroom. These patterns of interaction and relationships usually depend heavily on the teacher. Teachers and students can create positive patterns of interaction and relationships if they accept each other’s presence. Teachers who can present themselves as close, familiar friends, willing to listen, and help with any difficulties faced by students will possibly be more easily accepted by students than teachers who present themselves as fierce, scary, frightening, and often punish students. Hagenauer, Muehlbacher & Ivanova (2023) showed that good teachers create a positive learning climate by setting high expectations for learning, matching behavior with what they say, and fostering a culture that encourages students to learn. Margas’s (2023)

findings indicated that interpersonal atmosphere, teacher support, psychological safety, task structure, and classroom interaction norms form the foundations of the learning environment and determine whether students actively engage in higher-order thinking processes. This is because deep learning demands cognitive and affective engagement: students not only memorize but also connect concepts, analyze, synthesize, and transfer knowledge to new situations. A positive classroom climate (supportive, inclusive, oriented toward meaningful tasks, and allowing academic risk without stigma) creates the mental and social conditions needed for deep learning strategies to emerge and persist.

Metacognitive awareness and deep learning

Another important factor influencing the deep learning approach is metacognition, which is thinking about thinking, or the ability to understand what needs to be done when facing an event or thinking about thinking, namely the ability to know what needs to be done in an event that will occur (Stanton, Sebesta & Dunlosky, 2021). This metacognition helps students to self-regulate by knowing what learning strategies to use (Rivas, Saiz, and Ossa, 2022). It also helps someone regulate, for example, their knowledge to decide which learning strategy to use when facing a particular learning task.

Metacognitive awareness is a person's ability to recognize, monitor, and control their own thought processes during learning. Those with high metacognitive awareness focus not only on the final learning outcome but also on how and why they acquire knowledge (Stanton, Sebesta, & Dunlosky, 2021). In the context of deep learning, metacognitive awareness plays a crucial role because it helps students build more meaningful conceptual understanding, rather than simply memorizing information. Research by Tuononen, Hyytinen, & Räisänen (2023) found that students' metacognitive dimensions (knowledge about cognition and regulation of cognition) were positively related to a "deep" learning approach and an organized learning profile; more metacognitive students tended to use elaboration and monitoring strategies, which supported conceptual understanding. Metacognitive knowledge predicts the use of deep or surface strategies in teenagers. This suggests that improving metacognitive knowledge can promote deep learning strategies (Olop, Granström, & Kikas, 2024).

Based on the theoretical foundation and empirical evidence discussed above, this study proposes a comprehensive model that examines the relationships among epistemological beliefs, classroom climate, and metacognitive awareness, and determines

whether metacognitive awareness mediates the influence of epistemological beliefs and classroom climate on deep learning. The following hypotheses are proposed:

- H1: Epistemological belief has a negative direct effect on deep learning.
- H2: Epistemological belief has a negative direct effect on metacognitive awareness
- H3: Classroom climate has a positive direct effect on deep learning.
- H4: Classroom climate has a positive direct effect on metacognitive awareness
- H5: Metacognitive awareness has a positive direct effect on deep learning.
- H6: Metacognitive awareness mediates the relationship between epistemological belief and deep learning.
- H7: Metacognitive awareness mediates the relationship between classroom climate and deep learning.

■ **METHOD**

Research Design

This study used a quantitative, deductive approach, emphasizing hypotheses formulated at the outset based on theoretical constructs. Hypothesis testing is conducted using the survey method (quantitative), which involves a statistical description of research subjects through a data collection process involving the administration of a set of questions (Fowler, cited in Creswell, 1994).

Participants

The target participants of this study comprised students enrolled in Madrasah Aliyah (Islamic senior secondary schools) and general senior high schools in Central Java, Indonesia. Participants were recruited using convenience sampling, a non-probability sampling technique in which eligible students were selected based on their accessibility, availability, and willingness to participate in the study. This technique was selected because the study faced access and permission limitations, and it is more efficient for reaching students across multiple schools. This aligns with Andrade (2021), who states that convenience sampling is not inherently flawed; in fact, it is often necessary because researchers find it difficult to obtain a random sample from the entire target population.

Participants were recruited from selected schools that were accessible to the researchers. Students were invited to participate after receiving information about the study's purpose and procedures. Participation was entirely voluntary, and students who met the eligibility criteria and agreed to participate were included in the initial sample. A total of 430 students were initially recruited. Following data screening, 12

responses were excluded due to incomplete responses, failure to meet the eligibility criteria, or invalid response patterns. Consequently, 418 participants with complete and usable responses were retained for the final analysis.

Sample size adequacy was determined by considering the characteristics of the Structural Equation Modeling (SEM) analysis employed in this study. Unlike simpler statistical analyses, SEM sample size requirements depend on several factors, including model complexity, the number of latent variables and indicators, the magnitude of factor loadings and path coefficients, and the desired level of statistical power (Wolf et al., 2013). Simulation studies show that SEM sample size requirements can vary substantially with model characteristics; therefore, relying on a single rule of thumb may not always be appropriate. In the present study, the final sample of 418 participants was considered sufficiently

large to provide robust estimation of the SEM model and adequate testing of the hypothesized relationships among the study variables, while accounting for the model's complexity and the data's characteristics.

The final sample included 418 students: 92 male (22.01%) and 326 female (77.99%). By grade level, 84 students (20.10%) were in Grade 10, 181 (43.30%) in Grade 11, and 153 (36.60%) in Grade 12. Of the total participants, 195 (46.7%) attended Madrasah Aliyah, whereas 223 (53.3%) attended general senior high schools. Given the use of convenience sampling, the sample was not intended to be statistically representative of the entire population of senior secondary school students in Central Java. Accordingly, interpret the generalizability of the findings beyond the characteristics of the present sample with appropriate caution.

Table 1. Respondent Profile

Demographic Characteristic	Category	Respondent (N=418)	Percentage (%)
Gender	Male	92	22.01
	Female	326	77.99
	Total	418	100.00
Grade Level	Grade 10	84	20.10
	Grade 11	181	43.30
	Grade 12	153	36.60
	Total	418	100.00
School Type	<i>Madrasah Aliyah</i> (MA)	195	46.65
	Senior High School (SMA)	223	53.35
	Total	418	100.00

Research Instruments

This study measured deep learning using a deep learning approach scale with components described by Michael, Felice, Tami, and Karen (2013): looking for meaning, developing ideas, requiring evidence, and teaching to understand the material. This study will assess validity using construct validity, employing factor analysis. Based on the analysis results, the deep learning approach scale consists of 20 items. An example item is: *"I usually begin to understand the meaning of what I am learning on my own."*

This epistemological belief is measured using a modified epistemological belief scale based on one developed by Jehng, Johnson, & Anderson (1993). Epistemological belief in this study is divided into two components of belief, namely: belief in knowledge, which includes the aspects: (1) knowledge comes from someone

who knows well / an expert (authority/expert knowledge), (2) certain knowledge, and (3) orderly process. The belief scale included 8 statements about knowledge. A sample statement is: *"I like classes where the teacher sets the learning program units before teaching."* Meanwhile, belief in learning included: (1) quick learning and (2) innate ability. There are 6 statements on the belief scale in learning. A sample statement is: *"Students who have average achievements in junior high school/Islamic junior high school will remain the same and have average achievements when they become senior high school students"*. The higher the score obtained regarding epistemological beliefs, the more naive the epistemological beliefs held.

The classroom climate scale collects data on students' perceptions of classroom climate and was developed by the researcher based on

the Student Perceptions of Classroom Climate scale developed by Blazevski (2006), with components of support in seeking teacher assistance, academic pressure, and goal structure in the classroom. This classroom climate scale has 21 items. A sample statement is "Teachers often motivate students to be proud."

Data on metacognition were collected using a metacognitive awareness scale adapted from The Metacognitive Awareness Inventory (MAI), developed by Schraw and Dennison (1994). It has two components: cognitive knowledge (declarative, procedural, and conditional) and cognitive regulation (planning, information management, understanding monitoring, error finding, and evaluation). Based on the construct validity

analysis of the statement items, 32 items were declared invalid, and 20 items were declared valid. An example item is "I have a specific goal for each strategy I use."

Data Analysis Techniques

This study used Structural Equation Modeling to analyze the data. For analysis, the Analysis of Moment Structures (AMOS) software program was used.

RESULTS AND DISCUSSION

Before conducting the model analysis, descriptive statistics for each scale are presented. The statistical description of the research data is summarized in Table 2.

Table 2. Descriptive Statistics

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Epistemological Beliefs	418	2	8	4.59	1.372
Class climate	418	3	9	7.17	1.741
Metacognitive Awareness	418	2	8	5.72	1.199
Deep Learning	418	4	13	10.46	1.662

Based on Table 2 above, epistemological beliefs scores ranged from 2 to 8, with a mean of 4.59 (SD = 1.37), indicating moderate variability in students' epistemological beliefs. Class climate scores ranged from 3 to 9, with a mean of 7.17 (SD = 1.74), suggesting that students generally reported relatively positive perceptions of their classroom climate. Metacognitive awareness scores ranged from 2 to 8, with a mean of 5.72 (SD = 1.20), reflecting moderate to relatively high levels of metacognitive awareness among participants. Deep learning scores ranged from 4 to 13, with a mean of 10.46 (SD = 1.66), indicating that students generally demonstrated relatively high levels of deep learning within the observed score range.

Overall, the descriptive results indicate sufficient variability across all study variables, providing an appropriate basis for subsequent analyses of the hypothesized relationships among epistemological beliefs, class climate, metacognitive awareness, and deep learning. However, because the variables were measured on different score ranges, interpret direct comparisons of raw mean values cautiously.

Measurement Model Analysis

Construct reliability and convergent validity were evaluated using standardized factor loadings, Composite Reliability (CR), and

Average Variance Extracted (AVE). Following commonly accepted recommendations for confirmatory factor analysis, standardized factor loadings of .50 or higher were considered acceptable, although loadings of .70 or above were preferable. Composite Reliability values of .70 or higher were considered indicative of satisfactory internal consistency, while an AVE value of .50 or higher indicated adequate convergent validity.

The results demonstrated generally satisfactory reliability and convergent validity across the study constructs. Epistemological Belief showed strong construct reliability and convergent validity, with a CR of .849 and an AVE of .738. Similarly, Class Climate demonstrated satisfactory psychometric properties, with a CR of .880 and an AVE of .711. The standardized factor loadings for these constructs ranged from .785 to .920, indicating that their respective indicators adequately represented the underlying latent constructs.

For Metacognitive Awareness, the standardized factor loadings were .748 and .714. The construct yielded a CR of .697 and an AVE of .535. Although the CR value was marginally below the conventional .70 threshold, it was very close to the recommended criterion. At the same time, the AVE exceeded .50. Taken together, these results provide reasonable support

for the reliability and convergent validity of the Metacognitive Awareness construct.

The Deep Learning construct yielded a CR of .759, indicating satisfactory composite reliability. However, its AVE was .455, slightly below the recommended threshold of .50. Standardized factor loadings showed that three indicators had satisfactory loadings (D1 = .701, D2 = .796, and D3 = .739), whereas D4 had a relatively low loading of .386. This weak loading contributed to the construct's lower AVE. Nevertheless, the construct demonstrated

adequate composite reliability. Therefore, the decision to retain D4 should be based not only on statistical grounds but also on its theoretical relevance and contribution to the content validity of the Deep Learning construct.

Overall, the measurement results indicate that the constructs demonstrated acceptable levels of reliability and convergent validity. However, the relatively low loading of D4 and the resulting AVE for Deep Learning warrant careful consideration when interpreting the measurement model.

Table 3. Result of the Measurement Model

Construct	Cronbach's Alpha	Standardized Loading	CR	AVE	Assessment
Epistemological Belief	0.907	0.812-0.904	0.849	0.738	Satisfactory
Class Climate	0.817	0.785-0.920	0.880	0.711	Satisfactory
Metacognitive Awareness	0.687	0.714-0.748	0.697	0.535	Acceptable
Deep Learning	0.729	0.386-0.796	0.759	0.455	CR satisfactory; AVE marginal.

Although one indicator had a relatively low standardized factor loading and the construct's Average Variance Extracted (AVE) was slightly below the recommended threshold of 0.50, the measurement model was retained for theoretical reasons. The indicator represents a conceptually important dimension of the construct and is supported by the theoretical framework underlying the measurement instrument. Removing the indicator solely on statistical grounds could narrow the construct's conceptual domain and potentially compromise its content validity.

Furthermore, the construct demonstrated an acceptable level of Composite Reliability (CR), indicating adequate internal consistency among the indicators. Accordingly, the decision to retain the model balanced statistical criteria with theoretical integrity rather than statistical optimization alone. Preserving theoretically meaningful indicators was important for maintaining the construct's conceptual comprehensiveness. Therefore, the measurement model was retained for subsequent structural analysis, while the marginal AVE was acknowledged as a measurement limitation and interpreted with appropriate caution.

Structural Model Analysis

After validation of the measurement model, the next step is to analyze the research data. Data analysis will be conducted using a structural equation model (SEM) with the aid of the Amos

program. The overall analysis results are shown in Figure 1.

Based on the testing process, the required criteria were met. The goodness-of-fit indices indicated that the proposed structural model fit the observed data adequately. Although the chi-square statistic was statistically significant ($\chi^2 = 76.634$, $p < .001$), interpret this result cautiously because the chi-square test is sensitive to sample size and model complexity (Kline, 2023). Therefore, the overall model fit was evaluated using multiple complementary goodness-of-fit indices rather than relying solely on the chi-square statistic.

The normed chi-square ($\chi^2/df = 2.017$) was below the commonly recommended threshold of 3.00, indicating an acceptable model fit. The absolute fit indices also supported the model's adequacy, with GFI = .968 and AGFI = .944, both exceeding the conventional criterion of .90. Furthermore, the TLI value of .968 exceeded the recommended threshold of .95, indicating good incremental fit. The RMSEA was .049, which was below the recommended cut-off of .06 for a close-fitting model (Hu & Bentler, 1999). Collectively, these indices provide converging evidence that the hypothesized structural model adequately represents the observed data. Accordingly, the model was considered sufficiently well-fitting to interpret the hypothesized structural relationships.

In the AMOS statistical program, you can analyze and calculate regression weights

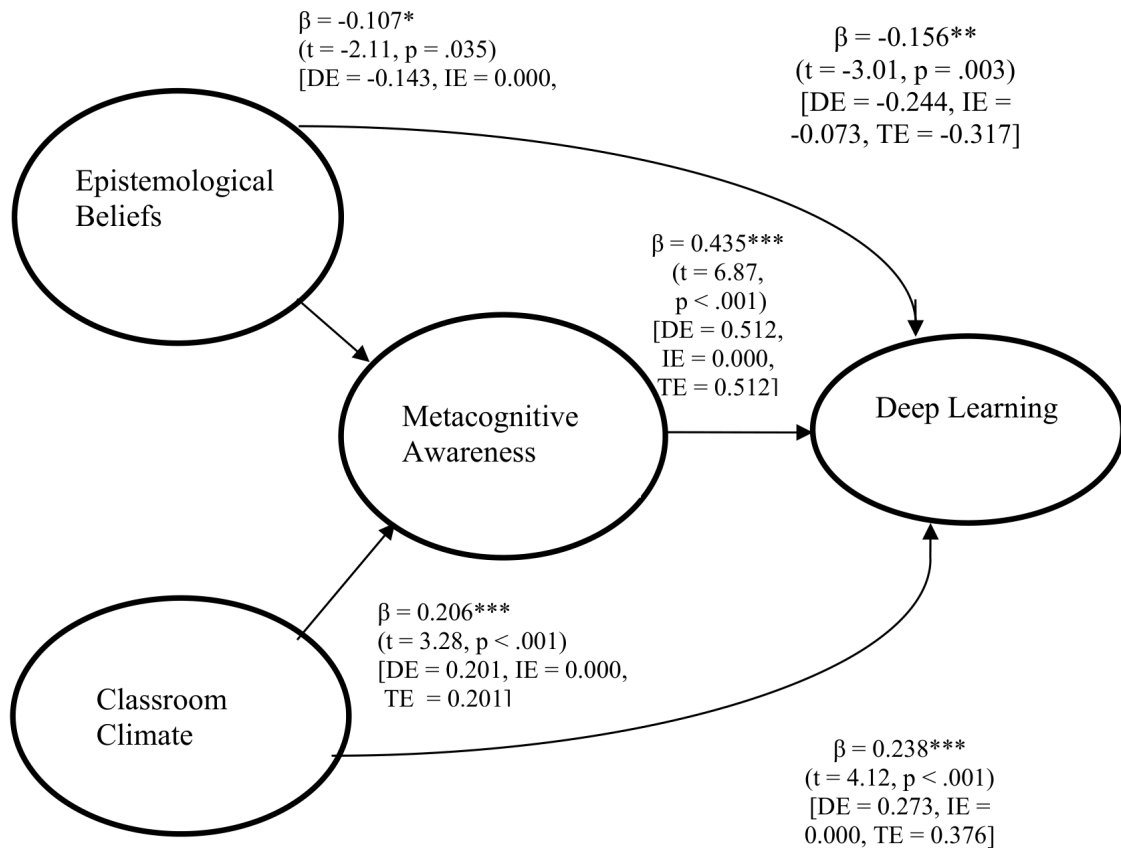


Figure 1. Structural Model of the Relationships Among Variables

Table 4. Goodness-of-Fit Indices for the Structural Equation Model

Index	Observed Value	Recommended Threshold	Evaluation
Chi-square (χ^2)	76.634	Smaller values preferred; non-significant p desirable	Significant
p -value	< .001	> .05	Not satisfied
CMIN/DF (χ^2/df)	2.017	< 3.00 acceptable; ≤ 2.00 good	Acceptable/near good
GFI	0.968	≥ 0.90 acceptable; ≥ 0.95 good	Good fit
AGFI	0.944	≥ 0.90 good	Good fit
TLI	0.968	≥ 0.95 good	Good fit
RMSEA	0.049	< 0.08 acceptable; ≤ 0.06 good	Good/close fit

between latent variables; these are often called loading factors or lambda values. In addition, the degrees of freedom (df), CR value, or t-count can also be known. Based on the significance of the t-count with a probability value (p) = 0.05, the results of the analysis showed that epistemological beliefs significantly influenced metacognitive awareness ($\beta = -0.107$, $p < 0.05$) and deep learning ($\beta = -0.156$, $p < 0.05$). Class climate variables significantly influenced metacognitive awareness ($\beta = 0.206$,

$p < 0.05$) and deep learning ($\beta = 0.238$, $p < 0.05$). Metacognitive awareness significantly influenced deep learning ($\beta = 0.435$, $p < 0.05$). Table 5 presents the regression weights for the causality test.

The amount of each latent variable's effect: the standardized direct effect and the standardized indirect effect, as well as the standardized total effect, is summarized in Table 6:

Table 5. Results of the Causality Test Regression Weights

Relationship between variables	Estimate	SE	CR	P
Epistemological Belief Variables on Metacognitive Awareness	-0.107	0.050	-2.150	0.032
Class climate variables on metacognitive awareness	0.206	0.069	2.981	0.003
Epistemological belief variables towards deep learning	-0.156	0.038	-4.051	0.003
Classroom climate variables on Deep Learning	0.238	0.049	4.861	0.000
Metacognitive Awareness Variables on Deep Learning	0.435	0.062	6.972	0.000

Table 6. Direct Effects, Indirect Effects, and Total Effects

Variables	Immediate Effect	Indirect Effects	Total Effect
Class climate towards metacognitive awareness	0.201	0.000	0.201
Classroom climate towards deep learning	0.273	0.000	0.376
Epistemological beliefs about metacognitive awareness	-0.143	0,000	-0.143
Epistemological beliefs about deep learning	-0.244	-0.073	-0.317
Metacognitive awareness of deep learning	0.512	0.000	0.512

The amount of each latent variable's effect: the standardized direct effect and the standardized indirect effect, as well as the standardized total effect, showed that the epistemological belief variable had a direct (negative) influence on metacognitive awareness of -0.143, a direct (negative) influence on deep learning of -0.244, and an indirect (positive) influence on deep learning of -0.073. Class climate variables had a direct (positive) influence on metacognitive awareness of 0.201, a direct (positive) influence on deep learning of 0.273, and an indirect (positive) influence on deep learning of 0.376; metacognitive awareness had a direct (positive) influence on deep learning of 0.512.

Regarding the indirect influence of independent variables on dependent variables through mediating variables, Solimun (2003) argued that the indirect effect coefficient is calculated as the product of the direct effect coefficient of the independent variable on the mediating variable and the direct effect coefficient of the mediating variable on the dependent variable. In addition, the significance test follows the criterion that if both direct influences are significant, the indirect influence is also significant; if either direct influence is not significant, the indirect influence is also not significant.

Based on the results, metacognitive awareness (as a mediating variable) affects deep learning and can mediate the relationship between the independent variables and the dependent variable. Therefore, the indirect

influence of epistemological belief and classroom climate on deep learning through metacognitive awareness is acceptable.

After evaluating the measurement model and confirming an acceptable overall model fit, the structural model was examined to test the hypothesized relationships among epistemological beliefs, classroom climate, metacognitive awareness, and deep learning. The analysis focused on the magnitude, direction, and statistical significance of the standardized path coefficients. Overall, the results provided empirical support for the proposed relationships among the study variables.

Specifically, epistemological beliefs had a significant negative effect on metacognitive awareness ($\beta = -0.107$, $p < .05$) and deep learning ($\beta = -0.156$, $p < .05$), indicating that higher levels of the measured epistemological beliefs were associated with lower levels of metacognitive awareness and deep learning. In contrast, class climate had a significant positive effect on both metacognitive awareness ($\beta = 0.206$, $p < .05$) and deep learning ($\beta = 0.238$, $p < .05$). These findings suggest that a more supportive classroom climate is associated with greater metacognitive awareness and stronger engagement in deep learning. Furthermore, metacognitive awareness had a significant positive effect on deep learning ($\beta = 0.435$, $p < .05$), the strongest direct effect among the predictors in the model.

Taken together, these findings indicate that students' epistemological beliefs and classroom climate influence deep learning directly, and that metacognitive awareness also plays a

role. The relatively strong positive path from metacognitive awareness to deep learning further highlights the potential importance of metacognitive processes in explaining how students engage in deeper approaches to learning.

The results of this study show that epistemological belief variables have a negative effect on deep learning. These findings also confirm that students with sophisticated epistemological beliefs, or those who believe that knowledge is tentative, complex, and accessible to anyone, are more likely to engage in deep learning strategies. Similarly, these findings confirm that students hold beliefs about learning in which understanding does not depend on when you first learn it and does not depend on innate ability or skill. These are in accordance with previous research in which epistemological beliefs influence the learning process (Mason & Bromme, 2010; Soleimani, 2020; Cashew, 2023), use of approaches in learning (Cano, 2005; Chan, 2003; 2004; 2007; Phan, 2006; 2008; Tsai, 2000; Tsai & Chuang, 2005; Bra'ten & Strømsø, 2006; Barnard, Lan, Crooks, Paton, 2008; etc, 2026).

This study also finds that self-confidence in learning significantly and negatively influences the deep learning approach. Self-confidence in learning is high when students believe learning can be done quickly and depends heavily on innate ability. Meanwhile, self-confidence in learning is low when students believe learning is a process they carry out and requires hard work to develop certain abilities. Students who believe learning can be done quickly and that abilities are innate tend to use a shallow learning approach. In contrast, students who believe learning is a process that requires hard work tend to use more effective learning strategies, leading to a deep learning approach (Ghufron & Suminta, 2020).

In addition to epistemological beliefs, classroom climate is also an essential factor in selecting a deep learning approach. These results also support research by Hagenauer, Muehlbacher & Ivanova (2023), which explains that the success of the teaching and learning process is often determined by the patterns of relationships and interactions between teachers and students in the classroom. These interaction and relationship patterns usually depend heavily on the teacher. Teachers and students can build positive patterns of interaction and relationships if they accept each other's presence. Teachers who can present themselves as close, familiar friends, willing to listen, and help with any difficulties faced by students will likely be more easily accepted by students than teachers who present themselves as fierce, scary, frightening, and often punish students. A good teacher creates a positive learning climate by setting high expectations, aligning behavior with what is said,

and fostering a culture that encourages students to learn.

Margas's (2023) research findings indicated that interpersonal atmosphere, teacher support, psychological safety, task structure, and classroom interaction norms form the foundation of the learning environment and determine whether students actively engage in higher-order thinking processes. Deep learning demands cognitive and affective engagement: students not only memorize but also connect concepts, analyze, synthesize, and transfer knowledge to new situations. A positive classroom climate (supportive, inclusive, oriented toward meaningful tasks, and allowing academic risk without stigma) facilitates the mental and social conditions needed for deep learning strategies to emerge and persist.

These results also demonstrate that metacognitive awareness influences the deep learning approach. Metacognitive awareness, or thinking about thinking, is the ability to understand what needs to be done when facing an event, and it helps students self-regulate by knowing which learning strategies to use (Stanton, Sebesta, & Dunlosky, 2021). Reed & Giessler (1995) also stated that metacognition is thinking about thinking, namely the ability to know what needs to be done in an event that will occur. Metacognition helps someone regulate, for example, the knowledge needed to decide which learning strategy to use when facing a particular learning task. In the context of deep learning, metacognitive awareness plays a crucial role because it helps students construct a more meaningful conceptual understanding, rather than merely memorizing information on a surface level (Rivas, Saiz, and Ossa, 2022).

The research results of Tuononen, Hyytinen, and Räisänen (2023) found that the dimensions of metacognition (knowledge about cognition & regulation of cognition) possessed by students are positively related to the "deep" learning approach and organized learning profile; more metacognitive students tend to use elaboration and monitoring strategies which support conceptual understanding. Metacognitive knowledge predicts the use of deep or surface strategies in teenagers. This suggests that improving metacognitive knowledge may encourage deep learning strategies (Olop, Granström and Kikas, 2024).

■ CONCLUSION

Achieving deep learning requires more than simply fostering a comfortable classroom climate or encouraging mature epistemological beliefs among students. Educators need to explicitly cultivate students' metacognitive awareness so that they can independently

manage, monitor, and direct their own thought processes. The analysis showed that epistemological belief variables significantly influenced metacognitive awareness and deep learning. Class climate variables significantly influenced metacognitive awareness and deep learning. The metacognitive awareness variable significantly influenced deep learning.

Based on these findings, several recommendations are outlined below. First, the results show that belief in knowledge, belief in learning, and classroom climate are positively correlated with metacognitive awareness and deep learning. In addition, metacognitive awareness mediates the influence of belief in knowledge, belief in learning, and classroom climate on deep learning. Thus, policymakers and teachers should pay attention to these factors. Second, this research approached the themes quantitatively. It is believed that many aspects remain unexplored through this quantitative approach alone. Therefore, employing other methodologies, such as experimental or qualitative methods, is highly recommended to deepen findings in the field.

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