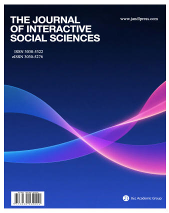
THE JOURNAL OF
INTERACTIVE SOCIAL SCIENCES
2026 Vol. 2, No. 4, ISSN 3030-5322



Teacher Support, Collaborative Learning, and Critical Thinking Development in College English Classrooms: A PLS-SEM Analysis of the Mediating Role of Deep Learning Strategies

Jing Yang [1] **Suthagar Narasuman**[1*]

[1] Kuala Lumpur University of Science and Technology, 43000, Malaysia
Corresponding Authors*: Suthagar Narasuman Email: stgnaras@gmail.com

ARTICLE INFO

Keywords

teacher support
collaborative learning
deep learning strategies
critical thinking
PLS-SEM

Published

01 December 2026

ABSTRACT

Critical thinking is increasingly regarded as an essential outcome of College English education because students must learn to interpret competing claims, evaluate evidence, identify assumptions, and construct defensible arguments in a foreign language. Nevertheless, the presence of critical-reading tasks, group discussions, or argumentative assignments does not necessarily ensure that students engage in the cognitive processing required for critical thinking. This study proposes a structural model explaining how teacher support and collaborative learning contribute to critical thinking through students' deep learning strategies. Drawing on Biggs' 3P Model of Learning, the Student Approaches to Learning tradition, the ICAP Framework, and research on learning strategies, teacher support is conceptualised as an environmental condition that communicates expectations for understanding, provides cognitive scaffolding, and helps students regulate complex learning tasks. Collaborative learning is conceptualised as a structured opportunity for explanation, comparison, knowledge construction, and interactive reasoning. Deep learning strategies refer to meaning-oriented processes involving elaboration, organisation, source integration, reflective monitoring, evidence evaluation, and transfer. Critical thinking is treated as a higher-order learning outcome involving interpretation, analysis, evaluation, inference, and reasoned judgement. A quantitative cross-sectional survey and Partial Least Squares Structural Equation Modeling are proposed to test five direct relationships and two indirect relationships. The study contributes to College English research by specifying deep learning strategies as the cognitive mechanism through which classroom support and collaborative activity may generate critical-thinking outcomes.

1. Introduction

Critical thinking has become a central concern in university education because students are

Citation: Yang, J., & Narasuman, S. (2026). Teacher support, collaborative learning, and critical thinking development in college English classrooms: A PLS-SEM analysis of the mediating role of deep learning strategies. *The Journal of Interactive Social Sciences*, 2(4), 1-18.

https://doi.org/ 10.64744/tjiss.2026.258.

required to make judgements in environments characterised by abundant information, conflicting interpretations, and increasingly accessible automated content. University learners must determine whether information is reliable, whether evidence is relevant, whether conclusions are logically justified, and whether alternative explanations have been adequately considered. Facione (1990) conceptualised critical thinking as purposeful, self-regulatory judgement involving interpretation, analysis, evaluation, inference, explanation, and self-monitoring. This definition distinguishes critical thinking from the simple possession of information: students may know a substantial amount about a topic while remaining unable to evaluate the quality of an argument or justify a conclusion.

These demands are particularly relevant to College English education. Learning English at university no longer involves only the acquisition of vocabulary, grammar, pronunciation, and examination techniques. Students are increasingly expected to interpret argumentative texts, compare information from different sources, evaluate media messages, participate in academic discussion, and produce evidence-based oral and written communication. Such practices place language learning and reasoning in direct interaction. Students use English not merely to express information but also to organise claims, qualify interpretations, respond to counterarguments, and explain how evidence supports a conclusion.

Research conducted in Chinese university English contexts indicates that students perceive teacher facilitation, meaningful tasks, access to diverse resources, interactive negotiation, and peer learning as important affordances for critical-thinking development (Du & Zhang, 2022). These findings suggest that critical thinking is influenced by the design and quality of the learning environment rather than developing automatically from exposure to English. However, environmental affordances alone do not ensure higher-order learning. Students must recognise, interpret, and cognitively use the opportunities provided by the classroom.

A student may, for example, participate in an argumentative-writing activity without evaluating the evidence included in the essay. Another student may contribute regularly to group discussion while repeating familiar opinions rather than examining assumptions. Similarly, students may complete peer-review tasks by correcting grammar while ignoring the quality of their classmates' reasoning. These examples demonstrate that visible classroom activity is not equivalent to deep cognitive processing. The central question is therefore not simply whether students participate, but whether they process learning materials in ways that produce conceptual integration, reflective monitoring, and reasoned judgement.

The distinction between surface and deep approaches to learning offers a useful explanation of this problem. Marton and Säljö (1976) showed that learners approach academic material with qualitatively different intentions. Some learners focus on reproducing isolated information, whereas others seek to understand relationships, identify organising principles, and reconstruct meaning. Subsequent work has demonstrated that deep approaches involve an intention to understand combined with strategies such as elaboration, organisation, integration, and application (Biggs et al., 2001). Deep learning is therefore not equivalent to working harder or spending more time on a task. It concerns the intellectual operations students use while learning.

Teacher support may influence these operations by communicating what kinds of learning are expected and by making complex cognitive work manageable. Teachers who provide reasoning prompts, explanatory feedback, modelling, and autonomy-supportive guidance may encourage students to move beyond reproduction. In a large study of Chinese university students, Zhao and Qin (2021) found that perceived teacher autonomy support had a substantial positive relationship with deep learning and that self-efficacy partly explained this association. Their findings indicate that supportive teaching may shape not only students' willingness to participate but also their approach to processing academic content.

Collaborative learning may also influence students' processing strategies. When collaboration is structured around explanation, comparison, and joint decision-making, students must articulate what they understand, listen to alternative interpretations, and respond to questions about their reasoning. Such interaction can stimulate knowledge construction that is unlikely to occur when learners merely divide tasks. Meta-analytic evidence demonstrates that collaborative problem-solving can promote critical thinking, although its effectiveness depends on instructional design, scaffolding, group size, and the nature of the learning task (Xu et al., 2023).

Existing studies have nevertheless often examined teacher support, collaboration, learning approaches, and critical thinking in separate research traditions. Research on teacher support frequently emphasises motivation, autonomy, or engagement, whereas collaborative-learning studies often focus on achievement or participation. Studies of critical thinking may evaluate the effectiveness of instructional activities without specifying the cognitive processing through which those activities influence outcomes. As a result, it remains insufficiently explained how classroom resources become internalised as strategies that ultimately support critical judgement.

The present study addresses this problem by positioning deep learning strategies as a mediator between two classroom conditions—teacher support and collaborative learning—and students' critical thinking. The model is grounded in the proposition that classroom conditions represent presage factors, deep learning strategies represent the learning process, and critical thinking represents the product of that process. This logic reflects Biggs' (1993) 3P Model of Learning and provides a basis for examining why students exposed to supportive and collaborative classrooms may differ in their critical-thinking outcomes.

Partial Least Squares Structural Equation Modeling is proposed to test the model because the study seeks to estimate multiple predictive relationships among latent constructs and assess specific indirect effects. PLS-SEM has been explicitly recommended for second-language and educational research when the objective is explanation and prediction, provided that researchers evaluate the measurement model rigorously and report the structural model transparently (Hair & Alamer, 2022).

The study therefore examines whether teacher support and collaborative learning predict deep learning strategies, whether these classroom conditions predict critical thinking directly, whether deep learning strategies predict critical thinking, and whether deep learning strategies transmit the effects of teacher support and collaborative learning to critical thinking.

2. Critical Thinking as a Product of Cognitive Processing

Critical thinking is sometimes presented as a general educational competence detached from the specific activities through which it develops. In practice, however, students exercise critical thinking while working with particular texts, claims, problems, and communicative situations. In College English learning, critical thinking is observable when students distinguish arguments from descriptions, identify implied assumptions, evaluate the credibility of sources, compare interpretations, recognise unsupported generalisations, and explain why a conclusion is warranted.

Facione's (1990) framework identifies interpretation, analysis, evaluation, inference, explanation, and self-regulation as interconnected components of critical thinking. Interpretation involves determining the meaning and significance of information. Analysis concerns identifying the relationships among claims, reasons, and evidence. Evaluation requires judging the credibility and logical strength of information. Inference involves drawing warranted conclusions, while explanation requires students to articulate the reasoning underlying their judgements. Self-regulation enables learners to monitor and revise their own interpretations.

These operations are particularly demanding in a foreign-language context. Students must simultaneously process linguistic form and conceptual content. Limited vocabulary, unfamiliar rhetorical conventions, or uncertainty about meaning can consume cognitive resources that might otherwise be used for evaluation. College English teachers must therefore design learning environments that support language comprehension without reducing tasks to surface-level exercises.

The development of critical thinking also depends on whether students treat texts as information to reproduce or as arguments to interrogate. When learners approach a reading passage as a collection of vocabulary items and examinable facts, they may understand its literal content while failing to evaluate its reasoning. When they approach the same passage by comparing evidence, tracing relationships among claims, and questioning assumptions, the activity becomes a context for critical thinking.

This distinction is consistent with evidence that critical-thinking affordances in university English learning depend on the interaction among task quality, teacher facilitation, resources, peer negotiation, and learners' willingness to use those conditions (Du & Zhang, 2022). The implication is that critical thinking cannot be attributed solely to an instructional technique. It develops through a process in which classroom conditions encourage particular forms of cognitive activity.

The present study therefore treats critical thinking as the product of meaning-oriented processing. Teacher support and collaborative learning are expected to create conditions favourable to this processing, while deep learning strategies represent the immediate cognitive pathway through which students interpret and use those conditions.

3. Deep Learning Strategies

3.1 From learning approach to learning strategy

The concept of deep learning emerged from Marton and Säljö's (1976) research on qualitative differences in how students approached reading. Students adopting a deep approach attempted to understand the author's meaning and the relationships within the text, whereas students adopting a surface approach concentrated on remembering discrete information. The distinction concerned the intention guiding learning and the processing activities resulting from that intention.

Biggs et al. (2001) subsequently operationalised deep and surface approaches through the Revised Two-Factor Study Process Questionnaire. A deep approach combines a motive centred on understanding with strategies involving idea connection, conceptual exploration, and application. A surface approach combines instrumental motives with memorisation, fragmentation, and minimum-effort completion. The instrument's development reinforced the view that learning approaches involve both why students learn and how they process learning materials.

In the present study, the term deep learning strategies is used rather than deep learning as a general orientation because the model focuses specifically on students' cognitive actions in College English learning. These actions include relating new ideas to prior knowledge, organising information into coherent structures, comparing claims across texts, elaborating explanations, evaluating evidence, reflecting on misunderstandings, and applying knowledge to new contexts.

This strategy-based definition avoids treating deep learning as a stable personality characteristic. Research indicates that students' approaches may vary according to their perceptions of teaching, assessment demands, workload, task design, and subject context. Asikainen and Gijbels' (2017) systematic review found that university students do not automatically develop increasingly deep approaches as they progress through higher education. In some studies, deep approaches remained stable or even declined, indicating that educational environments must deliberately support meaning-oriented learning.

3.2 Surface, deep, and transfer phases

Deep learning does not imply that surface knowledge is unnecessary. Students require vocabulary, grammatical knowledge, textual information, and basic concepts before they can evaluate or apply them. Hattie and Donoghue (2016) proposed a model distinguishing surface, deep, and transfer phases of learning. Surface learning supports initial acquisition, deep learning supports the integration and consolidation of ideas, and transfer involves applying understanding to unfamiliar situations. Strategies are therefore effective partly because they correspond to the learner's current phase of learning.

In College English education, surface learning may involve recognising vocabulary, understanding sentence structures, or identifying explicit information. Deep learning begins when students connect ideas across paragraphs, determine how evidence supports a claim, compare different authors, and reorganise information into a conceptual structure. Transfer occurs when students apply these understandings to evaluate a new text, construct an original argument, or respond to an unfamiliar problem.

The present model does not treat deep learning as the rejection of foundational language knowledge. Instead, it considers deep learning strategies to be the processes through which foundational knowledge is reorganised into understanding that can support evaluation and application. This interpretation is especially important because students cannot think critically about content they have not adequately understood.

3.3 Deep learning as constructive cognitive activity

The ICAP Framework provides a second perspective on cognitive depth. Chi and Wylie (2014) distinguished four modes of engagement: passive, active, constructive, and interactive. Passive activity involves receiving information, active engagement involves manipulating or selecting information, constructive engagement involves generating outputs that go beyond the information provided, and interactive engagement involves collaborative knowledge construction in which participants build on one another's contributions. The framework predicts stronger learning as activity progresses from passive towards constructive and interactive modes.

This distinction helps clarify why classroom activity may appear student-centred without producing deep learning. Highlighting a text or answering factual questions may be active, but it is not necessarily constructive. Students engage constructively when they generate explanations, infer relationships, formulate questions, or produce new arguments. Collaboration becomes interactive when students do more than exchange completed answers and instead revise understanding through reciprocal reasoning.

Deep learning strategies in the present study therefore reflect constructive cognitive activity. Students do not merely receive or manipulate information; they generate relationships, explanations, interpretations, and evaluative judgements that extend beyond the original material.

4. Teacher Support as a Presage Condition for Deep Learning

Teacher support is commonly described in relational or motivational terms, but its relevance to the present model lies primarily in how it shapes students' cognitive orientation towards learning. Supportive teaching communicates what counts as successful learning, makes demanding processes visible, and provides sufficient structure for students to undertake intellectual work that might otherwise be avoided.

Biggs' (1993) 3P Model conceptualises learning as an interaction among presage, process, and product factors. Presage factors include student characteristics and the teaching context. Process factors concern the approaches students adopt, while product factors include learning outcomes. The model implies that teaching does not influence outcomes only through direct transmission. Its effect operates substantially through the learning processes students adopt.

Teacher support constitutes a presage condition because it influences students' interpretation of learning tasks. When a teacher provides only answers and correction, students may infer that reproduction is sufficient. When the teacher asks for justification, models evidence evaluation, and provides feedback on reasoning, students receive a different signal: understanding requires analysis and revision.

Research on university teaching supports this contextual relationship. Trigwell et al. (1999) found that teacher-focused, information-transmission approaches were associated with students' surface approaches to learning, whereas more student-focused approaches were associated with deeper learning. Although this relationship does not establish a simple causal sequence, it demonstrates that students' approaches are connected to the educational environment created by teachers.

Teacher support can foster deep learning through cognitive scaffolding. In a College English reading lesson, a teacher may model how to distinguish a claim from supporting evidence, demonstrate how to question a source, or provide prompts that guide students through comparison. Such scaffolding does not replace students' reasoning. Instead, it reduces unnecessary difficulty while preserving the cognitive operations students must perform.

Constructive feedback is another component of support. Feedback that merely identifies incorrect language may improve accuracy but does not necessarily promote deeper processing. Feedback that asks students to explain a connection, reconsider the credibility of evidence, or address a counterargument directs attention to conceptual relationships. It transforms revision from error correction into knowledge reconstruction.

Autonomy support may also influence deep learning. Reeve and Cheon (2021) described autonomy-supportive teaching as an approach that acknowledges learners' perspectives, provides meaningful rationales, supports internal motivation, and uses non-controlling communication. When students perceive that they have intellectual ownership of a task, they may be more willing to explore ideas and revise their understanding rather than simply comply with instructions.

Evidence from Chinese higher education supports the link between autonomy support and deep learning. Zhao and Qin (2021) reported that students' perceptions of teacher autonomy support positively predicted deep learning, with self-efficacy partially mediating the relationship. This finding suggests that support can help students believe they are capable of handling demanding learning processes and, consequently, adopt strategies oriented towards understanding.

Teacher support may also influence critical thinking directly. Teachers can explicitly model argument analysis, establish standards for evidence, require justification, and incorporate critical judgement into assessment. Direct effects are therefore retained in the model. Nevertheless, the 3P perspective suggests that a substantial portion of the effect should operate through students' learning processes.

Hypothesis 1

H1: Teacher support has a positive effect on students' deep learning strategies in College English classrooms.

Hypothesis 3

H3: Teacher support has a positive effect on students' critical thinking in College English classrooms.

5. Collaborative Learning as a Structure for Knowledge Construction

Collaborative learning is frequently justified on the basis that students benefit from interaction, but interaction itself is not sufficient. Groups may exchange information without elaborating it, distribute work without integrating it, or reach agreement without evaluating competing claims. The cognitive value of collaboration depends on what students are required to do with one another's ideas.

In the present study, collaborative learning is defined as structured peer activity in which students explain interpretations, compare evidence, question reasoning, negotiate meaning, and construct shared conclusions. This definition places emphasis on interaction quality rather than the frequency of group work.

The ICAP Framework helps distinguish collaborative activity from interactive knowledge construction. A group may be active when members take turns presenting prepared information, but interactive learning occurs when participants build upon, challenge, and revise one another's contributions (Chi & Wylie, 2014). Interactive activity can produce knowledge that no individual student had generated before the discussion.

Collaborative learning may stimulate elaboration because explaining an idea requires students to organise what they know. A learner who believes that a text supports a particular conclusion must identify the claim, select relevant evidence, and articulate the relationship between them. Questions from peers can expose gaps in the explanation and require further clarification. This process turns implicit understanding into explicit reasoning.

Collaboration can also generate comparison. When students offer different interpretations, the group must determine whether the differences arise from evidence, assumptions, definitions, or background knowledge. The need to reconcile or evaluate these differences can promote deeper processing than individual study.

Peer criticism may support metacognitive monitoring. Students often fail to recognise weaknesses in their own reasoning because their assumptions remain invisible to them. A peer's request for evidence or identification of an inconsistency can prompt learners to reconsider their understanding. In this sense, collaboration provides an external mechanism for monitoring that may later become internalised.

Johnson and Johnson (2009) argued that the effectiveness of cooperative learning depends on positive interdependence, individual accountability, promotive interaction, social skills, and group processing. These conditions help prevent the common problem in which one student completes the cognitive work while others remain peripheral. Collaborative learning should therefore be designed so that each student must contribute to and understand the shared reasoning process.

Gillies (2016) similarly concluded that productive cooperative learning requires students to engage in questioning, elaborated explanation, feedback, and mutual support. The teacher's role is not eliminated in collaborative learning; teachers must design tasks, model interaction, monitor reasoning, and intervene when groups adopt superficial strategies.

Meta-analytic evidence confirms that collaborative problem-solving can enhance critical thinking but also reveals substantial variation across studies. Xu et al. (2023) found an overall positive effect while identifying instructional method, group organisation, duration, and scaffolding as important moderators. These results reinforce the argument that collaboration is not intrinsically deep; it becomes cognitively productive when structured around meaningful problems and reciprocal reasoning.

Collaborative learning may therefore affect critical thinking directly by exposing students to alternative perspectives and requiring them to justify their claims. It may also influence critical thinking indirectly by encouraging elaboration, integration, reflection, and evaluation—the processes represented by deep learning strategies.

Hypothesis 2

H2: Collaborative learning has a positive effect on students' deep learning strategies in College English classrooms.

Hypothesis 4

H4: Collaborative learning has a positive effect on students' critical thinking in College English classrooms.

6. Deep Learning Strategies and Critical Thinking

Deep learning strategies and critical thinking overlap in their emphasis on meaning and evaluation, but they are not interchangeable. Deep learning strategies describe the processes students use while learning. Critical thinking refers to the quality of judgement students can produce through those processes.

A student may use elaboration to connect a new concept with prior knowledge. This strategy does not itself constitute a critical-thinking outcome, but it creates a richer knowledge structure from which analysis becomes possible. Similarly, organising ideas helps students identify relationships among claims, while comparing sources provides the basis for evaluating consistency and credibility.

Deep learning strategies support interpretation because learners seek underlying meaning rather than isolated facts. They support analysis because students identify relationships and structures. They support evaluation because learners compare evidence and examine the strength of reasoning. They support inference because integrated knowledge enables students to draw conclusions that extend beyond explicit information. Reflective monitoring supports self-regulation by encouraging students to recognise uncertainty and revise inadequate interpretations.

Hattie and Donoghue’s (2016) model also indicates that deep-learning strategies are particularly important during the consolidation and integration of knowledge. Strategies such as concept mapping, elaboration, self-questioning, and metacognitive monitoring help students move from initial acquisition towards relational understanding and transfer. These processes provide a plausible cognitive foundation for critical-thinking performance.

Warburton (2003) similarly associated deep learning with conceptual integration, reflection, and the ability to connect knowledge with wider problems. Although developed in the context of education for sustainability, this analysis is relevant to College English because students must also integrate language, content, evidence, and perspective in order to construct reasoned communication.

The relationship is particularly visible in critical reading. Surface processing may allow students to identify what an author states. Deep processing enables them to determine why the author makes the claim, how the evidence functions, which assumptions remain unstated, and how the argument compares with another source. Critical thinking emerges when these processing activities result in an evaluative judgement.

Hypothesis 5

H5: Deep learning strategies have a positive effect on students’ critical thinking in College English classrooms.

7. The Mediating Role of Deep Learning Strategies

The central contribution of the model lies in treating deep learning strategies as the mechanism connecting classroom conditions with critical-thinking outcomes. Teacher support and collaborative learning are external resources. Critical thinking is an outcome. Deep learning strategies explain what students do cognitively with those resources.

Teacher support may create an environment in which deep processing is both expected and achievable. A teacher can make reasoning criteria explicit, model analytical procedures, provide prompts, and give feedback. However, students must still relate ideas, evaluate evidence, and monitor understanding. The teacher cannot perform these operations on behalf of learners.

For example, a teacher may ask students to compare two articles and determine which provides the stronger argument. The question establishes a critical task, but the outcome depends on whether students identify comparable claims, examine source credibility, evaluate evidence, and integrate their findings. These operations represent deep learning strategies. Without them, students may respond on the basis of personal preference or superficial textual features.

The relationship between teacher support and critical thinking is therefore expected to be partly indirect. Support influences the learning approach, and the learning approach influences the resulting judgement. This sequence reflects the presage–process–product logic of Biggs' (1993) model.

Hypothesis 6

H6: Deep learning strategies mediate the relationship between teacher support and students' critical thinking in College English classrooms.

Collaborative learning may similarly generate opportunities that require cognitive transformation. Exposure to a peer's opinion does not automatically improve critical thinking. Students must compare the opinion with evidence, determine whether it challenges their understanding, and decide whether revision is warranted.

Consider a group source-evaluation task. Students may simply assign one source to each member and combine their summaries. Although collaborative in organisational terms, such an approach may involve little deep processing. Alternatively, students may compare the credibility of all sources, discuss conflicting evidence, negotiate evaluation criteria, and construct a collective ranking. The second approach requires elaboration, integration, and reflective evaluation.

Deep learning strategies therefore explain why some collaborative activities promote critical thinking while others do not. Collaboration provides the social structure; deep strategies represent the cognitive work conducted within that structure.

Hypothesis 7

H7: Deep learning strategies mediate the relationship between collaborative learning and students' critical thinking in College English classrooms.

8. Research Model

The proposed model contains two exogenous constructs, one mediator, and one final endogenous construct. Teacher support and collaborative learning predict deep learning strategies and critical thinking. Deep learning strategies also predict critical thinking. Two specific indirect effects are tested:

- Teacher support to deep learning strategies to critical thinking;

- Collaborative learning to deep learning strategies to critical thinking.

The direct relationships are retained because teacher support may affect critical thinking through explicit instruction and feedback, while collaborative learning may affect it through direct exposure to alternative perspectives. The model therefore does not assume complete mediation in advance.

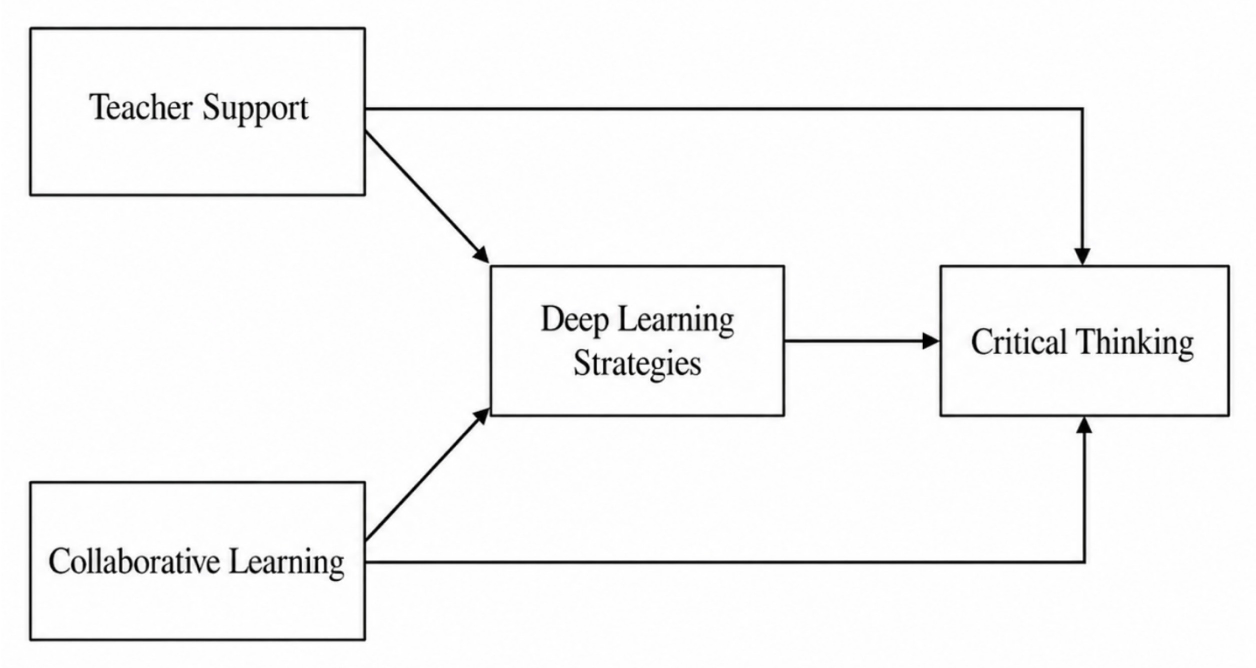


Figure 1 Conceptual Framework

9. Research Methodology

9.1 Research design

The study adopts a quantitative, cross-sectional, explanatory, and prediction-oriented research design. The design is appropriate because the study seeks to estimate relationships among latent constructs and determine whether deep learning strategies transmit the effects of classroom conditions to critical thinking.

The individual undergraduate student is the unit of analysis. Teacher support and collaborative learning are measured as students' perceptions of their College English classroom, while deep learning strategies and critical thinking concern their reported learning processes and outcomes.

Although the model uses the language of effects, cross-sectional data cannot establish definitive causality or developmental change. Results should therefore be interpreted as structural and predictive relationships consistent with the theoretical model.

9.2 Population and sampling

The target population comprises non-English-major undergraduate students enrolled in credit-bearing College English courses in mainland Chinese universities. Participants should have completed sufficient instruction to evaluate the support provided by their teacher, the quality of collaborative activity, and their own learning strategies.

Sampling from several classes or universities is preferable to reliance on a single class. A multistage sampling procedure may first identify institutions, then College English classes, and finally individual students. Stratification by university type, region, discipline, or year of study may improve sample diversity.

Sample size should be determined through a priori power analysis based on the number of predictors of the most complex endogenous construct, the minimum effect expected to be detected, the significance level, and the desired statistical power. The traditional ten-times rule should not be used as the sole sample-size justification because it may underestimate the number of observations required for stable estimates.

9.3 Measurement of teacher support

Teacher support should be measured as a classroom learning resource rather than only an affective relationship. Items should assess the extent to which the teacher:

- clarifies complex tasks;
- provides feedback on understanding and reasoning;
- models analytical processes;
- encourages students to explain their thinking;
- gives rationales for learning activities;
- respects alternative interpretations;
- supports students when they encounter conceptual difficulty.

Although these behaviours represent several forms of support, the construct may be modelled as a global reflective factor when the study's purpose is to estimate students' overall perception of cognitively supportive teaching.

9.4 Measurement of collaborative learning

Collaborative learning should be measured as interaction quality rather than the frequency of group activities. Items should assess whether students:

- explain ideas to peers;
- question one another's reasoning;
- compare evidence and interpretations;
- provide constructive feedback;
- integrate contributions into shared understanding;
- assume responsibility for group reasoning;
- revise ideas following peer discussion.

This operationalisation is consistent with the ICAP distinction between simple participation and interactive knowledge construction.

9.5 Measurement of deep learning strategies

Deep learning strategies may be adapted from the deep-approach dimension of the Revised Two-Factor Study Process Questionnaire developed by Biggs et al. (2001). Because the original scale measures general approaches to study, items should be contextualised carefully to College English without altering the conceptual domain.

The scale should capture strategies such as relating ideas, seeking underlying meanings, comparing sources, integrating information, evaluating evidence, monitoring comprehension, reflecting on interpretations, and applying learning in new situations.

The term “deep learning strategies” should be clearly defined in the questionnaire to prevent confusion with deep learning in artificial intelligence.

9.6 Measurement of critical thinking

Critical thinking should be assessed using a validated instrument reflecting interpretation, analysis, evaluation, inference, explanation, and self-regulation. Because self-report instruments measure perceived tendencies rather than demonstrated performance, the study should acknowledge the limitations of self-assessment.

Where resources permit, future validation may combine the self-report scale with performance tasks such as source comparison, argumentative writing, evidence evaluation, or scenario-based judgement.

9.7 Translation and content validation

If instruments originally developed in English are administered in Chinese, a translation and back-translation procedure should be conducted. Independent bilingual experts should compare the original and translated versions and resolve differences in meaning.

Experts in College English education, educational psychology, critical thinking, and quantitative methodology should assess the content relevance, clarity, and cultural suitability of each item. Item-level and scale-level content-validity indices may be calculated.

A pilot study should then examine item comprehensibility, questionnaire length, response variability, preliminary reliability, and possible floor or ceiling effects. Items should not be deleted solely to increase reliability because excessive deletion may narrow the conceptual coverage of a construct.

9.8 Common method bias

Because all constructs may be measured through the same questionnaire at one time, common method bias is a concern. Procedural remedies should include anonymity, neutral instructions, psychological separation of predictor and outcome sections, variation in scale presentation, and protection from evaluation apprehension.

Statistical diagnostics may include full-collinearity variance inflation factors. Harman’s single-factor test may be reported as a preliminary diagnostic but should not be treated as sufficient evidence that common method bias is absent.

10.PLS-SEM Analysis

PLS-SEM is appropriate for the proposed model because the study emphasises prediction, variance explanation, and mediation among latent constructs. Hair and Alamer (2022) provide specific guidance for applying PLS-SEM in second-language and educational research.

10.1 Data screening

Before estimating the model, responses should be screened for missing values, duplicate submissions, implausibly short completion times, straight-lining, inconsistent answers, and multivariate outliers. Descriptive statistics should include means, standard deviations, skewness, and kurtosis.

Although PLS-SEM does not require multivariate normality, highly non-normal data may affect bootstrap inference and should therefore be reported.

10.2 Measurement model

For reflectively measured constructs, indicator reliability should be examined first. Outer loadings should preferably exceed .708. Indicators with moderate loadings should be retained when they contribute important conceptual content and when their removal does not meaningfully improve reliability or validity.

Cronbach's alpha, composite reliability, and rho_A should normally fall between .70 and .95. Values exceeding .95 may indicate item redundancy.

Convergent validity should be evaluated through average variance extracted, with values above .50 indicating that a construct explains more than half of the variance in its indicators.

Discriminant validity should be assessed using the Heterotrait–Monotrait ratio. Henseler et al. (2015) developed HTMT as a more sensitive procedure for assessing discriminant validity in variance-based structural models. Values below .85 or .90 may be used depending on the conceptual similarity of the constructs.

10.3 Structural model

After measurement quality has been established, inner collinearity should be evaluated through variance inflation factors. Path coefficients should then be estimated using bootstrapping with at least 5,000 resamples.

The analysis should report coefficients, standard errors, t values, p values, and bias-corrected confidence intervals. Statistical significance should be interpreted together with effect magnitude and theoretical relevance.

The coefficient of determination should be reported for deep learning strategies and critical thinking. The (f^2) statistic should be used to assess the contribution of each exogenous construct to the explained variance of an endogenous construct.

Predictive assessment should include PLSpredict where appropriate. Because prediction is one justification for PLS-SEM, the study should evaluate whether the model predicts observations beyond the estimation sample rather than relying only on explanatory fit.

10.4 Mediation analysis

The mediation analysis should estimate two specific indirect effects: Teacher Support to Deep Learning Strategies to Critical Thinking; Collaborative Learning to Deep Learning Strategies to Critical Thinking.

Mediation should be determined from bootstrapped confidence intervals for the indirect effects. The indirect effect is statistically supported when the confidence interval does not include zero.

The direct effects should then be considered to determine whether mediation is indirect-only, complementary, or competitive. The absence of a significant direct effect is not a prerequisite for mediation.

11.Theoretical Contributions

The first contribution of the study is its explicit distinction between classroom participation and cognitive processing. Whereas the first article explains critical thinking through learning engagement, the present model explains it through how students organise, elaborate, evaluate, and transfer knowledge. Deep learning strategies are therefore not treated as another measure of effort or involvement.

Second, the study applies Biggs' presage–process–product logic to College English education. Teacher support and collaborative learning are conceptualised as presage conditions, deep learning strategies as the process, and critical thinking as the product. This structure specifies how classroom conditions become educational outcomes.

Third, the study integrates the Student Approaches to Learning tradition with the ICAP Framework. The deep-approach tradition explains learners' meaning-oriented intentions and strategies, while ICAP clarifies the types of classroom activity most likely to stimulate constructive and interactive processing.

Fourth, the model distinguishes deep learning strategies from critical thinking. Although the constructs are related, the former concerns the cognitive means used during learning, while the latter concerns the quality of resulting judgement. This distinction reduces conceptual overlap and allows mediation to be tested meaningfully.

Fifth, the study clarifies why collaborative learning produces inconsistent outcomes. Collaboration promotes critical thinking only when students use interaction to elaborate, compare, integrate, and revise ideas. Deep learning strategies therefore explain variation in the effectiveness of group activity.

12.Practical Implications

College English teachers should design support around the cognitive operations students need to perform. Rather than only explaining content or correcting language, teachers should model how claims are identified, how evidence is assessed, and how conclusions are revised. Feedback should address the quality of reasoning as well as linguistic accuracy.

Reading instruction can move beyond comprehension questions by asking students to compare sources, identify assumptions, evaluate the strength of evidence, and reconstruct the author's argument. Writing instruction can require students to explain why particular evidence was selected and how counterarguments influenced revision.

Collaborative tasks should prevent the mechanical division of work. Each group member should engage with the central problem, and the final product should require the integration of contributions. Evidence-ranking activities, argument mapping, collaborative source evaluation, and joint counterargument development are more likely to produce deep processing than parallel task completion.

Assessment must also communicate that understanding and evaluation are valued. If examinations reward memorised vocabulary, fixed templates, and isolated answers, students may adopt surface strategies even when classroom activities appear innovative. Alignment among instruction, collaboration, and assessment is therefore essential.

13.Limitations and Future Research

The cross-sectional design limits claims about temporal order. Students who already use deep learning strategies may perceive teachers and collaborative activities more positively. Longitudinal research should measure classroom conditions early in a semester, deep learning strategies during the learning period, and critical thinking at a later stage.

Self-report measurement may also inflate associations because students report both classroom conditions and their own learning. Future studies should combine questionnaire data with teacher observations, discourse analysis, learning artefacts, and performance-based assessments.

The model treats teacher support and collaborative learning as student-level perceptions. However, these constructs may also operate at the classroom level. Future studies with a sufficient number of teachers and classes should use multilevel modelling to distinguish individual perceptions from shared classroom conditions.

Future research may also compare the deep-learning mediation model with the learning-engagement model. The two mechanisms may operate in parallel, or engagement may precede deep learning in a sequential process.

Such comparisons would establish whether students must first become involved before they process information deeply, or whether supportive and collaborative conditions can influence cognitive strategies more directly.

14.Conclusion

This study proposes that the effects of teacher support and collaborative learning on critical thinking can be understood through the cognitive processing students adopt in College English classrooms. Teacher support functions as an environmental signal and scaffold that communicates expectations for understanding, while collaborative learning creates opportunities for explanation, comparison, and knowledge reconstruction.

Neither condition guarantees critical thinking. Their educational value depends on whether students use deep learning strategies to relate ideas, integrate sources, evaluate evidence, monitor understanding, and transfer knowledge. Deep learning strategies therefore form the central bridge between the classroom environment and students' critical judgement.

By applying Biggs' 3P Model, the Student Approaches to Learning tradition, the ICAP Framework, and a PLS-SEM methodology, the study offers a distinct explanation of critical-thinking development that does not duplicate the engagement-based model. It shifts the analytical focus from whether students participate to how they think while participating.

Acknowledgments
We are grateful to all respondents who participated in this study.

References

[1]. Asikainen, H., & Gijbels, D. (2017). Do students develop towards more deep approaches to learning during studies? A systematic review on the development of students' deep and surface approaches to learning in higher education. *Educational Psychology Review, 29*(2), 205–234. https://doi.org/10.1007/s10648-017-9406-6

[2]. Biggs, J. B. (1993). From theory to practice: A cognitive systems approach. *Higher Education Research & Development, 12*(1), 73–85. https://doi.org/10.1080/0729436930120107

[3]. Biggs, J., Kember, D., & Leung, D. Y. P. (2001). The revised two-factor Study Process Questionnaire: R-SPQ-2F. *British Journal of Educational Psychology, 71*(1), 133–149. https://doi.org/10.1348/000709901158433

[4]. Chi, M. T. H., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist, 49*(4), 219–243. https://doi.org/10.1080/00461520.2014.965823

[5]. Du, X., & Zhang, L. (2022). Investigating EFL learners' perceptions of critical thinking learning affordances: Voices from Chinese university English majors. *SAGE Open, 12*(2), Article 21582440221094584. https://doi.org/10.1177/21582440221094584

[6]. Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction—The Delphi report*. American Philosophical Association.

[7]. Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education, 41*(3), 39–54. https://doi.org/10.14221/ajte.2016v41n3.3

[8]. Hair, J. F., & Alamer, A. (2022). Partial least squares structural equation modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Research Methods in Applied Linguistics, 1*(3), Article 100027. https://doi.org/10.1016/j.rmal.2022.100027

[9]. Hattie, J. A. C., & Donoghue, G. M. (2016). Learning strategies: A synthesis and conceptual model. *npj Science of Learning, 1*, Article 16013. https://doi.org/10.1038/npjscilearn.2016.13

[10]. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

[11]. Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365–379. https://doi.org/10.3102/0013189X09339057

[12]. Marton, F., & Säljö, R. (1976). On qualitative differences in learning: I—Outcome and process. *British Journal of Educational Psychology, 46*(1), 4–11. https://doi.org/10.1111/j.2044-8279.1976.tb02980.x

[13]. Reeve, J., & Cheon, S. H. (2021). Autonomy-supportive teaching: Its malleability, benefits, and potential to improve educational practice. *Educational Psychologist, 56*(1), 54–77. https://doi.org/10.1080/00461520.2020.1862657

[14]. Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. *Higher Education, 37*(1), 57–70. https://doi.org/10.1023/A:1003548313194

[15]. Warburton, K. (2003). Deep learning and education for sustainability. *International Journal of Sustainability in Higher Education, 4*(1), 44–56. https://doi.org/10.1108/14676370310455332

[16]. Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications, 10*, Article 16. https://doi.org/10.1057/s41599-023-01508-1

[17]. Zhao, J., & Qin, Y. (2021). Perceived teacher autonomy support and students' deep learning: The mediating role of self-efficacy and the moderating role of perceived peer support. *Frontiers in Psychology, 12*, Article 652796. https://doi.org/10.3389/fpsyg.2021.652796