Contemporary Educational Technology, 2026, **18**(2), ep642
ISSN: 1309-517X (Online)

Review Article

SPOC model and deep learning in higher education: A systematic review (2020-2025)

Long Yujie [1*]
0009-0009-7714-5658

Nurfaradilla Binti Mohamad Nasri [2]
0000-0001-8572-3838

Muhammad Helmi Bin Norman [2]
0000-0002-4717-3166

Zhang Shuran [1]
0009-0009-3911-7584

[1] Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, MALAYSIA
[2] Center for Educational Leadership and Policy Research, Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, MALAYSIA
[*] Corresponding author: p120115@siswa.ukm.edu.my

Citation: Yujie, L., Nasri, N. B. M., Norman, M. H. B., & Shuran, Z. (2026). SPOC model and deep learning in higher education: A systematic review (2020-2025). *Contemporary Educational Technology, 18*(2), Article ep642. https://doi.org/10.30935/cedtech/18059

ARTICLE INFO

Received: 13 Jun 2025
Accepted: 31 Jan 2026

ABSTRACT

Amid the digital transformation of higher education, fostering deep learning–emphasizing higher-order thinking, autonomy, and knowledge transfer–has become a critical reform goal. The small private online course (SPOC) model, known for its interactivity and personalized support, shows strong potential to promote deep learning. However, prior research remains fragmented and lacks systematic integration. This study addresses the gap by conducting a systematic review of 37 empirical studies published between 2020 and 2025. Using preferred reporting items for systematic reviews and meta-analyses for screening and the mixed methods appraisal tool for quality appraisal, the review synthesizes findings across five dimensions: conceptualization, effectiveness, methodology, influencing factors, and theoretical foundations. Results reveal that 35 studies affirm SPOC's effectiveness in enhancing deep learning, particularly in cognitive development, self-regulation, and engagement. Key enablers include task design, instructor facilitation, and platform feedback systems. The review concludes that SPOC serves as a viable pedagogical model for advancing deep learning in higher education and offers practical guidance for researchers and educators.

Keywords: SPOC model, deep learning, higher education, blended learning, systematic review, instructional design, educational technology

INTRODUCTION

Deep learning in education refers to an approach centered on meaning-making, knowledge transfer, critical thinking, and self-regulation. Initially distinguished from surface learning by Marton and Säljö (1976), it emphasizes learners' active engagement in integrating content and connecting new knowledge to prior experience. This construct has since been expanded within educational psychology and instructional design (Chen & Singh, 2024).

With the global shift toward a knowledge-based society, higher education faces increasing pressure to cultivate students' higher-order thinking and interdisciplinary skills. Deep learning has become a central goal of competence-oriented education and 21st century higher education reform (Jin, 2024). Studies show that well-designed pedagogical strategies enhance engagement, learner autonomy, and reflection, enabling a transition from knowledge acquisition to competence construction (Du & Qian, 2022; L. Jiang et al., 2024b).

Technology-enhanced learning environments have created new opportunities to promote deep learning, particularly through online platforms (Pan, 2023). Among these, the small private online course (SPOC) model–blending online learning with traditional classroom instruction–has emerged as a promising strategy. Proposed by Armando Fox (2013) as a solution to the shortcomings of MOOC, SPOC combine scalable technology with the pedagogical benefits of in-person learning. Unlike MOOC, SPOC features closed cohorts, structured interaction, and greater personalization, resulting in better engagement, completion rates, collaboration (Ruiz-Palmero et al., 2020), and community development (Fox, 2013).

The SPOC model has gained recognition for its potential to foster deep learning. Previous research has explored its theoretical foundations (Filius, 2018) and its effectiveness in enhancing critical thinking and knowledge transfer (An & Qu, 2021; Gan & Zhang, 2020; Huang & Annamalai, 2024; Hui, 2021; L. Jiang et al., 2024a). However, the online component of SPOC-based blended learning presents significant challenges. Compared to face-to-face instruction, it demands greater self-regulation, technological literacy, and social interaction from learners. These challenges extend beyond technical issues to include broader pedagogical concerns associated with digital transformation (Rasheed et al., 2020). Despite promising individual findings, a systematic synthesis of how SPOC promotes deep learning in higher education is still lacking, limiting both theoretical development and practical implementation.

To address this, the present study conducts a systematic review of empirical research published between 2020 and 2025, examining how SPOC affect deep learning outcomes in higher education. The review draws on 37 studies and follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines for selection and the mixed methods appraisal tool (MMAT) for quality appraisal (**Appendix A**). It identifies key enablers and mechanisms of deep learning in SPOC contexts, aiming to provide a cohesive theoretical and practical understanding.

The review is guided by the following research questions (RQs):

RQ1: How is deep learning conceptualized, and what SPOC application modes and research trends characterize its implementation in higher education?

RQ2: To what extent do SPOC enhance deep learning competencies, and what dimensions are used to assess these outcomes?

RQ3: What research methodologies are employed to evaluate SPOC's effectiveness for deep learning?

RQ4: What factors significantly affect the efficacy of SPOC in promoting deep learning?

RQ5: What theoretical frameworks underpin the integration of deep learning within SPOC models?

By answering these questions, this review contributes to consolidating the fragmented literature, clarifying how SPOC function as a pedagogical model, and informing future instructional design and policy development in higher education. **Appendix B** shows the methods used to evaluate SPOCs' effectiveness for deep learning.

METHODOLOGY

This systematic literature review (SLR) adopts a structured approach to synthesize empirical research on how the SPOC model facilitates deep learning in higher education. Adhering to the PRISMA framework (Page et al., 2021), the review ensures transparency, rigor, and reproducibility by specifying RQs, conducting systematic searches, applying clear inclusion/exclusion criteria, and performing quality appraisals (Smela et al., 2023; Shaheen, 2023).

Data Collection and Processing

Three major databases—Web of Science, Scopus, and EBSCOhost—were systematically searched to capture relevant literature, informed by established protocols in blended learning research (Gudoniene et al., 2025; Luo & Zhou, 2024; McCarthy & Palmer, 2023). Boolean operators were used to construct the search queries, with the main keywords being "SPOC," "deep learning," and "higher education," including relevant

Table 1. Inclusion and exclusion criteria

Category	Inclusion criteria	Exclusion criteria
Language	Studies published in English	Studies not written in English
Time frame	Studies published between 2020 and 2025	Studies published before 2020
Article type	Empirical research only	Non-empirical articles
Accessibility	Full-text must be accessible	Full text is not retrievable
Research content	Explicitly addresses both SPOC and deep learning	Does not address both SPOC and deep learning or focuses on unrelated topics
Research focus	Focuses on the impact of SPOC-based blended learning on deep learning outcomes	Does not examine the impact of SPOC-based blended learning on deep learning
Target population	Participants from higher education	Participants not from higher education
Data completeness	Clearly reports objectives, methodology, sample, results, and conclusions	Unclear or incomplete data, lacking methodological detail or result interpretation

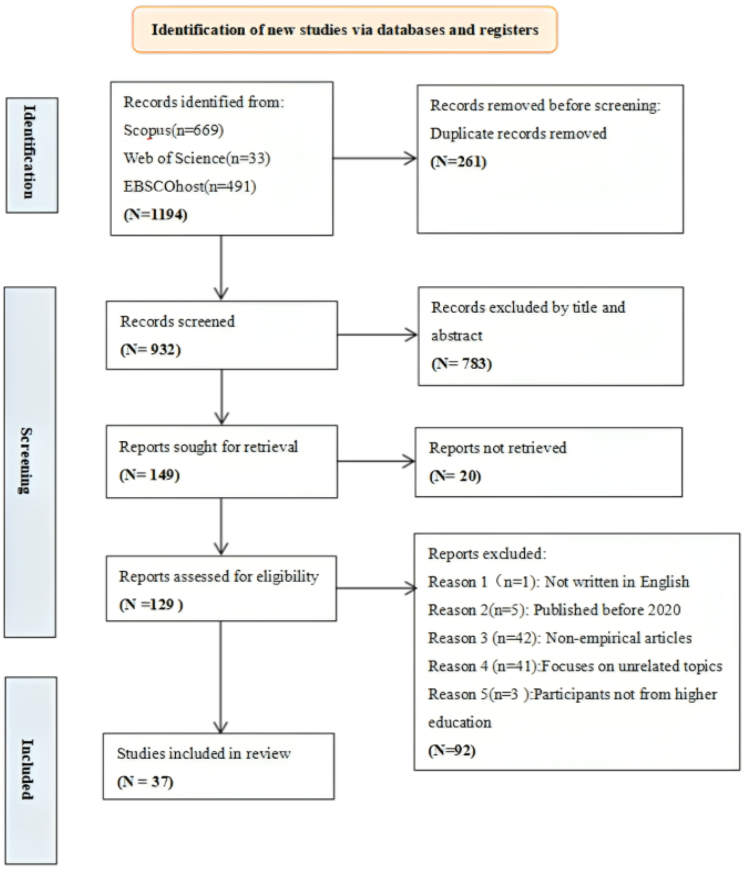

Figure 1. Overview of the systematic review process on PRISMA [Adapted from Page et al. (2021)]

synonyms and variants. The search period was limited to the years 2020 to 2025, and all search activities were completed on April 20, 2025.

The search string is as follows: "spoc" OR "small private online course*" AND "deep learning" AND "higher edu*" OR "universit*" OR "college*".

A total of 1,193 records were retrieved. After removing 261 duplicates, 932 unique titles remained. Title and abstract screening excluded 783 irrelevant studies, leaving 149 full-text articles for assessment. Of these, 112 were excluded based on predefined criteria. Ultimately, 37 empirical studies were included for analysis. Eligibility criteria are summarized in **Table 1**. Only empirical, English-language studies focusing on both SPOC and deep learning in higher education were considered. Articles were excluded if they were non-empirical, lacked methodological transparency, did not address deep learning outcomes, or did not involve higher education learners.

Figure 1 provides a visual representation of the selection process, following the recommendations of the PRISMA statement (Page et al., 2021).

Table 2. Coding framework based on RQs

RQ	Primary coding dimension	Key coding items
RQ1	Conceptualization and implementation	Definitions of deep learning (goal vs. theory), application modes of SPOC (direct, integrated, enhanced), year of publication, source journals, author groups, research locations, participant groups, course types
RQ2	Effectiveness and evaluation dimensions	Cognitive development, reflective thinking, autonomy, motivation, collaboration, engagement, academic achievement, satisfaction
RQ3	Methodological approaches	Use of questionnaires, interviews, control/experimental designs, pre-test/post-test comparisons; combination of methods (e.g., mixed-method designs)
RQ4	Critical influencing factors	Learner characteristics (e.g., self-regulation, prior knowledge, tech acceptance), instructor roles (e.g., LMS competence, facilitation quality), instructional design (e.g., task-based, collaborative, project-based learning), platform functions (e.g., analytics, feedback, interaction)
RQ5	Theoretical foundations	Blended learning theory, constructivist learning theory, self-regulated learning theory, social learning theory

Quality Assessment

The MMAT was used to assess methodological quality. All 37 studies first passed two screening questions verifying research clarity and data relevance. They were then evaluated according to five criteria tailored to their methodological type (quantitative, qualitative, or mixed methods). Two reviewers independently scored the studies, resolving discrepancies by consensus.

Only studies with moderate or high methodological quality were included. One grounded theory study (Jiang & Liang, 2023) was retained despite being ineligible for standard MMAT scoring due to its strong theoretical value and rigorous design.

Coding Scheme

To systematically analyze the selected studies, a thematic coding framework was developed following the guidelines for thematic analysis outlined by Braun and Clarke (2006). The framework was structured around the five guiding RQs (RQ1-RQ5) and comprised five primary dimensions:

(1) conceptualization and implementation,

(2) effectiveness and evaluation,

(3) methodological approaches,

(4) influencing factors, and

(5) theoretical foundations.

Each study was coded manually by two researchers using a standardized matrix in Excel. Coding focused on extracting keywords, analytic categories, and evidence relevant to each dimension (**Table 2**). Inter-coder reliability was high, with 34 of 37 studies showing full agreement. The overall reliability coefficient exceeded 0.90, indicating robust consistency (Gaur & Kumar, 2018).

The finalized coding results were subsequently used to support descriptive statistics, trend analysis, and cross-dimensional comparisons, thereby ensuring the structural validity and thematic completeness of the study's conclusions.

RESULTS AND DISCUSSION

Conceptualization and Implementation

Definitions of deep learning

This review adopts Pan's (2023) classification framework to conceptualize deep learning in SPOC-based research. Within this framework, SPOC is seen as a course delivery model, while deep learning is understood either as a targeted educational outcome or as an instructional theory guiding pedagogical design (An & Qu, 2021; Pan et al., 2023).

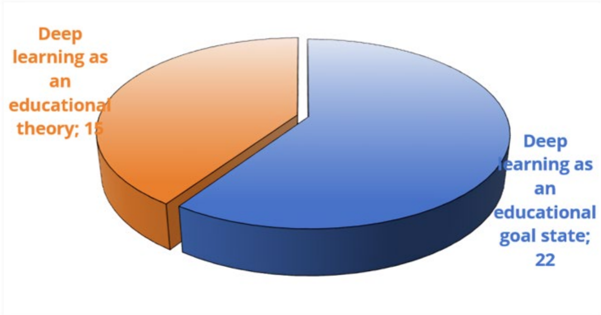

Figure 2. Deep learning in SPOC model [Developed by the authors based on the reviewed studies (2025)]

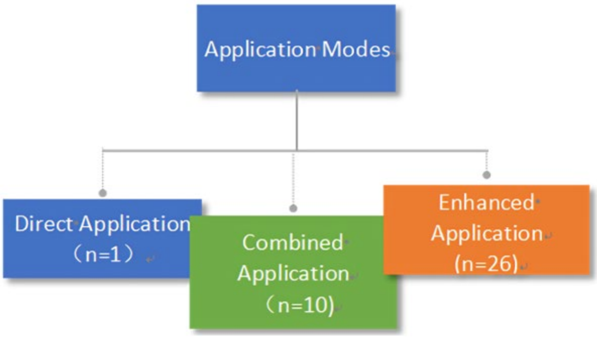

Figure 3. Application modes of SPOC [Developed by the authors based on the reviewed studies (2025)]

Among the 37 reviewed studies, 22 conceptualize deep learning as a desired competency–emphasizing higher-order thinking, self-regulation, knowledge transfer, and collaborative problem-solving (L. Jiang et al., 2024a; Li & Jiang, 2022; Yang et al., 2020). These studies report positive outcomes in engagement, motivation, academic achievement, and learner satisfaction (Geronimo et al., 2024; He, 2020; Pan et al., 2025; Xue & Dunham, 2023).

The remaining 15 studies treat deep learning as a theoretical construct that informs SPOC instructional design. They draw upon foundational models such as Marton and Säljö's (1976) surface/deep learning distinction, Bloom's (1956) taxonomy, and Jensen's (2017) deeper learning cycle. These works apply theory to guide task design, assessment, and instructional strategies aimed at enhancing learning depth (Hui, 2021; Peng & Wang, 2024; Wang, 2024; Zhu & Liu, 2024) (**Figure 2**). This dual conceptualization highlights SPOC's flexibility–serving both as a means to foster specific competencies and as a theory-driven pedagogical framework.

Application modes of SPOC

According to Pan (2023), the application of SPOC in promoting deep learning can be classified into three types: direct application, integrated application, and enhanced application (see **Figure 3**).

Direct application involves the straightforward implementation of the SPOC model in instructional practice. Among the reviewed studies, only Geronimo (2024) explicitly adopted this approach. Integrated application refers to combining SPOC with other instructional formats in teaching practice, such as "MOOC + SPOC" or "SPOC + flipped classroom" models, aiming to improve students' deep learning levels through synergy. A total of 10 studies adopted this mode (Chen, 2023; Du & Qian, 2022; Gan & Zhang, 2020; He, 2020; Li & Jiang, 2022; Sanyal et al., 2024; Teng, 2024; Wang, 2024; Xiao, 2020; Zhu & Liu, 2024).

Enhanced application represents the most common mode, employed in 26 studies. It entails the purposeful adaptation or optimization of the SPOC to support deep learning through design interventions. Examples include the integration of AI-based recommendation systems (Peng & Wang, 2024) and learning analytics (Zhang, 2024). These studies focus on refining SPOC components to maximize instructional impact and foster deep learning outcomes (Huang & Annamalai, 2024; L. Jiang et al., 2024a; Pan et al., 2025; Xue & Dunham, 2023; Zhu et al., 2023).

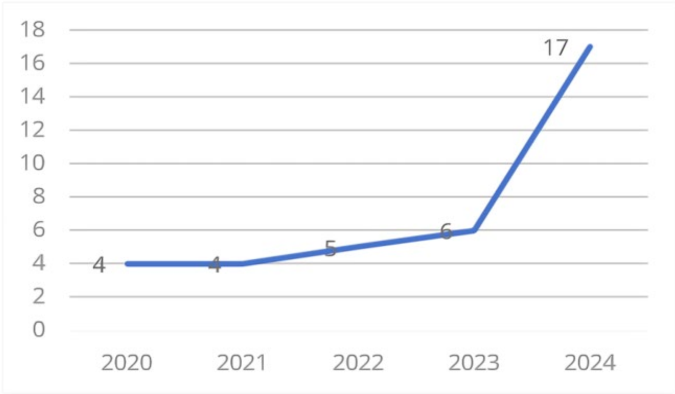

Figure 4. Number of published papers per year [Developed by the authors based on the reviewed studies (2025)]

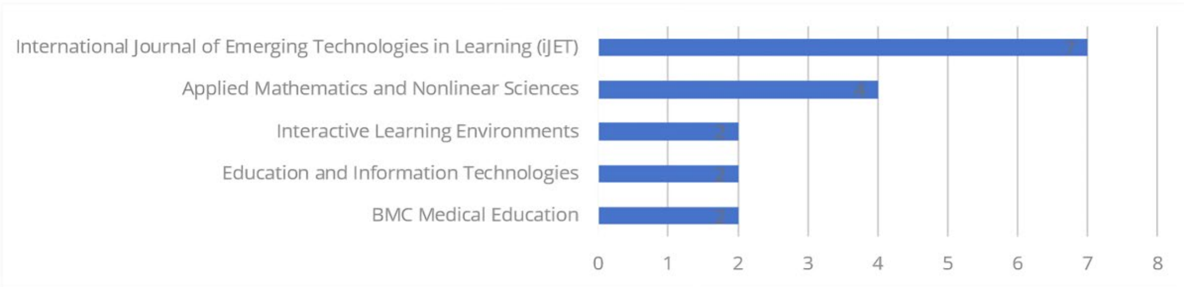

Figure 5. Journals publishing more than two articles [Developed by the authors based on the reviewed studies (2025)]

Research trends characterize

Between 2020 and 2023, SPOC-related research on deep learning remained stable with 4-6 studies annually. In 2024, however, the number surged to 17, reflecting growing scholarly interest. The publication trend of the 37 selected studies is illustrated in **Figure 4**. One 2025 study (Pan, 2025) was included as the search concluded in April 2025.

The 37 selected studies appeared across 26 journals, with *The International Journal of Emerging Technologies in Learning* contributing 7 papers and *Applied Mathematics* and *Nonlinear Sciences* publishing 4 (**Figure 5**). While research spans diverse disciplines, the majority is concentrated on educational technology and medical education, suggesting thematic consolidation.

Geographically, 34 studies were conducted in China, with provinces such as Hebei, Shaanxi, Henan, Shandong, and Guangdong prominently represented. Three international studies were from Brazil, the Netherlands, and the Philippines, indicating growing global engagement.

Most studies targeted undergraduate learners (n = 27), followed by those involving vocational college students and mixed-level cohorts (**Figure 6**), indicating that the SPOC model is predominantly applied at the foundational stages of higher education. Notably, research addressing postgraduate learners remains limited.

Language learning (18 studies, predominantly English) dominated due to SPOC's interactive nature. Additional studies focused on computer science (Teng, 2024), medical education (Jiang et al., 2025), and various other disciplines including management (Wen & Wu, 2022), education (Yan, 2024), and physical education (Zhu et al., 2023). **Figure 7** illustrates the distribution of course types among the reviewed studies, indicating an ongoing expansion of SPOC model applications across academic fields.

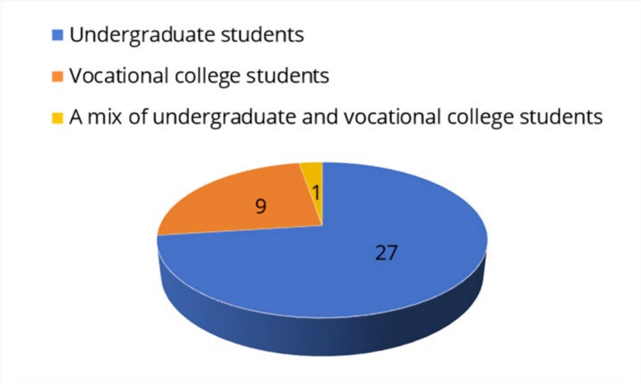

Figure 6. Distribution of participant groups in included studies [Developed by the authors based on the reviewed studies (2025)]

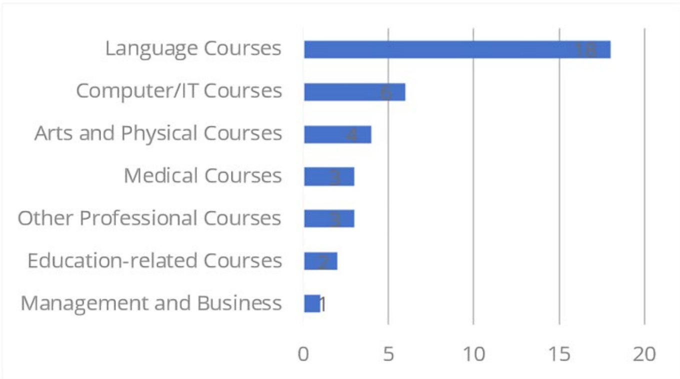

Figure 7. Distribution of course types in included studies [Developed by the authors based on the reviewed studies (2025)]

Effectiveness and Evaluation Dimensions

Impact of the SPOC model on deep learning

Analysis of 37 empirical studies demonstrates a strong consensus on the effectiveness of the SPOC model, with 35 studies reporting statistically significant improvements in deep learning outcomes. SPOCs enhance learner motivation, autonomy, cognitive development, emotional engagement, and overall satisfaction, while also promoting critical thinking, academic performance, and reflective learning practices (Huang, 2024; Jiang et al., 2025; Pan, 2025).

Evidence further indicates that SPOCs support higher-order cognitive development. Twenty-two studies reported gains in knowledge construction, problem-solving, creative thinking, and real-world application, while 18 studies highlighted improvements in self-regulated learning (SRL) facilitated by autonomous tasks, progress tracking, and multi-layered feedback (Du & Qian, 2022; He et al., 2023; Huang & Annamalai, 2024; Liu et al., 2024; Zhu & Liu, 2024). Flipped SPOC designs were particularly effective in fostering active knowledge construction (Du & Qian, 2022; Hui, 2021), as summarized in **Figure 8**.

Completion rates in SPOCs are consistently higher than those reported for MOOCs. Empirical evidence indicates that SPOC completion commonly ranges from approximately 62% to 94%, whereas MOOC completion typically remains below 15% and frequently falls into single-digit percentages (Jordan, 2015; Reich & Ruipérez-Valiente, 2019; Ruiz-Palmero et al., 2020). SPOC effectiveness, however, is contingent on implementation conditions. Reduced motivation and cognitive overload have been documented in settings characterized by limited feedback or interaction (Geronimo et al., 2024; Hamoen et al., 2022). Limitations in interaction depth, psychological burden, and scalability may further constrain the generalizability of SPOC effects across contexts (Freitas & Paredes, 2018; Pan, 2023).

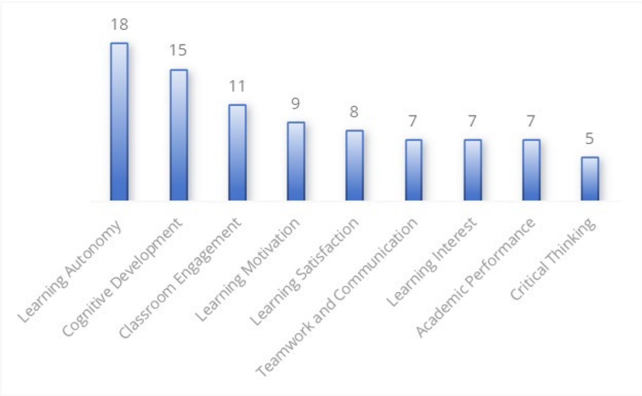

Figure 8. Frequency of deep learning-related competency in reviewed studies (≥ 5 times) [Developed by the authors based on the reviewed studies (2025)]

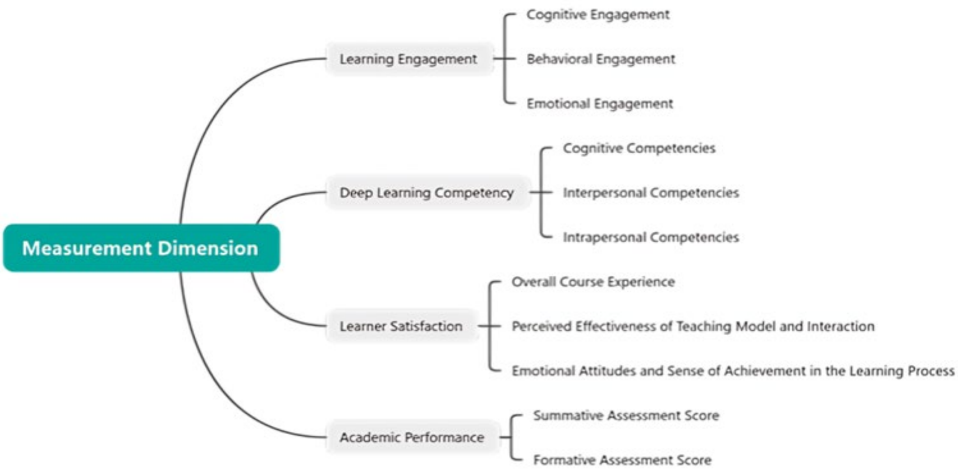

Figure 9. Measurement dimensions for deep learning outcomes [Developed by the authors based on the reviewed studies (2025)]

Dimensions for evaluating deep learning outcomes

Pan (2023) noted that evaluation standards for deep learning in SPOC contexts remain inconsistent and warrant further clarification. Based on cross-study comparisons, this review identifies four main outcome dimensions: learning engagement, deep learning competency, learner satisfaction, and academic achievement.

Learning engagement is commonly assessed using Fredricks et al.'s (2004) tripartite model. Behavioral engagement is measured through learning management systems (LMS) data such as task completion and interaction frequency (Chen et al., 2022; W. Jiang et al., 2024). Cognitive engagement focuses on metacognition and knowledge transfer, evaluated via problem-solving tasks (Gan & Zhang, 2020), while emotional engagement–covering motivation and affect–is typically measured through surveys and interviews.

Deep learning competency has gained recognition as a distinct construct. Drawing on Fullan and Langworthy's (2014) framework, it encompasses cognitive (e.g., critical thinking), interpersonal (e.g., collaboration), and intrapersonal (e.g., persistence) domains. Studies often use mixed methods to capture growth in these areas, such as Wang's (2024) cognitive focus and Hui's (2021) examination of motivational persistence. Learner satisfaction, a subjective measure, captures students' perceptions of course design and interaction quality, usually via Likert-scale instruments (; Huang & Annamalai, 2024; Pan et al., 202). Academic achievement, in contrast, reflects objective learning outcomes assessed through tests and pre/post comparisons (He, 2020; Zhao, 2024).

As illustrated in **Figure 9**, these dimensions collectively form an interconnected yet distinct evaluation framework. However, notable conceptual overlaps persist in practice–for instance, learning motivation may be classified under both emotional engagement and self-regulatory competencies, while collaborative behaviors bridge interpersonal competencies and behavioral engagement. This ambiguity underscores the necessity for researchers to prioritize theoretical coherence and discriminant validity when designing assessment instruments.

Methodological Approaches

Questionnaire survey

Questionnaire surveys are widely used to assess variables such as learners' deep learning competencies, SRL, learning satisfaction, and learning behaviors. A total of 26 studies adopted this method, demonstrating strong operability and theoretical compatibility (Jiang, 2022; Pan et al., 2023; Zhu & Liu, 2024). Most studies constructed survey dimensions based on established models such as the technology acceptance model, community of inquiry framework, expectation confirmation model, and the Kirkpatrick evaluation system, ensuring structural validity in measurement (Wang et al., 2024; Wen & Wu, 2023). These studies commonly modeled behavioral, cognitive, affective, and contextual elements in a multidimensional manner and conducted data analysis using descriptive statistics, regression analysis, factor analysis, and structural equation modeling.

Interview

The interview method was employed to explore in depth the mechanisms of deep learning, authentic learning experiences, emotional engagement, and continuous learning intention in SPOC environments (Chen et al., 2022; Jiang & Liang, 2023; L. Jiang et al., 2024b), with a total of 13 studies using this approach. Three representative studies applied the grounded theory methodology proposed by Glaser and Strauss (1967), using open coding, axial coding, and selective coding to iteratively categorize student interview texts and construct structured models of influencing factors, aiming to provide a theoretical explanation for deep learning or continued learning intention. Findings suggest that interviews offer unique advantages in uncovering cognitive, emotional, and behavioral mechanisms in real teaching settings, particularly useful for theoretical construction and process-oriented research.

Experimental design

Experimental design is one of the primary methods used in research to validate the effectiveness of instructional interventions. 24 studies adopted this method. Many of these studies employed a control group and an experimental group, using pre-test and post-test comparisons to assess changes in cognitive skills, behavioral performance, or deep learning competencies (Yang et al., 2020; Zhong & Shao, 2024). Common statistical techniques included paired-sample t-tests, ANCOVA, and regression analysis to verify the significance of intervention effects, with findings often emphasizing improvements in higher-order cognitive skills, collaborative abilities, and practical application competencies (He et al., 2023; Yan, 2024). Overall, experimental design is highly applicable for exploring the direct impact of instructional interventions on learning outcomes in SPOC-based deep learning research.

Combined approaches for comprehensive evaluation

It is noteworthy that an increasing number of studies (An & Qu, 2021; Gan & Zhang, 2020; Hui, 2021; Jin, 2024; L. Jiang et al., 2024b; Peng & Wang, 2024; Prates et al., 2023; Xiao, 2020; Xue & Dunham, 2023; Zhang, 2024) have integrated questionnaire surveys with experimental designs to enhance causal inference and interpret students' subjective perceptions (L. Jiang et al., 2024b; Zhang, 2024). These studies typically include control and experimental groups before and after the intervention, quantitatively evaluating changes in learners' cognitive mastery, learning satisfaction, and motivational engagement. Structured questionnaires are also used to collect learners' subjective evaluations of cognition, motivation, and experience in SPOC teaching, thereby achieving multidimensional measurement of deep learning outcomes (Hui, 2021; Jin, 2024).

Critical Influencing Factors

Learner

Individual learner characteristics serve as the internal foundation for deep learning. Four core factors–SRL, intrinsic motivation, learning strategies, and reflective thinking–are repeatedly emphasized in the literature. Learners with strong self-regulation and internal motivation tend to engage more actively in cognitive and reflective tasks, thereby enhancing knowledge construction and transfer (Geronimo et al., 2024; L. Jiang et al., 2024b; Yang et al., 2020). Metacognitive strategies, goal-directed behaviors, and critical reflection further promote cognitive depth and support the transition from surface reception to deep comprehension (An & Qu, 2021; Sanyal et al., 2024; Yan, 2023; Zhu & Liu, 2024). In addition, prior knowledge provides cognitive scaffolding that facilitates understanding and application of new concepts (L. Jiang et al., 2024b; Prates et al., 2023). Learners' technology acceptance–reflected in their familiarity with and trust in SPOC platforms–also plays a pivotal role by enhancing participation, satisfaction, and self-directed learning, ultimately improving engagement and critical thinking outcomes (Onjewu et al., 2022; Wen & Wu, 2022).

Instructor

In the SPOC model, instructors go beyond traditional roles and assume multi-layered responsibilities in both online and offline settings (Pan, 2023). They must coordinate curriculum structure, content planning, and teaching pacing while organizing video materials, learning tasks, assessment tests, and interaction mechanisms (Chen et al., 2022; Yan, 2024). Instructional guidance directly influences students' engagement, achievement motivation, and emotional investment (Chen et al., 2022; Geronimo et al., 2024). Additionally, instructors' proficiency with LMS and digital platforms enhances course resource integration, interactive design, and assessment mechanisms, improving instructional precision and adaptability (Geronimo et al., 2024). Studies widely agree that instructional preparedness, subject-matter expertise, and digital literacy determine the overall quality of SPOC instruction and directly affect deep learning outcomes (Sanyal et al., 2024; Yuan, 2024). Therefore, building systematic and sustainable instructor training programs to enhance pedagogical capacity in blended learning environments is a key guarantee for promoting deep learning (Yan, 2023; Zhong & Shao, 2024).

Instructional design

The systematicity and rationality of instructional design are essential for achieving deep engagement and higher-order cognition. Numerous studies highlight the "three-stage instructional design" in SPOC–pre-class autonomous learning, in-class collaborative inquiry, and post-class reflective integration–as highly effective in stimulating cognitive participation (Chen & Ma, 2023; Huang et al., 2024).Specifically, task-based learning uses contextualized and goal-driven tasks to guide students through problem-solving processes, promoting knowledge construction and transfer (Gan & Zhang, 2020; Wang, 2024).Collaborative learning relies on role division, peer review, and group reflection to foster responsibility and social interaction, thus enhancing communication and teamwork skills (Xiao, 2020; Yang et al., 2020). Project-based learning, driven by real-world tasks, emphasizes the application of knowledge in complex situations, boosting students' problem-solving abilities and overall competence (Wang, 2024). These strategies collectively help build deep learning environments centered on "cognitive development + social interaction."

Technological platform

As a key support system in the SPOC model, the technological platform influences deep learning primarily through its interaction mechanisms, feedback systems, learning analytics, and level of intelligence. First, platform interactivity and feedback mechanisms enhance teacher-student communication, peer collaboration, and real-time correction, thereby increasing learning motivation and cognitive engagement (Wang, 2024; Wang et al., 2021). Personalized feedback systems not only strengthen self-regulation but also facilitate deep knowledge construction. Second, learning analytics and intelligent features enable dynamic monitoring and personalized content delivery. Teachers can adjust instructional strategies in real time based on learners' behavioral data and learning trajectories, achieving flexible pacing and differentiated instruction (Peng & Wang, 2024; Yan, 2024). Jin (2024) emphasized that the "data-driven + intelligent feedback" model

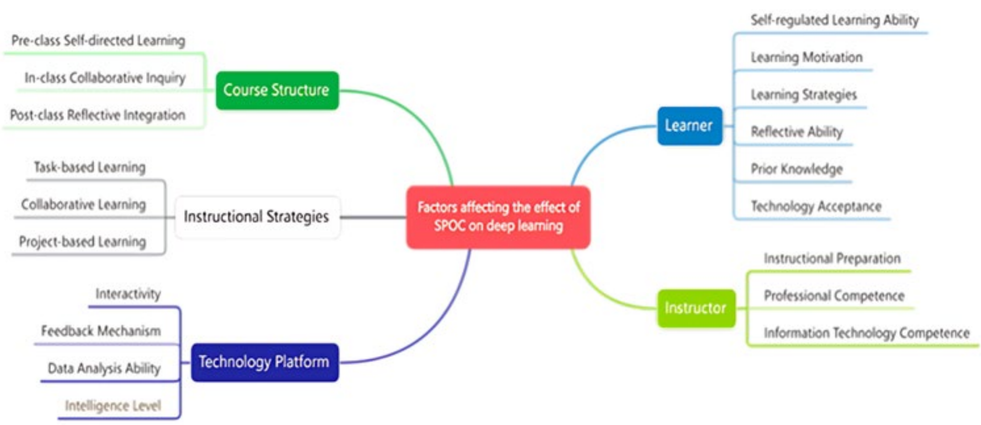

Figure 10. Factors affecting the effect of SPOC on deep learning [Developed by the authors based on the reviewed studies (2025)]

supports a learning ecology characterized by sustained reflection, deep engagement, and precise intervention.

As illustrated in **Figure 10**, the factors influencing SPOC's impact on deep learning form a multi-dimensional, interactive system. The effectiveness of SPOC is not solely determined by the platform or the teaching model itself, but rather by the synergy among learner characteristics, teacher support, curriculum design, and technological environment.

Theoretical Foundations

Blended learning theory

Blended learning theory (Graham, 2006) serves as a foundational framework in SPOC-related research, advocating for the seamless integration of online autonomous learning and offline interactive instruction to enhance pedagogical efficiency (He et al., 2023; L. Jiang et al., 2024b). The SPOC model represents a refined blended learning format, characterized by small cohorts, structured content, and strong personalization. It combines the scalability of MOOCs with the contextual richness of classroom teaching (L. Jiang et al., 2024b). Distinct from traditional blended formats, SPOCs emphasize sustained teacher-student interaction and integrated digital resources (Liu et al., 2024). Empirical studies commonly identify a three-phase instructional sequence: pre-class preparation via video content and guided reading, in-class collaborative inquiry and feedback, and post-class consolidation through quizzes and reflective tasks (He et al., 2023; Peng & Wang, 2024). This structure supports the transition from surface-level information reception to deep cognitive engagement (Jin, 2024).

Constructivist learning theory

Constructivism (Jonassen, 1999; Vygotsky, 1978) emphasizes that learners actively build knowledge in authentic contexts through social interaction. Within SPOCs, instructors shift from content transmitters to facilitators, while learners assume agency in meaning-making (He et al., 2023; Liu et al., 2024). SPOC environments are designed to align with constructivist principles, providing learners with contextualized, interactive, and self-directed learning spaces. Studies highlight the role of platform tools–such as discussion forums, peer review, and real-time feedback–in supporting collaborative inquiry and personalized learning pathways (Chen, 2024; Yang et al., 2021). Additionally, task-driven activities, project-based learning, and role-playing reinforce constructivist practices by promoting engagement with real-world problems (Wen & Wu, 2022; Zheng et al., 2021). These strategies are embedded throughout resource organization and task design, offering a robust foundation for fostering deep learning (Liang, 2021; Shi & Liang, 2021).

Self-regulated learning theory

SRL theory (Zimmerman, 2000) describes learning as a cyclical process involving planning, monitoring, strategy adjustment, and reflection. The structured, autonomous nature of SPOCs is well-aligned with SRL, as

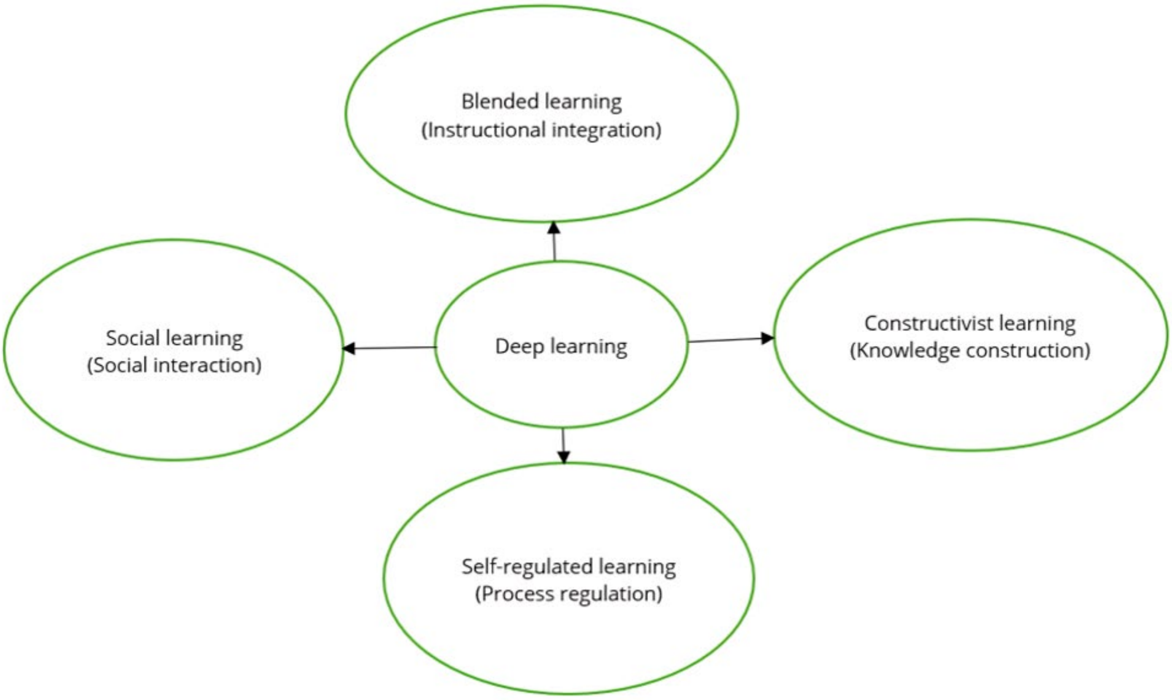

Figure 11. Theoretical foundations of deep learning in the SPOC model [Developed by the authors based on the reviewed studies (2025)]

students manage their learning progress across the pre-, during-, and post-class phases. Empirical studies indicate that features such as progress tracking, learning logs, and adaptive feedback mechanisms promote metacognitive awareness and persistence (Chen, 2024; Wen & Wu, 2022). Interventions by Liang (2021) and Shi and Liang (2021) in language courses demonstrated that phased tasks and reflection prompts significantly enhanced learners' autonomy and academic resilience. Giustini (2021) further validated that SRL strategies integrated into SPOC environments improved students' self-efficacy and achievement.

Social learning theory

Social learning theory (SLT) (Bandura, 1977) posits that learning is inherently social and occurs through observation, imitation, and feedback. In SPOC models, peer interaction, collaborative tasks, and instructor modeling constitute core mechanisms for behavior and knowledge acquisition. Jiang and Liang (2023) proposed a social influence model demonstrating that timely teacher feedback and peer support enhance learners' sustained engagement. Li and Li (2015) emphasized the value of integrating discussion forums, group activities, and peer assessments into SPOC designs to promote shared understanding and collective reflection. Tan et al. (2020) found that socially constructed evaluation tools–such as collaborative writing and peer review–significantly improved student motivation, aligning with SLT's emphasis on reciprocal learning cycles.

In conclusion, blended learning theory emphasizes instructional integration, constructivism highlights active knowledge construction, SRL focuses on self-management of the learning process, and SLT underscores the role of social interaction. Together, these theories form the cognitive scaffolding and design logic for enabling deep learning in the SPOC model, as illustrated in **Figure 11**.

CONCLUSION, LIMITATIONS, AND FUTURE DIRECTIONS

Conclusion

This study conducted an SLR of 37 empirical studies published between 2020 and 2025, focusing on the application of the SPOC model in promoting deep learning. Among them, 22 studies conceptualized deep learning as a targeted educational outcome, and the most frequently adopted instructional approach was the enhanced application mode of SPOC (26 studies). Moreover, this review comprehensively synthesized research trends and characteristics, evaluation dimensions, methodological approaches, influencing factors, and theoretical foundations concerning deep learning within the SPOC framework.

Since 2024, the field has witnessed a significant surge in scholarly attention, with most studies published in journals related to educational technology and medical education. The majority of the research focused on undergraduate students in China, particularly in disciplines such as English, computer science, and medical education, indicating a dual trend of subject expansion and practice deepening. Methodologically, survey-based studies, experimental designs, and interviews were predominant, with several high-quality studies employing mixed-methods approaches to strengthen causal inferences (L. Jiang et al., 2024b; Peng & Wang, 2024).

The findings suggest that the SPOC model exerts a consistently positive impact on deep learning, particularly in enhancing higher-order cognitive skills, learner autonomy, and multidimensional engagement. Core evaluation constructs included knowledge construction, reflective thinking, collaboration, and SRL (Du & Qian, 2022; Pan, 2023), alongside increasing attention to affective engagement and learner satisfaction (Huang & Annamalai, 2024). Notably, courses integrating task-based learning, collaborative inquiry, and contextualized instructional design demonstrated the most significant learning outcomes (Chen et al., 2022; Gan & Zhang, 2020).

This review also identified four key categories of factors influencing the effectiveness of deep learning:

(1) learner-level factors, including autonomy, prior knowledge, and technology acceptance;

(2) instructor-level factors, such as pedagogical design skills, platform proficiency, and feedback capacity (Geronimo et al., 2024);

(3) instructional design, with the three-stage blended learning model (pre-class preparation, in-class inquiry, post-class consolidation) consistently validated as optimal (Huang, Zhang & Wu, 2024); and

(4) technological infrastructure, where interactive mechanisms, intelligent feedback systems, and learning analytics significantly enhanced learner motivation and cognitive engagement (Jin, 2024; Peng & Wang, 2024).

Theoretically, this review identified four dominant educational frameworks supporting current SPOC research: blended learning theory, which emphasizes the integration of online and offline instructional resources (L. Jiang et al., 2024b); constructivist theory, which highlights knowledge construction through contextual interaction (Liu et al., 2024); SRL theory, which focuses on learners' autonomous monitoring and goal regulation (Zimmerman, 2000); and social learning theory, which explains learning through observation, imitation, and feedback in social contexts (Jiang & Liang, 2023). Together, these theories form the cognitive scaffolding and instructional logic through which the SPOC model supports deep learning.

Despite these promising findings, several challenges remain. Hamoen (2022) and Geronimo (2024) demonstrate an overreliance on platform technologies, without adequately accounting for the essential role of instructor facilitation and instructional adaptability, which may result in low engagement or limited interaction.

Limitations and Future Research Directions

This study has several limitations due to methodological and scope constraints. First, the literature review was restricted to specific databases and a defined publication period (2020-2025). As such, relevant studies published in other databases or timeframes were excluded, which may limit the comprehensiveness of the review and result in the omission of valuable insights. Second, among the 37 empirical studies analyzed, the vast majority focused on undergraduate and vocational college students in China. Very few addressed postgraduate learners or adult education populations, thereby limiting the generalizability of the findings across educational levels and international contexts. Third, no standardized framework currently exists for assessing deep learning in SPOC-based environments. Dimensions such as cognition, emotion, behavior, and self-regulation often overlap, and operational definitions vary widely. Many studies lacked consistent reporting of reliability and validity, making cross-study comparison and synthesis more difficult.

To address these limitations, future research should expand the temporal and geographical scope of literature selection, incorporating empirical studies from more diverse educational systems and learner populations. Cross-national comparative studies are particularly recommended to examine the adaptability and effectiveness of SPOC models across cultural and institutional contexts. Moreover, researchers should work toward developing standardized and structured assessment instruments for deep learning in SPOC settings. These tools should clearly differentiate between cognitive, emotional, behavioral, and self-regulatory dimensions, while integrating data from learning management systems (e.g., activity logs, feedback interactions) to enhance objectivity, reliability, and validity. Ultimately, advancing this research field requires a dual focus on theoretical development and practical implementation–building models that not only explain learning mechanisms but also inform evidence-based instructional design and policy in technology-enhanced education.

Author contributions: **LY:** conceptualization, methodology, formal analysis, investigation, data curation: writing – original draft; **NBMN:** supervision, validation, writing – review & editing; **MHBN:** supervision, validation, writing – review & editing; **ZS:** writing – review & editing. All authors approved the final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Ethics declaration: This study is a systematic literature review based exclusively on previously published studies and does not involve human participants, human data, or animal subjects. Therefore, ethical approval and informed consent were not required for this research.

AI statement: Generative AI (ChatGPT, OpenAI) was used solely for language editing and improving clarity of expression. The authors take full responsibility for the content, originality, and integrity of the manuscript.

Declaration of interest: The authors declared no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

An, X., & Qu, C. (2021). A hierarchical learning model based on deep learning and its application in a SPOC and flipped classroom. *International Journal of Emerging Technologies in Learning, 16*(9), 76-93. https://doi.org/10.3991/ijet.v16i09.23009

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Chen, J., & Singh, C. K. S. (2024). A systematic review on deep learning in education: Concepts, factors, models and measurements. *Journal of Education and Educational Research, 7*(1), 125-129. https://doi.org/10.54097/gzk2yd38

Chen, M., Ye, L., & Weng, Y. (2022). Blended teaching of medical ethics during COVID-19: Practice and reflection. *BMC Medical Education, 22*(1), Article 361. https://doi.org/10.1186/s12909-022-03431-6

Du, M., & Qian, Y. (2022). Application of massive open online course to grammar teaching for English majors based on deep learning. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.755043

Freitas, A., & Paredes, J. (2018). Understanding the faculty perspectives influencing their innovative practices in MOOCs/SPOCs: A case study. *International Journal of Educational Technology in Higher Education, 15*(1), Article 5. https://doi.org/10.1186/s41239-017-0086-6

Gan, B., & Zhang, C. (2020). Research on mixed teaching mode of deep learning based on MOOC+SPOC environment. In *Proceedings of the 2020 International Conference on Big Data and Informatization Education* (pp. 263-266). IEEE. https://doi.org/10.1109/ICBDIE50010.2020.00067

Geronimo, C. A., Adriano, R. C., & Celestino, J. R. F. (2024). Learnings, issues, and challenges encountered by students and faculty members in the implementation of small private online courses (SPOCs). *International Journal of Multidisciplinary: Applied Business and Education Research, 5*(2), 696-710. https://doi.org/10.11594/ijmaber.05.02.28

Gudoniene, D., Staneviciene, E., Huet, I., Dickel, J., Dieng, D., Degroote, J., Rociao, V., Butkiene, R., & Casanova, D. (2025). Hybrid teaching and learning in higher education: A systematic literature review. *Sustainability, 17*(2), Article 756. https://doi.org/10.3390/su17020756

Hamoen, E. C., De Jong, P. G. M., Van Blankenstein, F. M., & Reinders, M. E. J. (2022). Design and first impressions of a small private online course in clinical workplace learning: Questionnaire and interview study. *JMIR Medical Education, 8*(2), Article e29624. https://doi.org/10.2196/29624

He, J. (2020). Construction of “three-stage asynchronous” instructional mode of blended flipped classroom based on mobile learning platform. *Education and Information Technologies, 25*(6), 4915-4936. https://doi.org/10.1007/s10639-020-10200-9

He, J., Ma, T., & Zhang, Y. (2023). Design of blended learning mode and practice community using intelligent cloud teaching. *Education and Information Technologies, 28*, 10593-10615. https://doi.org/10.1007/s10639-023-11606-x

Huang, R., & Annamalai, N. (2024). Seeking the optimal SPOC-based blended learning approach to enhance deep learning from the community of inquiry perspective. *Contemporary Educational Technology, 16*(4), Article ep537. https://doi.org/10.30935/cedtech/15574

Hui, Y. (2021). Evaluation of blended oral English teaching based on the mixed model of SPOC and deep learning. *Scientific Programming, 2021*(1), 1-9. https://doi.org/10.1155/2021/7044779

Jiang, L., & Liang, X. (2023). Influencing factors of Chinese EFL students’ continuance learning intention in SPOC-based blended learning environment. *Education and Information Technologies, 28*, 13379-13404. https://doi.org/10.1007/s10639-023-11734-4

Jiang, L., Chen, X., & Huang, L. (2024a). An empirical study of factors influencing deep learning among vocational college English learners based on SPOC. In A. J. Tallón-Ballesteros (Ed.), *Modern management based on big data V* (pp. 565-572). IOS Press. https://doi.org/10.3233/FAIA240293

Jiang, L., Lv, M., Cheng, M., & Chen, X. (2025). Design and implementation effects of SPOC-based blended teaching from the perspective of deep teaching: A case study of EFL students. *Innovations in Education and Teaching International, 62*(3), 986-1000. https://doi.org/10.1080/14703297.2024.2350519

Jiang, L., Lv, M., Cheng, M., Chen, X., & Peng, C. (2024b). Factors affecting deep learning of EFL students in higher vocational colleges under small private online courses-based settings: A grounded theory approach. *Journal of Computer Assisted Learning, 40*(6), 3098-3110. https://doi.org/10.1111/jcal.13060

Jiang, W., Zhan, Y., Sun, D., Sun, J., & Tian, P. (2024). Exploring the effects of SPOC-based blended learning on students’ learning performance at higher vocational education. *Interactive Learning Environments, 32*(10), 6949-6966. https://doi.org/10.1080/10494820.2023.2294774

Jordan, K. (2015). Massive open online course completion rates revisited: Assessment, length and attrition. *The International Review of Research in Open and Distributed Learning, 16*(3), 341-358. https://doi.org/10.19173/irrodl.v16i3.2112

Li, Z., & Jiang, W. (2022). Research on the teaching reform of inorganic chemistry based on SPOC and FCM during COVID-19. *Sustainability, 14*(9), Article 5707. https://doi.org/10.3390/su14095707

Liu, R., Chai, Y., & Wei, X. (2024). Engaging student engagement in blended learning environments through integration of small private online courses. In *Proceedings of the 2024 International Symposium on Educational Technology* (pp. 274-278). IEEE. https://doi.org/10.1109/ISET61814.2024.00061

Luo, R. Z., & Zhou, Y. L. (2024). The effectiveness of self-regulated learning strategies in higher education blended learning: A five years systematic review. *Journal of Computer Assisted Learning, 40*(6), 3005-3029. https://doi.org/10.1111/jcal.13052

McCarthy, S., & Palmer, E. (2023). Defining an effective approach to blended learning in higher education: A systematic review. *Australasian Journal of Educational Technology, 39*(2), 98-114. https://doi.org/10.14742/ajet.8489

Pan, B., Latada, F. B., Bin Mohamad, A. M., & Yubo, S. (2025). Factors influencing speaking proficiency improvement in EFL students under SPOC-based blended learning. *Journal of Curriculum and Teaching, 14*(1), 314-324. https://doi.org/10.5430/jct.v14n1p314

Peng, P., & Wang, J. (2024). SPOC flipped classroom blended teaching reform practices in the context of digital transformation. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns-2024-0490

Prates, J. M., Melo, S. M., Dias Valle, P. H., Garcia, R. E., & Maldonado, J. C. (2023). Integrating SPOCs in software testing education: Evidence in emergency remote courses. *Informatics in Education, 22*(1), 121-139. https://doi.org/10.15388/infedu.2023.08

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education, 144*, Article 103701. https://doi.org/10.1016/j.compedu.2019.103701

Reich, J., & Ruipérez-Valiente, J. A. (2019). The MOOC pivot. *Science, 363*(6423), 130-131. https://doi.org/10.1126/science.aav7958

Ruiz-Palmero, J., Fernández-Lacorte, J.-M., Sánchez-Rivas, E., & Colomo-Magaña, E. (2020). The implementation of Small Private Online Courses (SPOC) as a new approach to education. *International Journal of Educational Technology in Higher Education, 17*, Article 27. https://doi.org/10.1186/s41239-020-00206-1

Sanyal, K., Sri, S. S., Gupta, S., Sonawane, D. A., Divetia, K., & Sahoo, D. R. (2024). Delving into reverse active learning approaches for IT-English education integrated with IoT. In *Proceedings of the 2024 International Conference on Advances in Computing, Communication and Applied Informatics* (pp. 422-424). IEEE. https://doi.org/10.1109/ACCAI61061.2024.10602074

Shaheen, N., Shaheen, A., Ramdan, A., Hefnawy, M. T., Ramadan, A., Ibrahim, I. A., Hassanein, M. E., Ashour, M. E., & Flouty, O. (2023). Appraising systematic reviews: A comprehensive guide to ensuring validity and reliability. *Frontiers in Research Metrics and Analytics, 8*. https://doi.org/10.3389/frma.2023.1268045

Smela, B., Toumi, M., Swierk, K., Gawlik, K., Clay, E., & Boyer, L. (2023). Systematic literature reviews over the years. *Journal of Market Access & Health Policy, 11*(1), Article 2244305. https://doi.org/10.1080/20016689.2023.2244305

Teng, Y. (2024). Methods of improving and optimizing English education level in higher vocational colleges under the background of big data. *International Journal of e-Collaboration, 20*(1). https://doi.org/10.4018/IJeC.345239

Wang, M. (2024). Construction and practice of a blended teaching model based on MOOC+SPOC+Flipped classroom. *MATEC Web of Conferences, 395*, Article 01039. https://doi.org/10.1051/matecconf/202439501039

Wang, S., Xu, X., Li, F., Fan, H., Zhao, E., & Bai, J. (2021). Effects of modified BOPPPS-based SPOC and Flipped class on 5th-year undergraduate oral histopathology learning in China during COVID-19. *BMC Medical Education, 21*, Article 540. https://doi.org/10.1186/s12909-021-02980-6

Wen, D., & Wu, X. (2022). Influence of SPOC classroom teaching on e-learning satisfaction. *International Journal of Emerging Technologies in Learning, 17*(12), 16-28. https://doi.org/10.3991/ijet.v17i12.31761

Xiao, X. (2020). The diversified teaching reform of the mixed flipped classroom Python Foundation course is aimed at deep learning. *E3S Web of Conferences, 218*, Article 02001. https://doi.org/10.1051/e3sconf/202021802001

Xue, X., & Dunham, R. E. (2023). Using a SPOC-based flipped classroom instructional mode to teach English pronunciation. *Computer Assisted Language Learning, 36*(7), 1309-1337. https://doi.org/10.1080/09588221.2021.1980404

Yan, D. (2023). Design and application of SPOC hybrid teaching for college basketball teaching based on artificial intelligence technology. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns.2023.2.01578

Yang, Y., Li, H., & Liu, S. (2020). Exploring cooperative learning in programming SPOC. In *Proceedings of the 2020 4th International Conference on Deep Learning Technologies* (pp. 44-48). ACM. https://doi.org/10.1145/3417188.3417203

Yu, L., Zhang, N., & Zhang, Y. (2023). Multilevel Analysis of the effects of participation, peer support, SRL and course disciplines on academic performance in SPOCs. *Interactive Learning Environments, 31*(7), 4507-4520. https://doi.org/10.1080/10494820.2021.1974053

Zhang, C. (2021). Research on the SPOC teaching model from the perspective of deep learning: A third language course as an example. In *Proceedings of the 2021 International Conference on Education, Information Management and Service Science* (pp. 292-296). IEEE. https://doi.org/10.1109/EIMSS53851.2021.00070

Zhang, H. (2024). The application of SPOC teaching model in Japanese language teaching. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns-2024-1144

Zhong, Y., & Shao, Z. (2024). Application of SPOCs-based blended teaching into explicit instruction on syntactically complex constituents. In *Proceedings of the 2024 12th International Conference on Information and Education Technology* (pp. 274-279). IEEE. https://doi.org/10.1109/ICIET60671.2024.10542818

APPENDIX A

Table A1. MMAT assessment summary

No	Study title	RT	Overall judgment
1	An empirical study of factors influencing deep learning among vocational college English learners based on SPOC	QDES	High
2	Factors influencing speaking proficiency improvement in EFL students under SPOC-based blended learning	QDES	High
3	Factors affecting deep learning of EFL students in higher vocational colleges under small private online courses-based settings: A grounded theory approach	QUAL	High
4	Seeking the optimal SPOC-based blended learning approach to enhance deep learning from the community of inquiry perspective	MM	High
5	Delving into reverse active learning approaches for IT-English education integrated with IoT	QNRS	Moderate
6	Methods of improving and optimizing English education level in higher vocational colleges under the background of big data	QNRS	Moderate
7	Design and implementation effects of SPOC-based blended teaching from the perspective of deep teaching: A case study of EFL students	QNRS	High
8	The application of SPOC teaching model in Japanese language teaching	QNRS	High
9	Engaging student engagement in blended learning environments through integration of small private online courses	MM	High
10	Construction and application of university English smart classroom teaching model based on deep learning	RCT	Moderate-to-high
11	Application of SPOCs-based blended teaching into explicit instruction on syntactically complex constituents	QNRS	Moderate
12	Design and application of SPOC hybrid teaching for college basketball teaching based on artificial intelligence technology	QNRS	Moderate
13	SPOC flipped classroom blended teaching reform practices in the context of digital transformation	QNRS	Moderate
14	Design of teaching mode and evaluation method of effect of art design course from the perspective of big data	QNRS	Moderate
15	Design of blended learning mode and practice community using intelligent cloud teaching	RCT	Moderate-to-high
16	Analysis of students' online learning engagement during the COVID-19 pandemic: A case study of a SPOC-based geography education undergraduate course	QNRS	Moderate
17	Exploring the effects of SPOC-based blended learning on students' learning performance at higher vocational education	QNRS	High
18	Blended teaching of medical ethics during COVID-19: Practice and reflection	QUAL	High
19	Multilevel analysis of the effects of participation, peer support, SRL and course disciplines on academic performance in SPOCs	QNRS	High
20	Integrating SPOCs in software testing education: Evidence in emergency remote courses	RCT	Moderate-to-high
21	Design and first impressions of a small private online course in clinical workplace learning: Questionnaire and interview study	MM	High
22	Research on the teaching reform of inorganic chemistry based on SPOC and FCM during COVID-19	MM	High
23	Application of massive open online course to grammar teaching for English majors based on deep learning	QNRS	Moderate
24	Evaluation of blended oral English teaching based on the mixed model of SPOC and deep learning	QNRS	High
25	Effects of modified BOPPPS-based SPOC and flipped class on 5th-year undergraduate oral histopathology learning in China during COVID-19	QNRS	Moderate-to-high
26	Exploring cooperative learning in programming SPOC	QNRS	Moderate-to-high
27	A diversified teaching reform of the mixed flipped classroom python foundation course is aimed at deep learning	QDED	Moderate-to-high
28	A hierarchical learning model based on deep learning and its application in a SPOC and flipped classroom	MM	High
29	Research on mixed teaching mode of deep learning based on MOOC+SPOC environment	QNRS	Moderate-to-high
30	Construction of "three-stage asynchronous" instructional mode of blended flipped classroom based on mobile learning platform	MM	High
31	Learnings, issues, and challenges encountered by students and faculty members in the implementation of small private online courses (SPOCs)	MM	Moderate-to-high
32	Construction and practice of a blended teaching model based on MOOC + SPOC + flipped classroom	QDED	Moderate
33	Information security construction of SPOC: Path selection for Japanese information acquisition	QNRS	High
34	Using a SPOC-based flipped classroom instructional mode to teach English pronunciation	QNRS	High
35	Influence of SPOC classroom teaching mode design on e-learning satisfaction	MM	High
36	Influencing factors of Chinese EFL students' continuance learning intention in SPOC-based blended learning environment	This qualitative study on grounded theory does not fall under the five MMAT categories	
37	Influencing factors of the blended teaching effect of SPOCs: A comprehensive evaluation technology based on the Kirkpatrick model and interpretive structural modeling	QNRS	High

Note. QUAL: Qualitative research; RCT: Randomized controlled trials (quantitative); QNRS: Non-randomized studies (quantitative); QDES: Descriptive studies (quantitative); MM: Mixed methods studies; RT: research type; Q1 refers to the clarity of research questions; Q2 assesses whether the data collected are adequate to address those questions—both must be answered 'yes' to proceed with the full MMAT appraisal; C1-C5 represent the five methodological quality criteria defined by MMAT (2018); Results are coded as Y: Yes, N: No, and CT: Can't tell

APPENDIX B

Table B1. Methods used to evaluate SPOCs' effectiveness for deep learning

No	Questionnaire	Interview	Experiment (control group)	Experiment (pre-/post-test)
1	✓			
2	✓			
3		✓		
4	✓	✓		
5			✓	
6			✓	
7	✓		✓	
8	✓		✓	
9	✓	✓		✓
10	✓		✓	
11				✓
12			✓	
13	✓		✓	
14			✓	
15			✓	
16	✓			
17		✓	✓	
18		✓		
19	✓			
20	✓			✓
21	✓	✓		
22	✓	✓	✓	
23	✓	✓	✓	
24	✓		✓	
25	✓	✓	✓	
26			✓	
27	✓		✓	
28	✓		✓	
29	✓		✓	
30	✓	✓	✓	
31	✓	✓		
32	✓			
33	✓	✓	✓	
34	✓		✓	
35	✓			
36		✓		
37	✓			
Total	26	13	21	3

Note. ✓ indicates that the respective method was used in the corresponding study and study numbers correspond to those listed in **Appendix A**

◆❖◆