

## MICRO-LEARNING ACTIVITIES TO SUPPORT COGNITIVE TRANSFER IN HIGH-LOAD LEARNING CONDITIONS

R. Bărbulescu

*Bucharest University of Economic Studies (ROMANIA)*

V.A. Enăchescu

*Bucharest University of Economic Studies (ROMANIA)*

**Abstract:** As higher education increasingly addresses complex and interdisciplinary knowledge, students are frequently required to process substantial amounts of information within limited timeframes. Such high-load learning conditions may constrain knowledge retention and the transfer of learning to new contexts. This paper examines micro-learning as an instructional strategy for managing cognitive demands while strengthening retrieval, application, and transfer. Rather than replacing comprehensive instruction, micro-learning is conceptualized as a sequence of short, focused interventions strategically inserted before, during, and after complex learning episodes.

The study adopts a structured conceptual analysis informed by recent literature on cognitive load theory, retrieval practice, active learning, spacing, and instructional design. The analysis examines how established cognitive and pedagogical principles can inform the timing, duration, purpose, and sequencing of micro-learning interventions. Concepts were comparatively synthesized to identify design principles that reduce unnecessary processing demands while maintaining opportunities for active retrieval, reflection, and application. As a conceptual study, the paper does not test intervention effectiveness empirically but translates theoretical mechanisms into an actionable instructional framework.

The analysis results in a Micro-Learning for Cognitive Transfer Framework organized around four design components: activation, consolidation, application, and transfer. Activation occurs immediately before complex instruction through 2–3-minute prior-knowledge prompts, prediction questions, or concept-recall tasks. Consolidation is inserted during instruction at natural transition points through 3–5-minute retrieval questions, concept summaries, or misconception checks. Application follows major learning segments and uses 5–7-minute worked-example completion, short problem-solving tasks, or scenario-based decisions requiring learners to apply newly acquired knowledge. Transfer occurs after instruction, typically through 5–10-minute delayed activities in which students apply principles to unfamiliar cases, compare alternative solutions, or explain how knowledge can be used in a different context. Immediate or brief corrective feedback accompanies each stage where appropriate.

The framework suggests that the effectiveness of micro-learning depends less on simply shortening content than on where, when, and why short activities are embedded within the learning sequence. It guides educators in selecting intervention timing, cognitive purpose, activity type, feedback, and task complexity across face-to-face, blended, and online environments. The paper contributes an operational approach to learner-centred instructional design by connecting cognitive principles with concrete micro-level teaching decisions. Future empirical research should test the proposed sequence across disciplines and compare its effects on retention, transfer, cognitive load, and learner engagement.

**Keywords:** Retrieval practice; Instructional design; Knowledge retention; Spaced practice; Learner engagement

### 1 INTRODUCTION

Higher education increasingly requires students to engage with dense, interdisciplinary, and rapidly evolving bodies of knowledge while simultaneously developing the capacity to interpret, apply, and transfer that knowledge beyond the immediate instructional context. This combination creates a fundamental instructional challenge. The availability of information has expanded considerably, yet the cognitive resources through which learners process new material remain constrained. When complex concepts, unfamiliar terminology, multiple representations, and problem-solving demands are

introduced within compressed learning periods, instructional intensity may exceed the learner's capacity to integrate new information meaningfully. Under such conditions, successful teaching cannot be understood simply as the efficient delivery of content; it requires deliberate management of when information is introduced, when learners are required to retrieve it, and when they are asked to apply it in progressively less familiar situations. This distinction is particularly important because immediate comprehension does not necessarily indicate durable learning, and successful performance within the original instructional setting does not itself demonstrate that knowledge can be transferred to a different problem or context.

Micro-learning has emerged as one response to this challenge, particularly in digitally mediated and flexible learning environments. Its defining pedagogical value, however, should not be reduced to the brevity of instructional materials. Research on the integration of micro-learning into established e-learning environments indicates that short learning units can be incorporated within broader instructional architectures rather than treated as substitutes for comprehensive courses [1]. Similarly, experimental and practice-oriented applications have associated micro-learning with opportunities to restructure learning into focused and accessible episodes [2], while evidence from online higher education suggests that micro-learning designs can support student engagement when they are purposefully integrated into course organization [3]. More recent systematic work has reinforced the importance of design and structuring decisions, demonstrating that micro-learning is better understood as an instructional design approach than as a particular media format or predetermined duration [4]. Consequently, the educational question is not whether learning should simply be made shorter, but whether brief interventions can be positioned within longer learning sequences so that their cognitive function is explicit.

This distinction exposes an important limitation in prevailing discussions of micro-learning. Fragmenting complex material into smaller units may make information easier to access, but fragmentation alone does not ensure conceptual integration, durable retention, or transfer. Recent systematic evidence suggests that the effects of micro-learning depend substantially on the design characteristics through which short learning experiences are structured and connected to broader learning objectives [5]. If excessively atomized, micro-learning may even separate concepts that learners need to understand relationally. Its pedagogical relevance therefore depends on preserving the coherence of the larger knowledge structure while using short interventions to regulate particular cognitive processes within it. This interpretation is compatible with practice-oriented approaches that combine micro-learning with active and contextualized forms of instruction [6] and with research suggesting that socially embedded micro-learning can support higher-order learning when learners are required to contribute, interact, and move beyond passive content consumption [7].

The problem becomes especially consequential when the intended outcome is cognitive transfer. Transfer requires learners not merely to recall previously encountered information but to recognize the relevance of knowledge under changed conditions, select appropriate principles, and adapt those principles to problems that may differ from the examples through which learning originally occurred. Micro-learning designed primarily around content consumption may therefore be insufficient for this purpose. By contrast, short interventions organized around prior-knowledge activation, retrieval, misconception detection, problem completion, comparison, explanation, and application to unfamiliar cases can perform different functions within a larger learning sequence. The distinction between micro-content and micro-activity is consequently central to the argument developed in this paper. Whereas micro-content primarily concerns the size and accessibility of information units, a micro-learning activity is understood here as a deliberately bounded instructional intervention with a defined cognitive purpose, a specific point of insertion, and an explicit relationship to preceding and subsequent learning.

This activity-oriented interpretation is also consistent with the broader evolution of micro-learning research. Recent scholarship has extended the discussion from the technical delivery of small learning objects toward questions of engagement, learner behaviour, social interaction, and sustainable participation [8]. Research addressing micro-learning in lifelong and digitally intensive learning environments likewise suggests that its significance extends beyond immediate content acquisition toward the development of more flexible learning practices and the capacity to engage continuously with changing knowledge requirements [9,10]. At the same time, emerging evidence concerning digital literacy and micro-learning activities illustrates how short interventions can be embedded within more complex experiential environments rather than operating as isolated instructional fragments [11]. Taken together, these developments suggest a need to move the conceptual focus from the *size* of micro-learning toward its *instructional position and function*.

Against this background, the present study addresses a specific gap between the expanding literature on micro-learning design and the more demanding problem of designing for cognitive transfer under high-load learning conditions. Existing studies provide valuable evidence regarding micro-learning formats, technological integration, engagement, and course structuring [1,3–5], yet they offer less explicit guidance on how differentiated micro-learning activities should be sequenced around a complex learning episode according to their cognitive purpose. The present paper therefore conceptualizes micro-learning not as an alternative curriculum architecture, but as a complementary layer of instructional design through which strategically timed activities can activate relevant prior knowledge, consolidate newly introduced material, support guided application, and subsequently require transfer beyond the original learning context.

Accordingly, the purpose of the study is to develop a theoretically grounded and operationally usable Micro-Learning for Cognitive Transfer Framework for higher education. Through structured conceptual analysis of the supplied literature, the study examines how micro-learning principles can be synthesized into four interdependent instructional functions - activation, consolidation, application, and transfer - and how these functions can guide decisions concerning activity timing, duration, task complexity, and feedback. The intended contribution is therefore both conceptual and practical: conceptually, the paper reframes micro-learning from content fragmentation toward the strategic orchestration of short cognitive interventions; practically, it provides a framework through which educators can determine not merely *what* to shorten, but *where, when, and why* a micro-learning activity should be introduced within demanding learning sequences. This orientation positions cognitive transfer, rather than brevity itself, as the principal criterion against which micro-learning design should ultimately be evaluated.

## 2 LITERATURE REVIEW

Micro-learning has developed from an approach primarily associated with the decomposition and digital delivery of educational content into a broader instructional design perspective concerned with how relatively bounded learning experiences can be integrated into more extensive learning processes. Early implementation research demonstrated that micro-learning content can be incorporated within conventional e-learning platforms without requiring the replacement of existing instructional infrastructures, thereby positioning micro-learning as a complementary rather than disruptive pedagogical architecture [1]. Related practice-oriented work emphasized short learning episodes, accessibility, and flexible delivery as characteristics that make micro-learning particularly compatible with digitally mediated education [2]. Evidence from online courses further suggests that micro-learning can contribute to learner engagement when activities are deliberately aligned with course structure rather than offered as disconnected supplementary resources [3]. Collectively, these studies establish an important distinction: the instructional value of micro-learning does not derive automatically from brevity, but from the relationship between the micro-unit, its learning objective, and the larger sequence within which it is embedded.

Recent reviews have made this design dependency increasingly explicit. Boumalek et al. show that micro-learning encompasses decisions concerning content granularity, sequencing, duration, interaction, technological delivery, and course organization, indicating that there is no pedagogically meaningful universal definition based solely on the number of minutes assigned to an activity [4]. Monib et al. similarly synthesize a heterogeneous evidence base and propose that learning outcomes are shaped by the interaction of micro-learning design with learner characteristics, technological conditions, and pedagogical context [5]. Ananta et al. reinforce this interpretation by approaching effectiveness through design-oriented dimensions rather than treating micro-learning as a homogeneous intervention [6]. The convergence of these reviews is theoretically significant because it shifts attention away from the simplistic proposition that shorter necessarily means cognitively easier. A short activity can still impose unnecessary processing demands if it contains poorly organized information, lacks connection to prior knowledge, or requires learners to coordinate multiple unfamiliar elements simultaneously. Conversely, a carefully bounded activity may preserve substantial intellectual difficulty while reducing extraneous demands and directing attention toward a specific cognitive operation.

The distinction between cognitive manageability and intellectual simplification is particularly relevant under high-load learning conditions. Micro-learning should not be understood as a mechanism for reducing the conceptual sophistication of higher education, since complex disciplinary learning

frequently depends on understanding relationships among multiple concepts rather than mastering isolated informational fragments. Its more defensible role is to regulate the instructional conditions under which complexity is encountered. Practice-oriented approaches have consequently combined micro-learning with active learning and gamified formats, illustrating how short learning episodes can require meaningful learner participation rather than passive exposure [7]. Similarly, the “short burst” conception advanced by Dixit et al. highlights the possibility of creating bounded opportunities for focused engagement within and beyond conventional classroom structures [8]. These perspectives are compatible with the present study's assumption that cognitive load should be managed through instructional organization without eliminating the productive cognitive effort required for understanding, problem solving, and transfer.

Engagement represents a second recurrent strand in the literature, although it should be distinguished analytically from learning effectiveness. Kossen and Ooi's investigation of micro-learning in online courses demonstrates the relevance of design choices for sustaining learner participation [3], while Salleh et al. associate micro-learning with increased study interest in technology-supported environments [9]. More recent research extends engagement beyond individual interaction with content. Göschlberger et al. examine social micro-learning in relation to student performance, suggesting that micro-learning can operate through collaborative and socially mediated learning processes [10], whereas Samant connects socially contributory micro-learning activities with the pursuit of higher-order learning outcomes [11]. Wamba-Taguimdje and Bashengezi further situate micro-learning within contemporary social-media environments, emphasizing the relationship between digital platform characteristics, exploratory and exploitative use, and sustainable social relationships [12]. These developments challenge the assumption that micro-learning is inherently individualized or content-centred. Short activities may instead function as moments of explanation, comparison, contribution, peer interaction, or collective problem solving, provided that social engagement serves a defined cognitive purpose.

The literature also increasingly positions micro-learning within broader processes of educational adaptation and continuing competence development. Costache argues that changing attention environments, artificial intelligence, and emerging digital learning arrangements are reshaping the conditions under which educational experiences are designed and consumed [13]. Matei et al., from the perspective of lifelong learning and skills development, similarly emphasize the growing requirement for continuous competence renewal in digitally transforming environments [14]. Micro-learning is particularly relevant within this context because its modularity can support recurrent engagement with knowledge without requiring every learning need to be translated into a complete course. However, flexibility alone does not guarantee meaningful competence development. Digital and experiential applications, including micro-learning activities designed to support digital literacy and empathy, indicate that short interventions become pedagogically richer when they require participation and contextualized action [15,16]. Faculty-development research using asynchronous micro-learning likewise illustrates the importance of situating short-form learning within communities and professional interaction rather than treating it as merely individualized information consumption [17].

This broader evidence base reveals a persistent conceptual tension. Much of the micro-learning literature evaluates accessibility, engagement, satisfaction, knowledge acquisition, or implementation, whereas the stronger educational claim - that micro-learning can support the transfer of knowledge from an instructional episode to a novel context - requires additional design assumptions. Retention and transfer are related but not interchangeable outcomes. A learner may successfully retrieve a definition or reproduce a procedure without being able to determine when that knowledge is relevant to a new problem [18,19]. Transfer therefore requires instructional opportunities in which the learner must recognize underlying principles despite changes in surface features, select among possible strategies, justify a response, or adapt knowledge to circumstances not encountered during initial instruction. From this perspective, repeated exposure to shortened content is insufficient. Micro-learning must incorporate cognitive actions that progressively move learners from reactivation and consolidation toward application and ultimately toward contextual variation [20].

A further limitation concerns the temporal placement of micro-learning. Existing research provides increasingly sophisticated guidance concerning micro-course design and the characteristics of individual micro-learning experiences [4–6], yet comparatively less attention has been devoted to the functional differentiation of activities according to *when* they occur in relation to a cognitively demanding learning episode. An activity administered before instruction serves a different purpose from one inserted at a conceptual transition, just as an immediate application task differs cognitively

from a delayed problem requiring transfer. Treating all of these interventions under the undifferentiated category of micro-learning obscures their distinct instructional functions. The literature therefore supports a transition from a format-based model, in which micro-learning is defined primarily through brevity and modularity, toward a sequence-based model in which the pedagogical value of each activity is determined by its timing, cognitive objective, level of contextual similarity, and relationship to feedback.

The present study develops this latter position by synthesizing the literature around four analytically distinct but sequentially related functions: activation, consolidation, application, and transfer. The framework does not assume that micro-learning independently produces cognitive transfer, nor does it propose that complex instruction should be fragmented into disconnected miniature lessons. Instead, it conceptualizes micro-learning activities as strategically positioned interventions within an intact instructional architecture. Activation prepares the cognitive conditions for new learning by re-establishing relevant knowledge; consolidation requires learners to retrieve, organize, or correct recently encountered concepts; application introduces bounded opportunities to use those concepts in structured problems; and transfer increases contextual distance by requiring knowledge to be adapted to unfamiliar cases. This synthesis addresses a gap between the literature's growing understanding of micro-learning as a design-dependent practice and the need for an operational model specifying how short activities can be sequenced toward increasingly demanding cognitive outcomes.

### **3 METHODOLOGY**

This study employed a structured conceptual analysis to develop an instructional framework for positioning micro-learning activities within cognitively demanding learning sequences. The methodological choice reflects the purpose of the research: rather than estimating the effectiveness of a particular intervention or conducting a systematic review intended to exhaustively identify all published studies on micro-learning, the analysis sought to integrate theoretically and pedagogically relevant findings into a coherent design proposition. Accordingly, the unit of analysis was not the individual study as an object of quantitative comparison, but the instructional principle that could be derived from the literature concerning the design, sequencing, timing, and cognitive function of micro-learning. This distinction is important because the proposed framework represents a theoretically informed design synthesis and should not be interpreted as an empirically validated intervention model.

The analytical corpus consisted exclusively of the literature identified for the present study and comprised 20 publications published between 2020 and 2026. The sources included peer-reviewed journal articles, systematic and integrative reviews, and conference proceedings addressing micro-learning or closely related educational practices. The corpus covered research on micro-learning integration and course structuring [1,4], learner engagement [3], design-oriented effectiveness [5,6], practice-oriented and gamified learning [7], short-form learning activities [8], social and collaborative micro-learning [10–12], digitally mediated educational change [13], lifelong competence development [14], digital literacy [15], and professional development [16]. This intentionally focused corpus was appropriate to the conceptual objective of the study because it incorporated both synthesis-level publications and applied studies addressing different educational settings and manifestations of micro-learning.

Sources were retained when they contributed directly to at least one of the analytical concerns established by the research objective: the instructional organization of short learning activities, the management of demanding learning conditions, learner engagement with micro-learning, the sequencing or structuring of learning episodes, active application of knowledge, or the relationship between micro-learning and broader competence development. Publications were excluded from the conceptual synthesis when their principal focus did not permit a meaningful connection with instructional design or the educational use of micro-learning. No restrictions were imposed according to a single disciplinary context because the proposed framework is intended to be transferable across higher-education settings. However, claims were not generalized from individual disciplinary studies to all higher education; instead, recurring design principles were interpreted at the conceptual level. The study did not apply meta-analytic procedures, calculate pooled effect sizes, or evaluate methodological quality through a formal systematic-review appraisal instrument.

The analysis proceeded through comparative conceptual coding. Each publication was examined for

statements and findings relevant to five predetermined design dimensions derived from the research objective: timing, cognitive purpose, activity type, feedback, and task complexity. Timing concerned the location of an intervention relative to the principal instructional episode. Cognitive purpose captured whether the activity primarily prepared, reinforced, retrieved, applied, or extended knowledge. Activity type distinguished, among other possibilities, recall prompts, summaries, misconception checks, worked examples, short problems, and contextualized tasks. Feedback concerned the opportunity for learners to confirm or revise their understanding following an activity, whereas task complexity addressed the cognitive distance between initial instruction and the demands subsequently placed on the learner. The dimensions functioned as analytical categories rather than quantitative variables; their purpose was to permit comparison across heterogeneous literature without implying equivalence among research designs or outcomes.

The second analytical stage examined relationships among these categories. Particular attention was given to whether apparently different micro-learning practices could be differentiated according to their position within a broader learning trajectory. This comparison produced four recurring instructional functions that became the organizing components of the proposed framework: activation, consolidation, application, and transfer. Activation was defined as a preparatory function through which relevant prior knowledge is made cognitively available before demanding instruction. Consolidation captured short interventions intended to retrieve, organize, check, or correct newly encountered knowledge. Application represented the transition from knowledge representation toward its use in bounded problems or decisions, whereas transfer represented the most contextually distant function, requiring learners to adapt previously acquired principles to unfamiliar cases or altered conditions. The four components were therefore differentiated not simply by duration or format, but by their intended cognitive function and their temporal relationship to the principal learning episode.

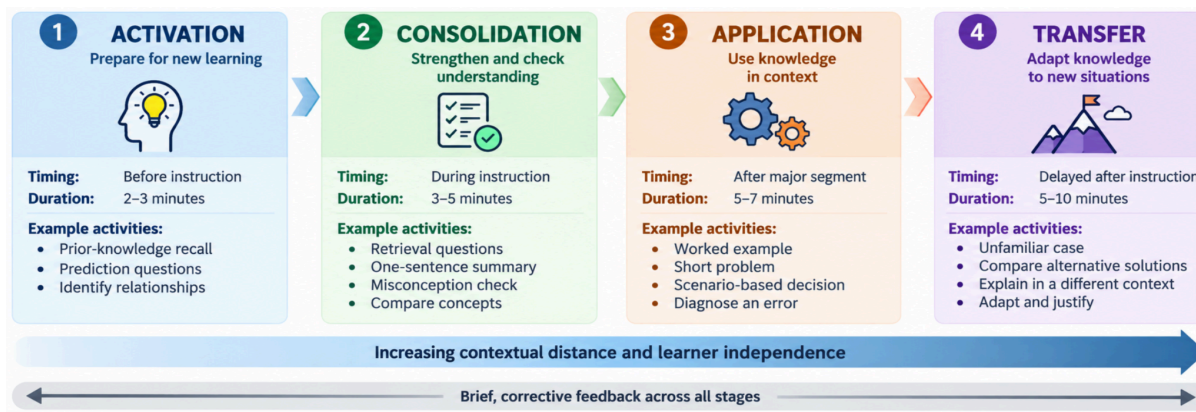
In the final stage, the conceptual categories were translated into design specifications by associating each function with an indicative insertion point, duration, activity form, and feedback requirement. The resulting durations - approximately 2–3 minutes for activation, 3–5 minutes for consolidation, 5–7 minutes for application, and 5–10 minutes for transfer activities, should be interpreted as practical design heuristics rather than experimentally established thresholds. Their purpose is to operationalize the framework sufficiently for instructional use while avoiding the assumption that micro-learning can be defined by a universal duration. The same principle applies to the sequencing of the four components: the sequence expresses increasing cognitive and contextual demands, but educators may adapt individual activities to disciplinary content, learner expertise, delivery mode, and task complexity.

Methodological consistency was maintained by separating propositions supported through conceptual synthesis from claims requiring future empirical validation. Consequently, the analysis does not infer causal improvements in retention, cognitive load, engagement, or transfer. Instead, it identifies design relationships that are sufficiently recurrent and theoretically coherent to justify formulation as testable instructional propositions. The methodological outcome is therefore an operational framework that translates an interdisciplinary micro-learning literature into a sequence of design decisions while preserving explicit boundaries between literature-supported reasoning, conceptual synthesis, and empirical evidence.

## **4 RESULTS**

The structured conceptual analysis produced the Micro-Learning for Cognitive Transfer Framework, organized around four sequentially related instructional functions: activation, consolidation, application, and transfer (Fig. 1). The framework is operationalized through five design dimensions - timing, cognitive purpose, activity type, feedback, and task complexity - and represents a progression from the activation of relevant prior knowledge toward increasingly independent application under

unfamiliar conditions.



Source: Authors' own conceptual contribution

**Fig. 1.** Micro-Learning for Cognitive Transfer Framework: sequencing short learning activities from activation to transfer

## 4.1 Activation

Activation constitutes the first component and is positioned immediately before a cognitively demanding instructional episode. Its purpose is not to introduce a miniature version of the forthcoming lesson, but to make relevant prior knowledge cognitively available and establish conceptual points of connection for new information. Within the framework, activation is operationalized through approximately 2–3-minute activities, such as prior-knowledge prompts, brief concept-recall questions, prediction tasks, or requests to identify relationships among previously learned concepts. The literature's emphasis on focused, manageable learning units [4,5,8] supports the use of bounded activities at this stage, while the framework extends this principle by assigning them an explicitly preparatory function. For example, before introducing a complex statistical procedure, students might be asked to identify in two minutes which characteristics of a dataset should influence the selection of an analytical method. In a management course, a brief prediction question could require students to anticipate how a change in one organizational variable might affect another before a more complex model is introduced. The pedagogical purpose is to establish cognitive readiness rather than assess mastery.

## 4.2 Consolidation

Consolidation constitutes the second component and occurs during instruction, preferably at natural conceptual transitions rather than according to arbitrary chronological intervals. The conceptual synthesis indicates that short-form learning becomes more educationally meaningful when learners actively engage with content instead of merely consuming smaller informational units [3,10,11]. Consolidation therefore interrupts continuous information intake with approximately 3–5 minutes of retrieval, organization, or misconception detection. Suitable activities include retrieval questions completed without notes, one-sentence concept summaries, identification and correction of an erroneous statement, or comparison of two easily confused concepts. The defining feature is that learners must reconstruct recently encountered knowledge rather than immediately re-read it. Brief corrective feedback follows the activity so that retrieval does not consolidate an incorrect interpretation. In a lecture addressing several interdependent theoretical models, for instance, students could be asked to identify the principal distinction between two models before instruction proceeds to their integration. Consolidation thus functions as a cognitive checkpoint within the larger instructional sequence.

## 4.3 Application

The third component, **application**, changes the nature of learner activity from reconstruction of knowledge to its **purposeful** use. The literature reviewed demonstrates that micro-learning can accommodate active, practice-oriented, socially contributory, and gamified forms of learning rather than being restricted to informational presentation [7,9–11]. On this basis, the framework assigns approximately 5–7 minutes to a short application episode following a substantial conceptual segment. Activities may include completing a partially worked example, solving a bounded problem, making a scenario-based decision, diagnosing an error, or selecting and justifying an appropriate procedure. Compared with consolidation, the learner receives less direct correspondence between the form in which knowledge was taught and the form in which it must now be used. In an economics course, students might apply a newly introduced principle to interpret a short market scenario; in engineering, they might complete a partially solved calculation and explain the reasoning underlying the missing step; in teacher education, they might select an instructional response to a classroom situation and briefly justify the choice. Feedback at this stage should address both correctness and the reasoning process that produced the response.

#### 4.4 Transfer

Transfer, the fourth component, introduces the greatest contextual distance from initial instruction. Whereas application asks learners to use knowledge under relatively structured conditions, transfer requires them to recognize the relevance of a principle when surface characteristics, disciplinary context, problem formulation, or available information have changed. This distinction is important because the reviewed literature contains stronger evidence concerning engagement, implementation, and immediate learning outcomes than concerning sustained transfer to novel conditions [5,6]. The framework consequently treats transfer as a separate design requirement rather than assuming that it follows automatically from successful micro-learning. Transfer activities are proposed as 5–10-minute delayed interventions, positioned after the main learning episode rather than necessarily within it. Students may be required to apply a principle to an unfamiliar case, compare competing solutions, explain how a concept operates in a different context, or identify which elements of a previously learned strategy remain applicable when problem conditions change. The delay and contextual variation are intentional because the activity is designed to require reconstruction and adaptation rather than immediate reproduction.

The relationship among the four components is cumulative but not mechanically linear. Activation increases the accessibility of relevant prior knowledge; consolidation strengthens and checks the representation of newly encountered material; application requires that representation to be used; and transfer increases the contextual distance across which the learner must recognize and adapt the underlying principle. Consequently, the framework can be represented conceptually as:

**Activation → Consolidation → Application → Transfer**

with feedback operating across the sequence rather than constituting a separate stage. This progression also changes the role of instructional support. Earlier activities can provide stronger cues because their purpose is cognitive preparation and stabilization, whereas later activities should progressively reduce direct guidance and increase the requirement for independent selection, justification, and adaptation.

A second result of the analysis concerns timing. The literature frequently defines micro-learning through short duration, modularity, accessibility, or content granularity [1,4–6], but the synthesis conducted here indicates that duration alone provides insufficient guidance for instructional design. A three-minute activity administered at the wrong point in a learning sequence may contribute little to learning, whereas an equally brief intervention located immediately before a conceptual transition can require learners to retrieve precisely the knowledge necessary for the next stage. The framework therefore treats duration as subordinate to cognitive purpose. The proposed time ranges are indicative design parameters, not thresholds defining what qualifies as micro-learning. In practical terms, where an activity is inserted and what cognitive operation it requires are more important than achieving a predetermined number of minutes.

The analysis further indicates that micro-learning need not be technologically dependent. Although digital platforms, online courses, social media, and emerging learning environments have contributed substantially to its development [1,3,12,13,15], each of the four framework components can be

implemented in face-to-face, blended, or fully online settings. A prediction prompt may be delivered verbally, through a learning management system, or via a mobile interface; a misconception check may be individual or collaborative; an application problem may be completed on paper or digitally; and a delayed transfer task may be delivered asynchronously. Technology therefore operates as an enabling infrastructure rather than as a defining property of the framework. This distinction preserves the instructional logic of micro-learning across different institutional and technological conditions.

Taken together, the results reposition micro-learning from a content-format decision to a micro-level instructional sequencing strategy. The framework identifies five design decisions that educators must coordinate - timing, cognitive purpose, activity type, feedback, and task complexity - and organizes these decisions around four progressively differentiated functions. Its principal proposition is therefore not that shorter learning activities necessarily reduce cognitive demands or improve transfer, but that carefully positioned micro-learning activities can create structured opportunities for learners to move repeatedly from knowledge accessibility toward reconstruction, use, and contextual adaptation. As the present research is conceptual rather than experimental, these relationships constitute theoretically grounded design propositions whose effects on cognitive load, retention, engagement, and transfer require subsequent empirical testing.

## **5 DISCUSSIONS**

The principal contribution of this study is the repositioning of micro-learning from a format defined primarily by brevity toward a functionally differentiated instructional design strategy. Although modularity, accessibility, and short duration remain characteristic of micro-learning [1,4,5], these properties alone do not explain how brief activities may contribute to cognitive transfer under demanding learning conditions. The Micro-Learning for Cognitive Transfer Framework instead proposes that instructional value emerges from the alignment of timing, cognitive purpose, activity type, feedback, and task complexity. This interpretation is consistent with design-oriented reviews showing that micro-learning effectiveness depends substantially on instructional configuration and contextual conditions [4–6], while extending this literature by making temporal placement and progression toward transfer explicit. Consequently, a short explanatory resource and a short retrieval activity should not be regarded as pedagogically equivalent merely because they require comparable amounts of time: the former primarily presents information, whereas the latter requires learners to reconstruct it. Duration is therefore a structural property of micro-learning, while cognitive purpose determines its instructional significance.

This distinction is particularly important under high-load learning conditions because managing cognitive demands should not be equated with simplifying the intellectual substance of higher education. Complex disciplinary learning necessarily requires students to coordinate multiple concepts, evaluate alternatives, solve problems, and establish relationships among ideas. Excessive fragmentation may therefore become counterproductive if it separates concepts that must ultimately be understood as an integrated structure. The framework addresses this tension by locating micro-learning *within* complex instruction rather than positioning it as a substitute for sustained learning. Activation makes relevant prior knowledge available before demanding instruction; consolidation interrupts continuous information exposure by requiring retrieval and conceptual organization; application moves learners from representation toward purposeful use; and transfer requires adaptation under increasingly unfamiliar conditions. In this configuration, micro-learning regulates the sequence through which complexity is encountered without removing the productive cognitive effort required for advanced understanding.

The progression toward transfer also clarifies an important limitation in equating engagement or immediate performance with durable learning. Existing research has associated micro-learning with engagement [3,9], social participation [10,12], and higher-order contributory activity [11], yet successful participation does not itself demonstrate that knowledge can subsequently be used outside the original instructional context. Similarly, immediate recall may indicate that information remains accessible shortly after instruction without demonstrating that learners can recognize the underlying principle when surface characteristics change. The framework therefore treats transfer as an explicit instructional requirement rather than an assumed consequence of short-form learning. Delayed activities involving unfamiliar cases, alternative solutions, explanation, or contextual variation require learners not only to retrieve knowledge but also to determine its relevance and adapt its use. This

distinction is consistent with recent design-oriented synthesis identifying sustained learning and knowledge transfer as areas in which the evidence base remains less developed [5,6]. The framework consequently advances a stronger criterion for evaluating micro-learning: not whether students complete or engage with short activities, but whether the sequence creates progressively demanding opportunities to reconstruct and use knowledge beyond the conditions of initial acquisition.

The framework nevertheless represents a flexible design architecture rather than a standardized pedagogical script. The proposed durations of 2–3 minutes for activation, 3–5 minutes for consolidation, 5–7 minutes for application, and 5–10 minutes for transfer are practical heuristics rather than empirically established thresholds, because appropriate duration necessarily varies with learner expertise, disciplinary complexity, task interactivity, and intended outcomes. The same principle applies to technology. Although micro-learning has developed substantially through e-learning platforms [1], online courses [3], social environments [12], and digitally mediated educational practices [13,15], none of the four functions requires a specific delivery technology. Retrieval prompts, misconception checks, short application problems, and delayed transfer tasks can be implemented in face-to-face, blended, or online environments. This modality independence is important because it separates pedagogical architecture from technological infrastructure: digital systems may increase accessibility, scalability, personalization, or feedback speed, but they cannot compensate for an activity whose cognitive purpose is poorly specified. The framework may consequently also be relevant to professional and lifelong learning contexts, where recurrent short interventions can complement continuing competence development [14,16].

These conclusions must be interpreted within the methodological boundaries of the study. The framework derives from structured conceptual analysis of a focused literature corpus rather than from a systematic review, meta-analysis, or experimental intervention; accordingly, it does not establish causal effects on cognitive load, retention, engagement, or transfer. The heterogeneity of the underlying literature further limits direct comparison among reported outcomes, while the proposed activity durations and sequencing remain design propositions requiring empirical validation. Future research should therefore compare the complete activation–consolidation–application–transfer sequence with conventional instruction and with micro-learning based predominantly on content segmentation, while distinguishing immediate achievement from delayed retention and transfer. Experimental and quasi-experimental studies should additionally examine whether the four components produce additive or interactive effects, how feedback and contextual distance influence transfer, and whether optimal sequencing varies according to prior expertise and disciplinary domain. Such research would determine whether the framework's central proposition - that strategically positioned micro-learning activities can support progression from knowledge accessibility to reconstruction, application, and contextual adaptation - translates into measurable improvements in learning under high-load conditions.

## 6 CONCLUSIONS

This study examined micro-learning as an instructional strategy for supporting cognitive transfer under high-load learning conditions in higher education. Rather than defining micro-learning primarily through brevity, content fragmentation, or technological delivery, the analysis conceptualized it as a sequence of short, cognitively purposeful interventions embedded within more extensive learning episodes. This interpretation responds to evidence that the educational value of micro-learning depends substantially on instructional design, contextual alignment, and the relationship between individual activities and broader learning objectives [4–6]. Accordingly, managing cognitive demands should not imply simplifying intellectually complex content, but organizing learners' engagement with that complexity in ways that create repeated opportunities for retrieval, interpretation, and use.

The structured conceptual analysis resulted in the Micro-Learning for Cognitive Transfer Framework, comprising four interconnected functions: activation, consolidation, application, and transfer. Activation makes relevant prior knowledge available before demanding instruction; consolidation requires retrieval, organization, and misconception checking during instruction; application moves learners from knowledge representation toward its purposeful use; and transfer requires previously acquired principles to be recognized and adapted under unfamiliar conditions. The framework therefore shifts the central design question from *how short a learning activity should be* to *when it should occur, what cognitive operation it should elicit, and how it should prepare learners for increasingly independent use of knowledge*.

From an instructional perspective, the framework emphasizes the coordinated design of timing, cognitive purpose, activity type, feedback, and task complexity. The proposed durations of approximately 2–3 minutes for activation, 3–5 minutes for consolidation, 5–7 minutes for application, and 5–10 minutes for transfer should be regarded as adaptable design heuristics rather than universal thresholds. Their implementation can similarly extend across face-to-face, blended, and online environments because technology constitutes an enabling infrastructure rather than a defining characteristic of the framework. Micro-learning consequently complements rather than replaces comprehensive instruction: its purpose is to introduce strategically bounded cognitive activities while preserving the conceptual coherence and intellectual demands of the larger learning experience.

The study's conceptual methodology necessarily limits the claims that can be made about effectiveness. The framework does not demonstrate causal improvements in cognitive load, retention, engagement, or transfer, and its proposed sequence and temporal parameters require empirical validation. Future experimental and quasi-experimental research should therefore compare the complete activation–consolidation–application–transfer sequence with conventional instruction and with micro-learning based predominantly on content segmentation, while distinguishing immediate achievement from delayed retention and transfer. Research should also examine how learner expertise, disciplinary complexity, feedback, contextual distance, and instructional modality moderate the effectiveness of individual framework components.

Ultimately, the contribution of micro-learning to higher education may depend less on making learning shorter than on making short learning activities cognitively consequential. By integrating activation, consolidation, application, and transfer around demanding instructional episodes, the proposed framework connects the flexibility of micro-learning with the more substantive educational objective of enabling learners to reconstruct, apply, and adapt knowledge beyond the conditions in which it was initially acquired.

## ACKNOWLEDGEMENTS

*During the preparation of this work, the author(s) utilized ChatGPT 4 to enhance readability and language clarity. Following the use of this tool, the author(s) meticulously reviewed and revised the content as necessary and assume(s) full responsibility for the final content of the publication.*

## REFERENCES

- [1] R. P. Díaz Redondo, M. Caeiro Rodríguez, J. J. López Escobar, and A. Fernández Vilas, "Integrating micro-learning content in traditional e-learning platforms," *Multimedia Tools and Applications*, vol. 80, no. 2, pp. 3121–3151, 2021. <https://doi.org/10.1007/s11042-020-09523-z>
- [2] R. K. Dixit, P. S. Yalagi, and M. A. Nirgude, "Breaking the walls of classroom through micro learning: Short burst of learning," *Journal of Physics: Conference Series*, vol. 1854, no. 1, p. 012018, 2021. <https://doi.org/10.1088/1742-6596/1854/1/012018>
- [3] C. Kossen and C. Y. Ooi, "Trialling micro-learning design to increase engagement in online courses," *Asian Association of Open Universities Journal*, vol. 16, no. 3, pp. 299–310, 2021. <https://doi.org/10.1108/AAOUJ-09-2021-0107>
- [4] K. Boumalek, A. Bakki, A. El Mezouary, B. Hmedna, and M. Eddahibi, "Micro-learning design and micro-course structuring: A systematic literature review," *Interactive Learning Environments*, vol. 34, no. 4, pp. 2411–2437, 2026. <https://doi.org/10.1080/10494820.2025.2545955>
- [5] W. K. Monib, A. Qazi, and R. A. Apong, "Microlearning beyond boundaries: A systematic review and a novel framework for improving learning outcomes," *Heliyon*, vol. 11, no. 2, 2025.
- [6] M. P. Ananta, M. S. U. Qolby, and H. Miarto, "Unpacking micro-learning effectiveness: An integrative systematic review of design-oriented dimensions," *Galaxy: Jurnal Pendidikan MIPA dan Teknologi*, vol. 3, no. 1, pp. 1–8, 2026.
- [7] R. P. D. Redondo, A. Ktena, N. Kunicina, A. Zabasta, A. Patlins, and D. E. Mele, "Advanced practices: Micro learning, practice oriented teaching and gamified learning," in *2020 IEEE 61st International Scientific*

*Conference on Power and Electrical Engineering of Riga Technical University (RTUCON)*, 2020, pp. 1–7.  
<https://doi.org/10.1109/RTUCON51174.2020.9316555>

- [8] D. Salleh, M. Ibrahim, and N. Khairudin, "Micro learning: A creative technological move to boost study interest," in *The 2nd International Recent Trends in Engineering, Advanced Computing and Technology Conference (RETREAT 2021)*, AIP Conference Proceedings, vol. 2608, no. 1, p. 020056, 2023.  
<https://doi.org/10.1063/5.0128602>
- [9] B. Göschlberger, F. Dopler, and G. Kotsis, "Social micro-learning and student performance," in *2022 20th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, 2022, pp. 184–189. <https://doi.org/10.1109/ICETA57911.2022.9974766>.
- [10] A. Samant, "Social contributory micro-learning activities motivate learners to pursue higher order learning outcomes," in *Proceedings of the International Conference on Best Innovative Teaching Strategies (ICON-BITS 2021)*, 2022.
- [11] S. L. Wamba-Taguimdje and P. K. Bashengezi, "From FoMO to learning: How social media characteristics drive explorative and exploitative use and sustainable social relationships in micro-learning activities," *Computers in Human Behavior*, p. 108993, 2026.
- [12] B. Costache, "From TikTok attention spans to virtual campuses: How AI, microlearning, and emotional intelligence are reshaping education," *International Journal of Education, Leadership, Artificial Intelligence, Computing, Business, Life Sciences, and Society*, vol. 7, pp. 79–98, 2026.  
<https://doi.org/10.65222/VIRAL.2026.4.27.47>
- [13] M.-A. Matei, A. R. Mihaila, and M.-I. Vulpe, "Public administration and life-long learning: Rethinking skills development for the digital state," *International Journal of Education, Leadership, Artificial Intelligence, Computing, Business, Life Sciences, and Society*, vol. 5, no. 1, pp. 153–163, 2026.
- [14] A. Suvandy, P. Chatwattana, and P. Nilsook, "Development of digital literacy and digital empathy with micro-learning via activities on Metaverse," *Higher Education Studies*, vol. 14, no. 2, pp. 79–87, 2024.
- [15] M. A. Bulut, T. Adigüzel, and M. H. Kaya, "Exploring views and experiences of faculty members' participation in an asynchronous online program: Using a micro-learning format and CoP framework," *Innovations in Education and Teaching International*, vol. 63, no. 2, pp. 649–665, 2026.  
<https://doi.org/10.1080/14703297.2025.2532056>
- [16] C. Petcu and B. Costache, "Functional fixedness and organizational inertia: A microfoundational perspective on leadership failure," *International Journal of Education, Leadership, Artificial Intelligence, Computing, Business, Life Sciences, and Society*, vol. 5, no. 1, pp. 122–129, 2026.  
<https://doi.org/10.65222/VIRAL.2026.2.14.34>
- [17] T. D. Nguyen, T. Q. Le, G. T. Luong, D. T. Nguyen, and T. T. Nguyen, "A review of applying game-based learning and learning motivation: Game-based learning and learning motivation," *International Journal of Education, Leadership, Artificial Intelligence, Computing, Business, Life Sciences, and Society*, vol. 3, no. 3, pp. 67–74, 2025. <https://doi.org/10.65222/VIRAL.2025.12.20>
- [18] A. Kostas, G. Koutromanos, and D. Tsoumani, "Micro-learning in formal and informal education: A systematic review," in *Optimizing Education Through Micro-Lessons: Engaging and Adaptive Learning Strategies*, pp. 1–19, 2024. <https://doi.org/10.4018/979-8-3693-0195-1.ch001>
- [19] B. Costache, "Rethinking the training of teaching staff through the development of internship and mentoring programs," in *ICERI2024 Proceedings*, pp. 5846–5852, IATED, 2024.  
<https://doi.org/10.21125/iceri.2024.1419>
- [20] Costache, B. (2026). Educational Leadership in the Era of Emerging AI Adoption: An Exploratory Study of Human - AI Collaboration in Higher Education. *International Journal of Education, Leadership, Artificial Intelligence, Computing, Business, Life Sciences, and Society*, 10, 169-191.  
<https://doi.org/10.65222/VIRAL.2026.7.44.64>
-