Microlearning and Clinical Performance: A Conceptual Model of Cognitive Load and Learning Engagement

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Abstract

Microlearning as a novel pedagogical strategy can provide brief, customised, and accessible learning content that can help overcome concerns regarding the increasing complexity of healthcare education and drawbacks of traditional teaching approaches. This paper presents a conceptual model of the impact of microlearning on clinical performance mediated by cognitive load and learning engagement in the context of nursing education. Based on cognitive load theory and principles of engagement, the framework posits that effective microlearning activities can lower cognitive load while increasing learner engagement, leading to better retention of knowledge and effective application of skills. The paper synthesises the current literature to illustrate the interconnections among the three constructs of microlearning, cognitive load and learning engagement in the context of better performers in the clinical setting, while also providing a theoretical framework for further evidence-based field research and some practical suggestions regarding issues in instructional design in student-teacher interactions during healthcare learning.

Keywords: Microlearning, Cognitive Load, Learning Engagement, Clinical Performance, Nursing Education, Instructional Design

I. Introduction

The complexity of healthcare systems and the rapid expansion of knowledge in healthcare has created a significant challenge for nursing and clinical education to be effective and efficient. While traditional formats of instruction are generally considered to be long and full of information (Sweller, 1988; Mayer, 2009), many are often criticized for using too much of working memory or failing to deliver any benefits in terms of student learning outcomes. In clinical settings, where learners need to learn theory and practice skills concurrently, high cognitive load leads to lower retention of information, lower on-task engagement and ultimately lead to poor clinical performance (Paas 2003; Fraser 2012). The need for novel pedagogy that can facilitate learning in a way that both taps into constraints of cognition in realistic contexts as well realizes efficiency in healthcare education had already been recognised.

In this context a potential pedagogical response to meet these challenges comes in the form of microlearning, where content is delivered in discretely packaged and easily digestible units (Hug, 2005; De Gagne 2019). Grounded in theories of instructional design and digital pedagogy, microlearning is characterized by short duration, immediacy, flexibility and accessibility that enables learners to access content at any time and location on mobile or online (Zarshenas 2022; Buchem & Hamelmann, 2010). There is empirical evidence that microlearning improves retention, learner satisfaction and facilitates autonomous learning in healthcare and nursing education, where the associated cognitive load is great and the time available for learning is limited (Leong 2021; Kapp & Defelice, 2019). However, despite its growing popularity, the microlearning format by itself is not enough to be effective, the effectiveness of microlearning is dependent upon certain instructional design features like content chunking, how we consume information, spaced repetitions, personalization and just-in-time delivery.

Theoretically, Cognitive Load Theory (CLT) offers a solid theoretical framework that can be helpful in explaining the effect of microlearning on learning outcomes. According to CLT, the limited capacity of working memory means that learning can be impeded by cognitive overload and hence instruction should be designed to decrease extraneous cognitive load while optimising germane processing (Sweller, Ayres, & Kalyuga, 2011). Microlearning closely aligns with the principles of breaking down complex information, reducing overload and allowing schema construction (Mayer & Moreno, 2003; Kalyuga, 2011). Simultaneously microlearning offers the benefits of multidimensional learning engagement, including behavioral, emotional and cognitive facets that are fundamental to outcomes related to how learners respond to attendance effort or value associated with instructional content (Fredricks, Blumenfeld, & Paris, 2004). Micro-learning environments that are interactive and personalized facilitate engagement, an improved cognitive state that is directly linked to learning outcomes and skills (Bond 2020).

Although previous studies have reported the solitary influence of microlearning, cognitive load optimization and learner engagement on clinical performance, the systematic review yielded no integrated framework against which could be evaluated for joint impact. Clinical performance is an important outcome of nursing education that involves the demonstration of skills, knowledge and decision-making in clinical practice (Benner, 1984; Epstein & Hundert, 2002). Many existing studies have investigated the outcomes of microlearning independently, that is, without considering which mediating mechanisms explain the role of instructional design on clinical competence. This piecemeal approach is restrictive in developing educational interventions that are both theoretically informed and practically valid.

In light of this gap, the current conceptual paper proposes an integrative model to investigate how microlearning activities relate to clinical performance through cognitive load and learning engagement. This paper combines elements from both cognitive load theory and engagement-based learning frameworks to offer a comprehensive support for the strategic design of microlearning to drive positive clinical outcomes. Hence, this paper proposes a conceptual model that explicates the mechanisms by which microlearning tasks influence clinical performance through the mediating effects of cognitive load and collaborative learning engagement. This model also contributes to the theoretical development of healthcare education research and has implications for teachers, instructional designers and policy makers in their quest to create effective digital learning environments in clinical settings.

1.1 Inter-disciplinary Perspective on Microlearning

Although this paper is situated in nursing and clinical education, microlearning also has strong roots in workplace learning and professional training. It has been widely used in workplace training and human resource development, particularly where employees need to learn in short, focused intervals alongside their regular work responsibilities (Major & Calandrino, 2018; Kapp & Defelice, 2019). This makes microlearning relevant to management and organisational behaviour, where learning, employee engagement, training effectiveness, and performance have long been important areas of study.

From this perspective, the way microlearning is designed matters because learners have limited cognitive and attentional resources. Decisions about how content is broken into smaller units, how learning is spaced, and how learning experiences are personalised can influence how easily learners process information and how actively they engage with it. These concerns are particularly relevant in clinical education, where students are expected to learn and apply knowledge in demanding environments.

Bringing a management and organisational behaviour perspective to clinical microlearning therefore adds another way of understanding the relationship between learning design and performance. Rather than viewing microlearning only as a method of delivering educational content, this study considers how its design may shape cognitive load and student engagement, which in turn may influence clinical performance. In this way, the proposed framework connects research on workplace learning and human performance with the specific demands of nursing and clinical education.

2.Literature Review

2.1Microlearning in Healthcare Education

With the application of a lean design of instruction with rich and reusable assets, microlearning has received attention in healthcare education where there is a strong focus on a learner-centric approach as learners have limited time. Microlearning is referred to as the process of delivering content in short, focused learning units that allows learners to consume educational material in a way that is more manageable and effective (Hug 2005 & Buchem Hamelmann 2010). Microlearning has been linked to positive outcomes associated with knowledge retention in nursing and medical education (De Gagne 2019; Leong 2021), satisfaction with learning experience, and accessibility.

Microlearning is supported by empirical evidence as appropriate for continuous professional development and just-in-time learning, especially for the clinical environment. (Kapp & Defelice, 2019; Major & Calandrino, 2018) However, some scholars have expressed concern that with the widespread use of poorly designed micro-learning, one may end up with a reductionistic (rather than holistic) notion of clinical concepts (Bruck 2012). This highlights the need for studying the instructional design quality as well.

2.2 Microlearning Design Dimensions

The effectiveness of microlearning largely relies on design traits like content chunking, spaced repetition, mobile access, personalization and just-in-time delivery. Content chunking, for instance, allows to break up learning into smaller parts which results in decreased cognitive load (Mayer & Moreno, 2003), whereas spaced learning promotes long-term memory through distributed practice (Cepeda 2006). Mobile accessibility, allows learners to access the content in a flexible context; an approach that has been shown to be useful in clinical settings (Park, 2011). But learning is even more enhanced when personalization is incorporated in the learning process in which the content is developed based on the individual preferences and needs (Dabbagh & Kitsantas, 2012). Just-in-time learning: providing relevant information at the point of need, makes it flexible to use for learners in real time performance (Gagnon 2019).

However, literature has demonstrated that it is important to consider attitudes to the impact of these design features in conjunction. Although there are multiple studies on the clinical performance, an integrated perspective of the influence of instructional design and engagement is limited (Buchem and Hamelmann 2010, DeGagne 2019).

2.3 Cognitive Load Theory in Medical Education

A classic framework for understanding how instructional design affects learning is Cognitive load theory (CLT). Each theory draws its conclusions from different premises, yet all theories agree that working memory has limited capacity; excessive cognitive load can inhibit learning (Sweller, 1988; Sweller 2011). CLT distinguishes types of loads such as intrinsic, extraneous and germane cognitive load (Paas 2003; Kalyuga, 2011).

The amount of information required in clinical knowledge and skills makes cognitive overload a major concern in medical education (Fraser 2012). Research indicates that with CLT principles for instructional strategies, learning efficiency and performance outcomes can be enhanced (Leppink 2014). Social learning, in contrast, is not directly related to CLT because it consists of presenting content in smaller, but unstructured, chunks, which have to fit into the learner's schema without any meaningful support, and thus have to be integrated with extraneous load to be added to their cognitive processing (Mayer, 2009; Mayer & Moreno, 2003).

In another aspect, if the content is broken into small parts, learners might not connect the parts into a whole, leading to a high intrinsic load (Kalyuga, 2011). This means there should be a balance or harmony in the design of microlearning between simplicity and conceptual depth.

2.4 Learning Engagement and Its Relevance to Education

Learning engagement is generally accepted as a key influence on educational outcomes, as it includes the cognitive, emotional, and behavioral aspects that reflect the extent to which learners are engaged in active learning (Fredricks 2004). This is correlated with increased motivation, deeper learning and stronger performance outcomes (Bond 2020). Research has cited that microlearning includes interactive tasks, colourful content and adaptive resources that engages the students (Kapp & Defelice, 2019; De Gagne 2019). Engagement is critical in education, as it affects not only knowledge acquisition but also clinical skills and decision-making ability in healthcare (Benner 1984).

Engagement is a multidimensional construct that is not merely the result of a single external factor, but rather one that incorporates many facets of learner characteristics and instructional design in context (Zepke & Leach, 2010). Previous research often conceptualizes engagement as an outcome (e.g., persistence or retention) rather than a mechanism, and thus does not realize the potential of engagement as a connection between methodologies and performance.

2.5 Clinical Performance within Nursing Education

Clinical performance can be considered the ability to utilize knowledge, skills and professional judgement in a practical situation (Epstein & Hundert, 2002). It is a core nursing education outcome reflecting competence and preparedness for practice (Benner, 1984). Evidence shows that clinical performance can improve with better retention of knowledge, critical thinking and decision-making skills through the use of effective instructional strategies (Cant & Cooper, 2010). Technology-enhanced learning approaches, such as simulation and digital learning, have been demonstrated to enhance the development of clinical competence (Cook 2010).

Nonetheless, the connection between instructional design and clinical performance is not straightforward. This relationship may be mediated by factors including cognitive load and engagement, which affects how learners process and apply knowledge to clinical contexts (Fraser 2012; Leppink 2014).

2.6 Microlearning, Cognitive Load and Engagement

Even though there is an abundance of literature that discusses microlearning, cognitive load and engagement separately, few studies have integrated these constructs into a single framework. Previous research has typically studied these variables in isolation (De Gagne 2019; Bond 2020), resulting in a partial understanding of the linkage between instructional design and learning outcomes. New evidence indicates that microlearning can decrease cognitive load and increase the level of interest, which would provide better learning efficiency and performance (Mayer, 2009; Kapp & Defelice, 2019). Additionally, the mediating roles of cognitive load and engagement between microlearning and clinical performance requires further study.

While most studies are set in general educational contexts, with little attention to research specifically on healthcare and nursing education. The identified absence of a unified conceptual model integrating the key aspects impacting clinical performance, such as microlearning design, cognitive processing and learner engagement to account for clinical performance outcomes is evident from the review of existing literature. These studies support the need for an overarching theoretical framework that can explain how microlearning affects both cognitive processing and learning engagement to generate quantifiable clinical performance effects.

3. Problem Statement

Students in healthcare and nursing education need to absorb complex theoretical knowledge and apply it in clinical practice. Conventional methods of delivering content typically present large amounts of information in a condensed manner, which can give rise to cognitive overload and decrease learning (Sweller, 1988; Mayer, 2009). High cognitive load impairs the acquisition of knowledge, willingness to engage with tasks, and performance of clinical skills in learners (Paas 2003; Fraser2012).

Considering these challenges, microlearning is proposed as an innovative solution that delivers content in small chunks which will provide better comprehension (Hug, 2005; De Gagne 2019). In medical education, as there is limited time and attention span amongst learners (Kapp & Defelice, 2019; Leong 2021), microlearning may support acquisition and retention of knowledge over longer periods. Although microlearning has the potential to enhance health practitioner professionalism and performance, there is currently limited understanding of the mechanisms through which it can improve clinical performance. The specific mechanisms that link microlearning to clinical outcomes, particularly those of cognitive load reduction and learning engagement, are not clearly elucidated in existing research. This underscores the need for a systematic conceptual model.

4. Research Gap

While existing studies have looked at microlearning, cognitive load and learning engagement one by one, the integration of these three variables in a comprehensive framework remains scarce (De Gagne 2019; Bond 2020). Only half of the studies (39 out of 78) investigate indirect relationships and take into account mediators through which microlearning is expected to lead learning outcomes.

Table 1 illustrates this methodological synthesis, mapping a representative subset of the 39 (of 78) studies that examine indirect relationships onto the five core microlearning design dimensions adopted in the present model, and specifying how each stream of evidence informs the cognitive-load or engagement pathway proposed here.

Table 1. Mapping of Prior Studies to Core Microlearning Design Dimensions

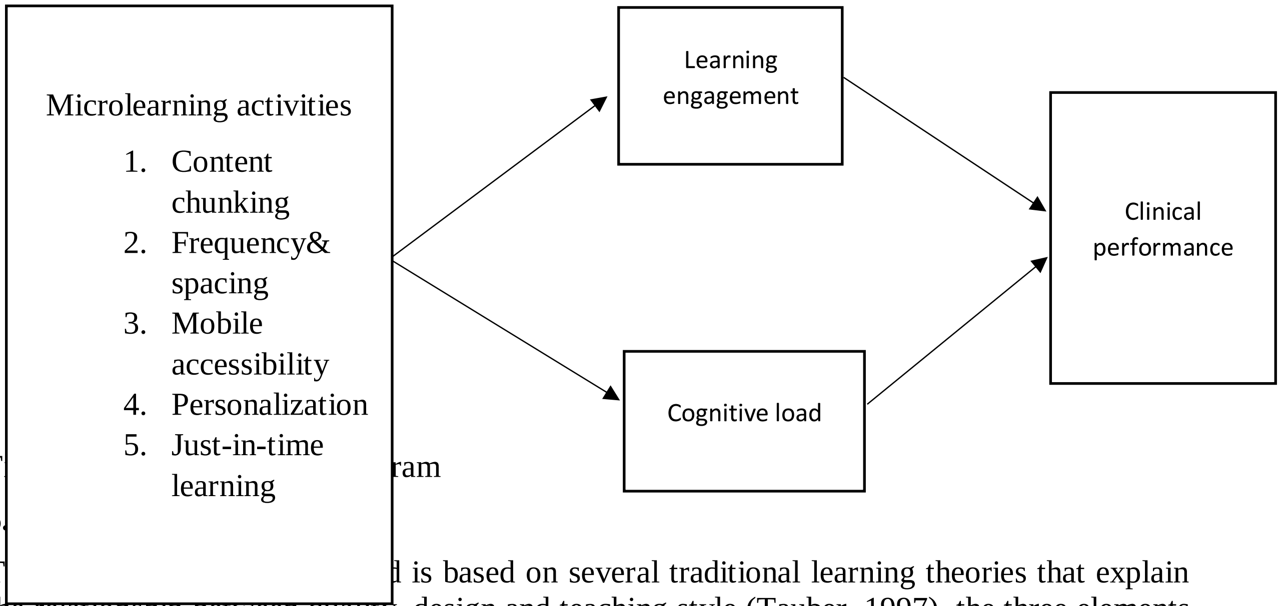
Design Dimension	**Representative Prior Studies**	**Primary Focus of Prior Study**	**Contribution to the Present Conceptual Model**
Content chunking	Mayer & Moreno (2003); Clark, Nguyen & Sweller (2006)	Showed that segmenting information into smaller units reduces extraneous processing demands	Establishes the cognitive-load-reduction pathway linking chunking to intrinsic processing capacity
Spaced repetition	Cepeda (2006); Leppink (2014)	Demonstrated that distributed practice intervals improve long-term retention over massed practice	Supports the retention/transfer link between spacing and durable clinical knowledge
Mobile accessibility	Park (2011); Zarshenas (2022)	Found that anytime/anywhere access increases learner autonomy and eases time-pressure-related overload	Anchors the flexibility–engagement pathway, particularly behavioural engagement
Personalisation	Dabbagh & Kitsantas (2012); Kapp & Defelice (2019)	Linked adaptive content sequencing to self-regulated learning and perceived relevance	Justifies personalisation as a driver of emotional and cognitive engagement
Just-in-time delivery	Gagnon (2019); De Gagne (2019)	Associated point-of-need information delivery with improved application of knowledge in practice	Connects just-in-time delivery to the germane-load and transfer components of the model

Finally, health professions education research has not yet investigated how characteristics of specific microlearning activities such as chunking (which represents the amount and format of information), spacing (raw and relative amounts of time that separate learning occurrences), personalization, or just-in-time learning works preferably to influence cognitive load and engagement similarity during an overall look for retrieval purposes (Buchem & Hamelmann, 2010; Kapp & Defelice, 2019).

In addition, there is very limited research on how these factors translate to clinical performance, the critical endpoint in nursing education (Epstein & Hundert, 2002). Previous research frequently focused on immediate educational outcomes instead of actual clinical performance. Such a conceptual model that provides empirical support of the relationship between microlearning activities, cognitive load and learning engagement to clinical performance is absent.

5. Conceptual Model

A conceptual model in which cognitive load and learning engagement serve as mediators of the relationship between microlearning activites and clinical performance. Microlearning content chunking, frequency& spacing, mobile accessibility, personalization and just-in-time learning are grounded on the hypothesis that minimal cognitive load is associated with reduction of extraneous cognitive load so that larger amount of resources are available for intrinsic processing thereby improving clinical performance. Simultaneously, these activities promote learning engagement by activating cognitive, emotional and behavioral involvement leading to improved retention, upskilling and transferability in clinical practice. Reducing cognitive load, increasing learning engagement through microlearning can possibly lead to interaction effect with improved clinical performance. Based on the principles of Cognitive load theory and Engagement theory, instructional design should not only cover content efficiently but also enhance active engagement, leading to improved clinical outcomes.



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T ... d is based on several traditional learning theories that explain the relationship between quality, design and teaching style (Tauber, 1997), the three elements clubbed together as instructional design and their influence on cognitive processing and learner behaviour. This study constructs a theoretical model based on Cognitive Load Theory (CLT), Engagement Theory, and Multimedia Learning Theory to explain the relationships between microlearning, cognitive load, learning engagement and clinical performance.

6.1 Cognitive Load Theory (CLT)

Cognitive Load Theory, by John Sweller argues that human working memory has limited processing capacity for new information and that instructional design must be cognitively responsible. The theory makes a distinction between three types of cognitive load: intrinsic load (complexity of the content), extraneous load (inefficient instructional design) and germane load (mental effort devoted to learning) (Sweller, 1988; Sweller 2011).

In the field of healthcare education where learners are faced with complex and often high stakes information, too much cognitive load may prevent students from acquiring and applying knowledge (Fraser 2012). Microlearning adheres more to the principles of CLT since it breaks down information into smaller units (content chunking) that lowers extraneous cognitive load, enabling the brain to process content with greater efficiency (Mayer & Moreno, 2003). In addition, other strategies including spaced learning and just-in-time access enhance assimilation by cumulating knowledge structures while managing the germane cognitive load (Paas 2003). Thus, the theoretical framework developed by CLT can logically explain this pathway from the microlearning activities through cognitive load to clinical performance.

6.2 Engagement Theory

Engagement Theory stresses that learners must play an active part in the learning process in order to achieve meaningful learning outcomes. Engagement includes cognitive, emotional, and behavioral dimensions that play an important role in learning (Fredricks et al., 2004). High quality engagement leads to greater motivation, deeper learning that is linked to better academic performance (Bond 2020).

Microlearning environments encourage engagement through interactive, flexible and learner-centered features. Elements like personalization, mobile friendliness, and multimedia integration compel learners to take part in the learning process (Kapp & Defelice, 2019). Engagement in clinical education is paramount because it shapes not only knowledge acquisition but also the cultivation of skills and professional competencies (Benner, 1984). Therefore the association between microlearning activities and learning engagement through Engagement Theory to substantiate the previously established link between engagement and clinical performance is validated.

6.3 Multimedia Learning Theory

Multimedia Learning Theory posited by Richard Mayer states that people learn better from words accompanied by visual images rather than from just words (Mayer, 2009). The theory depends on the dual-channel presumption, which states that humans have two channels (visual and auditory) for processing the received information. Visual images includes multimedia, such as video, infographics, and interactive modules that are well designed (Mayer & Moreno, 2003) to lead to a better understanding and retention. Multimedia Learning supports cognitive efficiency and engagement by presenting information in multiple formats and minimizing excessive cognitive processing. This theory could also provide a rationale for the importance of microlearning design features that can strike an optimal balance between cognitive load and learner engagement.

6.4 Integration of Theories

These three theories provide a good foundation for the proposed conceptual model. Engagement theory supports the proposition that microlearning can reduce cognitive load for better retention and learning experience. The multimedia learning theory emphasises the importance of instructional design on cognitiveand behavioral learning. The two theories combined help to support the relationships outlined in the model. The relationship between microlearning activities and clinical performance is proposed to be mediated through cognitive load reduction and learning engagement. This integration of these theories strengthens the conceptual model and provides the basis for future empirical studies in healthcare education.

7. Discussion

The model proposes that microlearning is not just a passing fad, but a fundamental theory of learning that can enhance clinical performance by reducing the extraneous elements of cognitive load and allowing for more efficient processing of information, ultimately leading to the transfer of these learning experiences into clinical practice (Sweller, 1988; Paas 2003). Meanwhile many aspects of engagement, including flexibility, personalization and interactivity offered by microlearning environments are expected to increase learning and result in a strong relationship with performance outcomes (Fredricks 2004; Bond 2020). Microlearning goes beyond delivering content to improve cognitive processing and maintaining learner engagement through a dual pathway. This dual mediation viewpoint expands both existing literature by providing a coherent explanation of how instructional design can translate into better clinical competence through healthcare education (Bloxham, 2023; Epstein & Hundert, 2002).

8. Implications

This paper has important implications for the theory, practice, and policy of healthcare education. Theoretically, it expands Cognitive Load Theory and engagement frameworks with microlearning context to provide a better explanation of the interface between instructional design and performance in clinical practice (Sweller, 1988; Fredricks 2004). In practice, the model provides educators and instructional designers with guidance to help effectively formulate microlearning modules by highlighting design elements that reduce cognitive load (such as content chunking, spacing, and personalization), thus enhancing engagement to improve clinical competence. The implications of this review highlight that the incorporation of microlearning approaches into nursing curricula and digital learning strategies, through creative delivery methods can support flexible, learner-centric, accessible education and performance-driven content. This paper provides a structure for the proposed development of learning innovations based on evidence regarding cognitive and practical demands, and contextual patterns and process in health professional education.

9. Limitations and Future Research

As the paper is driven purely by theory and past research literature it may be difficult to generalise these hypothesized relationships into real clinical domains. As the framework focuses on a healthcare-centric and pedagogical context, it may have limited application to other disciplines. The model could be expanded to include other significant measures such as self-efficacy, motivation, prior knowledge and technological readiness(Bandura; 1997; Deci & Ryan 2000). The proposed model should be tested in the future – through more quantitative approaches such as structural equation modeling to explore direct and mediating effects. Furthermore, it is recommended for researchers to test for further variables, pursue longitudinal designs to evaluate long-term learning outcomes, and assess the model in different educational and cultural settings so it can be validated within varying populations thus improving generalizability.

10. Conclusion

This conceptual paper focuses on the increasing significance of microlearning as a powerful instructional strategy within healthcare and nursing education. This study presents an integrative model of how clinical performance can be improved through microlearning activities, combining the principles of Cognitive Load Theory and theories from learning engagement literature. The paper centres on the idea that well-designed microlearning reduces cognitive overload, increases learner engagement and thus contributes to assessable knowledge retention, knowledge application, skill development (learning), and transfer of learning in a clinical context (Sweller 1988; Fredricks 2004; Epstein & Hundert 2002). It also provides significance to the academic literature by moving away from direct relationships and highlighting that cognitive load and engagement as mediators, thus allowing for a deeper understanding of what is happening when learning (Santos & Silva, 2021; Schuman et al., 2019). The model provides educators and instructional designers with practical suggestions needed to create more effective, flexible and learner-centered digital learning environments. Hence, this paper provides a robust framework for future empirical work and lays the groundwork for microlearning as a clinical competence-enhancing (and thus healthcare education-optimizing) strategic tool. This theoretical model will be an useful explanatory framework for generating microlearning strategies based on cognitive and engagement principles to improve healthcare education towards building clinical competence.

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