Small Bites, Big Impact: The Power of Nanolearning

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Abstract. Nanolearning (NL) is a promising approach to education and training as it delivers small, bite-sized chunks of learning content that can be easily consumed and retained by learners. This allows quickly accessing specific pieces of information and knowledge, which can be delivered through a variety of mediums, such as videos, podcasts, or mobile applications, etc. NL has significant potential in educational and training settings, where learners or trainers can quickly upskill or reskill in specific contexts, improving their productivity and mastering some topics. This study provides an overview of NL, addressing the design of NL educational materials and its implementation in several educational applications. It also highlights some considerations and issues. In conclusion, it is recommended that reliable learning resources be used by teachers, the content be closely assessed, the source format be considered, bias be checked for, and learner feedback be obtained to ensure the quality of NL materials. By following the proposed NL framework, teachers can provide their learners with top-notch and productive NL resources.

Keywords: Nanolearning · NANO framework · Short-form videos · Bite-sized content · Cognitive load theory · Spaced repetition

1 Introduction

Traditional learning and training methods consume much time and require learner's dedication in today's fast-paced society, where learners have shorter attention spans and many distractions [1]. Cognitive load theory suggests that learners have limited capacity for processing information, and that information should be presented in small, manageable chunks to avoid overwhelming learner's working memory [2]. This can be accomplished

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through strategies such as chunking information, providing worked examples, and utilizing visual aids. Consequently, the concept of Nanolearning (NL) has become a well-liked method for disseminating focused, bite-sized chunks of information that are simple to absorb and remember [3]. For instance, several big social networking platforms like Facebook (Meta) provide a feature "Reel" which is a new way to create short, entertaining videos that can be discovered by new audiences. Similarly, TikTok is also providing similar features that gained users interest and have been widely adopted in education. Some cross-sectional studies suggest an association between NL and Microlearning (ML) in terms of high flexibility, scalability, and cost-effectiveness [4]. NL is a new educational paradigm that focuses on delivering small, focused, and easily understood learning content. It is designed to provide learners with quick and specific information, typically in the form of short videos, interactive learning modules, short quizzes, or infographics resources. The specific objective of NL is to make learning more accessible and efficient, allowing learners to easily consume and retain information in a short amount of time [5].

National Association of State Boards of Accountancy (NASBA) defined NL as "an educational program designed to allow a participant to learn a specific topic in a ten-minute period using electronic media and without real-time interaction" [6]. Khlaif and Salha [7] considered NL as "the condensing of microcontent into small units that are controlled and delivered by learners to achieve a single learning objective." Several lines of evidence described NL as "quick hits of information" and "self-contained or stand-alone, and it offers small nuggets of information" [8].

ML, on the other hand, is "an approach that focuses on a single concept, utilizing multisensory and multimodality in a focused short amount of time" [9]. Both NL and ML, as technology-mediated approaches, have many similarities as both approaches involved delivering small, bite-sized units of knowledge to learners [10]. Despite the widespread use of NL applications, there is a relatively small body of literature that is concerned with it in terms of effectiveness, design, implementation, and the challenges facing its integration in education in general, and in professional development. The purpose of this study is to review recent evidence on the power of NL in education by answering the following research questions:

1) What are the differences between ML and NL?
2) What are the characteristics of NL?
3) How can teachers ensure the quality of NL materials?
4) What are the best practices for designing effective NL?

2 Research Method

Due to the rapid and successive changes in the concept of NL design and implementation, this study used the rapid review approach as emerging methodology to synthesize and summarize evidence on knowledge of single topics in a short period of time [11]. This method provides an overview of the current state of NL to answer the aforementioned research questions, following the rapid review methods recommendations suggested by Garritty et al. [12]. Scientific databases (Scopus, Web of Science, and Google Scholar) were searched because of their wide coverage of the literature and resources related

to the topic. Searching for the literature started in October 2022 and updated in March 2023 by two researchers, using the following term "Nano Learning", A total of 32 papers were obtained from the databases, 12 papers were excluded because of repetition, and the rest of the collected papers were screened and read considering the selection criteria as follow: the paper should be published in the English language and explicitly includes the term NL, in addition to the presence of case studies, presenting results, applications, assessment of educational effectiveness, and providing implications of best practices for designing effective NL.

3 Results and Discussion

This section provides the results reflecting the concept of NL and distinguishing it from ML. Moreover, it presents the characteristics of NL and applications in which NL can be implemented. Several propositions are suggested based on the characteristics of NL, which should be kept in mind by teachers when adopting NL in their teaching practices. Then we are proposing a framework for designing effective NL units and are highlighting the associated challenges in education.

3.1 What is the Difference Between ML and NL?

Notwithstanding, both NL and ML involve delivering small, focused pieces of information, NL is typically used for the delivery of simple concepts or facts, while ML can be used to support a broader range of learning needs and is often designed to meet specific learning objectives. NL, however, is more focused on delivering the smallest possible learning units, while ML activities may be slightly larger in scope and duration [7]. NL is commonly used in situations where learners need to quickly acquire knowledge or skills, such as in emergency response training or safety training [13]. The differences between both approaches are shown in Table 1.

3.2 What Are the Characteristics of NL?

NL can be an effective way to improve learners' learning and engagement, particularly in today's fast-paced and technology-driven age [14]. The first serious discussions and analyses of NL characteristics have been articulated by Gramming et al. [8] as they focused on terms of engagement, retention, and personalization using a variety of media formats such as videos, infographics, or animations to capture learners' attention. It is now well established from a variety of studies that NL enables students to focus on small units of information, which can help to improve their retention and recall of the learning concepts [4]. Moreover, NL can be tailored to individual learners' needs and preferences, allowing for a more personalized learning experience [14]. NL activities are often repetitive in nature, designed to reinforce previously learned concepts or to introduce learners to new topics. This repetition helps to improve retention and recall of information [15]. Figure 1 illustrates some key characteristics of NL which were identified from [1, 3, 7, 13, 15].

Table 1. The difference between ML and NL.

Items	Nanolearning and Microlearning	
	Nanolearning	Microlearning
Focus	Specific and discrete pieces of information	Cover broader topics or multiple related pieces of information
Scope	Focuses on delivering the smallest possible learning activities, dealing with only one idea per piece	Activities are slightly larger in scope and may include more than one idea per piece
Duration (Estimated)	30 s to 2 min	2 to 15 min
Depth	Superficial training with quick reminders for audience	Used to introduce new concepts, improve skills, and provide more comprehensive training
Format	Short videos, visual images, infographics, and text-based activities	Short videos, visual images, infographics, and text-based activities
Audience	Busy professionals, learners with limited time and competency-based training in the workplace, over a short period of time, e.g., one day	Used for a wider range of learners, including those who need to develop some professional skills over a longer period of time, e.g., one month
Learning styles	Self-contained, self-directed	Collaborative and gained feedback from instructors or peers
Cost-effective	More cost-effective than ML methods, as it requires less time and resources to produce and deliver	Needs more cost to produce and deliver learning units

The implementation of NL has many positive effects [5], including keeping the learning material brief and straightforward, cost-effective, and promoting the reusability of learning contents. This involves identifying learning concepts, creating engaging learning activities, delivering them through accessible channels, monitoring and evaluating their effectiveness, and refining them based on feedback and evaluation [16]. NL can also reduce the cognitive load of students [17]. Moreover, NL extends its positive effects to deep learning and the survival of learners' learning by breaking down complex concepts, providing frequent and spaced repetition, personalizing the learning experience, and offering flexibility in delivery [18]. The identified benefits of using NL from the reviewed studies are summarized, as follows:

- *Survival of learning*: NL can help learners retain information over time by providing frequent and spaced repetition of key concepts. This approach helps to reinforce learning and prevent forgetting, which can be particularly helpful for long-term retention of information.

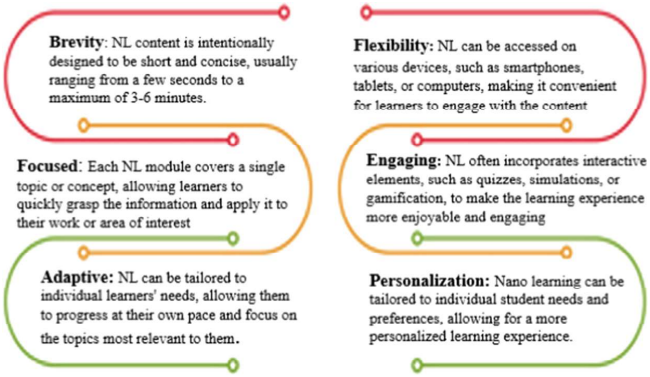

Fig. 1. The key characteristics of Nanolearning

- *Personalization*: NL can be personalized to individual learners' needs and preferences, allowing for a more tailored and effective learning experience. This can help them stay engaged and motivated, leading to better retention and survival of learning.
- *Flexibility*: NL can be delivered in various formats, such as videos, podcasts, or short articles, making it more accessible and flexible for learners who may not have the time or resources for lengthy study sessions. Therefore, this approach can help them fit learning into their busy schedules.

3.3 How Can Teachers Ensure the Quality of NL Materials?

To ensure the quality of NL materials, teachers not only should use reliable sources, evaluate the content carefully, consider the source format, check for bias, and solicit feedback from their students [5], but also consider the theoretical pillars when building their NL materials. Therefore, by analyzing the literature, it is seen that, to the best of our knowledge, no solid theoretical ground of NL is provided, and this hinders NL adoption in education, hence affecting the quality of the learning materials. Accordingly, this part attempts to develop some propositions of NL to ensure the quality of its design.

Proposition 1: Simple content does not imply "ugly" design.

Since the simple content and small amount of information are the main features of NL, this implies that the effective design of learning content is salient to achieve the learning objectives. Therefore, more concern should be paid to the instructional design of NL [14].

Proposition 2: Less is more but much less is much more.

We state this proposition inspired by the popular saying "less is more", when first adopted by a German architect Ludwig Mies van der Rohe. NL has flourished as a promising approach applying the minimalism [19] as lifestyle practice and design philosophy and focused on minimizing distraction and unnecessarily details of things to prioritize what is important. Owing to minimalism as a broad concept of perception, NL strives to refine and shorten the great amount of information to the smallest level [5].

Proposition 3: Repetition of shorter content with repeated intervals facilitates information absorption.

This feature empowered learners to better and deepen their understanding of abstract contents, hence facilitating mastering their learning [21]. This proposition is supported by the spaced repetition learning theory suggesting that learners are more likely to remember information if they are exposed to it multiple times over a period. NL is often delivered in short, frequent sessions that allow learners to review and reinforce information on a regular basis [22].

Proposition 4: NL is a stimulus of learning experience.

The success of NL depends on the learners' motivation, engagement, and ability to transfer their learning to real-world situations. This approach leverages the sense of completion and achievement when the very short and smallest portion is delivered to learners, which motivates them to study and spend more time if they feel engaged with the learning content [10].

Proposition 5: Very short-form of content leads to more control of learning.

While ML aims to achieve a single objective in a short amount of time using short form of content, NL attempts to overpass the microlevel of short content to miniaturize the microlevel to a smaller scale. This miniaturization is in favor of supporting learners' perceptions of control, which could positively reflect on their learning experiences [23]. NL can be used to promote self-directed learning and provide learners with more control over their learning experiences.

3.4 What Are the Best Practices for Designing an Effective NL?

NL has been successfully implemented in various learning settings using apps, online platforms, and gamified learning [19]. These approaches have helped learners learn at their own pace, understand difficult concepts, and improve their grades [20]. Examples of how NL has been successfully implemented in education are given below.

- *Duolingo*: Duolingo is a language learning app that uses NL to deliver bite-sized lessons. The app divides each lesson into small, manageable chunks that can be completed in just a few minutes. This approach has successfully helped learners in learning a new language at their own pace.
- *Quizlet*: Quizlet is a study app that offers NL flashcards and other study tools. The app provides learners with small, bite-sized pieces of information that can be easily memorized. This approach has successfully helped learners in preparing for their exams and improving their grades.
- *Ted-Ed*: Ted-Ed is an educational platform that offers NL videos on various subjects. The platform provides learners with short, engaging videos that explain complex topics in an easy-to-understand manner. This approach has been successful in helping students retain information and understand difficult concepts.
- *Classcraft*: Classcraft is a gamified learning platform that uses NL to deliver game-based lessons. The platform provides learners with small, bite-sized quests that are designed to teach various concepts. This approach has been successful in engaging learners and helping them learn in a fun and interactive way.

4 Nanolearning Framework

Based on the various definitions of NL, as well as its benefits and advantages (see Sect. 1) and propositions (see Sect. 3.3), Fig. 2 proposes a framework to implement NL with various educational applications, considering the theoretical foundations of implementation and building on the aforementioned propositions. As can be seen from the Fig. 2, to effectively design an effective NL, four practical elements should be considered: (1) Needs which highlight to whom (i.e., which type of learners) NL is designed and what needs these types of learners have so that NL can cater to these needs. For instance, if we are targeting a type of learners who are on the move most of the times, static content (e.g., text, image) will not be helpful and it is better to consider a learning format that learners can easily watch, hence learning while moving (e.g., at the airport), such as short audio/video learning content; (2) Affordable design which means, as we pointed out in proposition 1, not anything short should be randomly designed. In contrast, it should be carefully thought of to make the content appealing and accessible; (3) Necessary strategies refer to the different pedagogies used to facilitate consuming the provided learning content, including repetition, visualization, etc.; and (4) Operation which covers the quality standards needed to ensure an effective design and delivery of the content. On the other hand, these practical elements are built on 4 theoretical elements, that is, (1) theories (i.e., learning theories, motivational theories, psychological theories, etc.); (2) Design thinking; (3) Pedagogies; and (4) Quality standards.

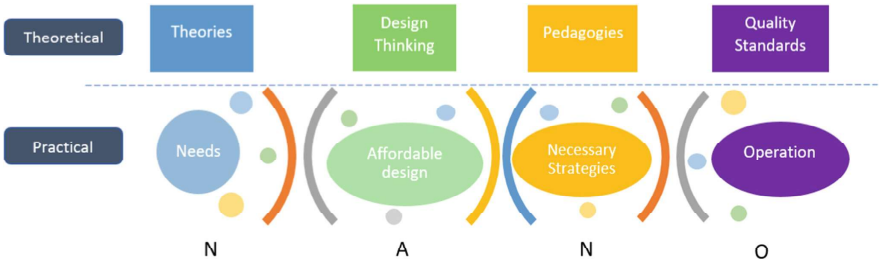

Fig. 2. NANO framework with theoretical and practical foundations

NL implementation with educational applications based on this framework can be summarized as follows:

- **Open Educational Resources (OERs)**: OERs are educational materials that are freely available online and have many forms. NL materials can be created as OERs to support open education [23].
- **Gamification**: Since the micro design approach showed positive impact when various game elements can be incorporated with the gamified assignments [19], incorporating game mechanics such as points, badges, leaderboards, levels, and challenges can make the nano learning experience more interactive and rewarding.
- **Short-form videos**: Short-form videos provide concise and focused information on specific topics, making them readily understandable. The duration of the video determines whether it is on the nano level (a few seconds to a few minutes) or the micro

level (a few minutes). Nano videos can introduce new concepts, demonstrate procedures, or summarize complex ideas. Short-form videos can also be gamified to engage viewers.

- **Location-based learning:** Location-based learning and NL can be connected to create a more immersive and contextualized learning experiences as follows:

  - Location-based triggers: It can be used to deliver NL content that is relevant to a learner's location. For example, a museum could use location-based triggers to deliver short-form videos to visitors as they move through the exhibits.
  - Augment reality (AR)-based NL: AR technology allows overlaying NL elements onto real-world locations. For example, learners could use a mobile app to scan a QR code at a specific location and access NL objects related to that location.

- **Flipped classrooms**: Flipped classrooms and NL can be combined to create an effective learning experience. A flipped classroom reverses the traditional order of learning, with learners engaging in pre-class learning materials and then attending class for interactive activities. NL can be incorporated into the pre-class learning materials to enhance the learning experience [17].

5 Conclusion

Nanolearning (NL) is a new approach for delivering small learning content that can be effectively retained. However, it is important to recognize its limitations, such as its limited scope and interactivity, and the risk of oversimplification. Consequently, it is crucial to ensure that the content is highly relevant, well-designed, and appropriately targeted to the intended audience to optimize the effectiveness of NL. By addressing these factors, NL has the potential to transform the way we learn and acquire knowledge in the digital age. Despite the limited information available on NL, this study takes a step forward in exploring its potential for enhancing education, as well as identifying key considerations for stakeholders such as educators and instructional designers. To this end, the study introduces the NANO framework and proposes a set of guidelines that stakeholders can use when adopting NL in their contexts.

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