Microlearning in Diverse Contexts: A Bibliometric Analysis

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Abstract
In recent years, publications on microlearning have substantially increased, as this topic has received extensive attention from scholars in the instructional design and technology discipline. To better characterize and understand microlearning, there is a need for comprehensive bibliometrics assessments of the literature on microlearning. To this end, this bibliometric study collected 208 relevant publications on microlearning from the Scopus database, published in diverse contexts. Using quantitative topic modeling and qualitative content analysis methods, we identified four major themes in these publications, namely: (1) design of microlearning; (2) implementation of microlearning as an instructional method strategy and an intervention; (3) evaluation of microlearning; and (4) the utilization of mobile devices for microlearning. Based on the study findings, we discuss the significance of the study and provide implications for research and practice, particularly in fostering rigorous inquiry on the topic of microlearning, expanding the context of research to include K-12 settings, and focusing on mobile-based microlearning.

Keywords Microlearning · Bibliometrics · Instructional design and technology

Introduction
Microlearning (Micro Learning, Micro-learning) is a format of learning that is becoming popular among learning professionals in both higher education and corporate settings. This format of learning, by design, emphasizes the brevity of learning experiences through a well-known instructional design technique known as chunking (Gobet, 2005). However, microlearning is not about just breaking down a three-hour recorded lecture or a five-hour training session into small pieces; it is an action-oriented, technology-enhanced learning format that converts complex information that transforms a specific outcome or learning goal into a bite-sized, easily digestible form that enables practice for the learners (Allela, 2021).

For instance, Walmart® wanted to predict at-risk behaviors in its distribution centers to provide a world-class safety culture by reducing safety incidents in all Walmart Logistics locations. Microlearning safety training was implemented across 150 distribution centers to 75,000 Walmart associates. This microlearning implementation resulted in a 54% reduction in safety incidents at eight Walmart distribution centers, 96% positive employee behavior observations, 91% of voluntary participation in training by employees, and an 8% increase in associates’ job confidence. Likewise, another popular retailer Bloomingdale® implemented safety training for all of its 10,000 employees using a gamified microlearning approach. This microlearning implementation was a huge success, resulting in $10 million savings in safety claims, 41% reduction in safety claims, 90% of voluntary employee participation, and 87% increase in job confidence reported by employees (Case-studies, 2018).

Microlearning enables learners to meet their immediate learning needs by providing just-in-time information on this...
constantly changing world (Leong et al., 2020). There are many modes and delivery formats of microlearning content, such as: (1) image-based microlearning content, including infographics, process-diagrams, memes, and animated GIFs; (2) audio-based microlearning content, including short narratives and podcasts; and (3) video-based microlearning content, including video flashcards, screencasts, microlearning vlogs, demonstration videos, and time-lapse videos. Therefore, in microlearning, the learning content is designed and delivered in short, manageable chunks for the learners, allowing them to access it whenever, wherever, and in whatever media format they like to learn (Mohammed et al., 2018).

Though many definitions exist for microlearning, we can safely say that they all represent small, digestible chunks of information that are heavily focused on a single learning objective and are logically organized so the learning content is available on demand, is compatible with mobile devices, and provides learners full control over their own learning. Hug (2005) provides a holistic definition of microlearning based on seven dimensions that is used by many researchers in the microlearning literature. Hug’s definition includes: (1) content: very small learning units, narrow topics, or simple issue; (2) curriculum: part of curricula, set of modules, or an element of informal learning; (3) form: fragments, knowledge episodes, or nuggets; (4) learning type: behaviorist, constructivist, classroom learning, problem-based learning, or corporate learning; (5) medium: face-to-face vs. multimedia, or learning objects; (6) process: stand-alone, situated, integrated, or iterative; and (7) time: relatively short effort, measurable time, or degree of time consumption.

Further, in their extensive review of 476 total publications using the Scopus database and internet searches through Google Trends, Leong et al. (2020) found that microlearning is new but an emerging global educational topic that soon could become a mature and major trend. Indeed, microlearning has become a novel instructional strategy in fields such as computer science and programming (Mathews et al., 2014; Polasek & Javorcik, 2019a); health sciences education (Gross et al., 2019; Prior Flipe et al., 2020; Wang et al., 2020); language learning (Edge et al., 2011; Khong & Kabilan, 2020); workplace learning (Dolasinski & Reynolds, 2020; Emerson & Berge, 2018; Göschlberger & Bruck, 2017); adult and continuing education (So et al., 2018; Zaqoot et al., 2020; Zhao et al., 2010) and vocational education and professional development (Shamir-Inbal & Blau, 2020; Zhang & West, 2020).

Subsequently, microlearning has evolved from a seven-dimensional framework proposed by Hug (2005) to a technology-enhanced learning format. This format uses focused, short-term learning units called microcontent that are highly interactive, outcome-oriented, and contain some form of learning assessment (Bruck et al., 2012; Hug, 2005; Kadhem, 2017; Kovachev et al., 2011). A few researchers have contributed significantly to the theoretical and empirical work to the existing body of knowledge, which further extends the definition of microlearning. For example, Kovachev et al. (2011) added a technology component to Hug’s (2005) definition, defining microlearning as a technology-enhanced learning format that uses small, focused learning units that could be learned in a short period of time (Kovachev et al., 2011). Further, Bruck et al. (2012) added two additional constructs to Kovachev et al.’s (2011) definition, namely (1) high interactivity and (2) instant feedback. Specifically, they defined microlearning as learning in small chunks of content with high-level interaction and instant feedback. Further, an assessment component was later added (Lin et al., 2019).

Similarly, Göschlberger and Bruck (2017) defined microlearning by focusing on the digital delivery medium. They defined microlearning as a didactic concept, where short, self-contained, and coherent learning content is delivered through digital media (Göschlberger, 2017; Göschlberger & Bruck, 2017). According to Buchem and Hamelmann (2010), the didactical design of microlearning content and microlearning activities included five major principles: (1) autonomy, (2) addressability, (3) focus, (4) format, and (5) structure.

Purpose of the Study

In this study, we define microlearning as an instructional strategy, where the learning content is divided into small, focused activities and delivered digitally in an easily digestible form that is outcome-oriented (Emerson & Berge, 2018; Grevtseva et al., 2017; Nikou & Economides, 2018). A handful of researchers have synthesized the current state of microlearning literature in their respective fields (e.g., De Gagne et al., 2019; Lee, 2021; Lin et al., 2019; Shail, 2019). However, to better understand and characterize the topic of microlearning in the instructional design and technology discipline, there is a need for a comprehensive bibliometric assessment of the literature across all diverse academic disciplines within education. Thus, the objective of this study is to conduct an empirical, bibliometric analysis of microlearning in diverse academic disciplines. The following research questions guided this study:

1. What is the publication landscape (year-wise distribution of publications, authorship patterns, most-relevant sources, and most cited publications) of microlearning research?
2. What are the common topics and themes that are addressed in microlearning publications?

Methods

In this section, we describe our study design, the search strategy we executed, and the selection procedure of literature. We also describe how we used qualitative content analysis.
**Study Design**

This study aimed to conduct a bibliometric analysis of microlearning literature to explore the publication landscape and to identify the common topics and research themes of this vibrant research area. Bibliometrics is a quantitative analysis technique used to broadly identify the bibliographic overviews of published literature in a particular field using statistical tools (Ellegaard & Wallin, 2015). These bibliographic overviews generally include but are not limited to author productions, publishing patterns such as geographical and institutional aspects, performance indicators over time, and types of literature and authorships (Ellegaard & Wallin, 2015). The bibliometric analysis is closely related to the field of scientometrics (Phillips & Ozogul, 2020). In order to conduct a bibliometric analysis, the corpus of literature in a given field is identified through search terms, and then a content or citation analysis is often used (Wallin, 2005). To that end, we first created the corpus of the published microlearning literature from the Scopus database using the search terms. Second, we employed a quantitative approach using topic modeling to investigate emerging themes in the abstracts (Eickhoff & Wieneke, 2018; Hesse-Biber, 2010). Then, we conducted a qualitative content analysis to draw meaningful themes dominant from the dataset. Using the Bibliometrix package in R studio, we sought to understand the publication landscape of the microlearning literature (n = 208) from the Scopus database. Following that, we conducted a quantitative topic modeling analysis to identify the dominant research topics and themes from these publications (Eickhoff & Wieneke, 2018; Hesse-Biber, 2010). Finally, we conducted a qualitative content analysis to analyze the abstract of these publications and assign them to research topics and themes that we identified from the topic modeling. Thus, quantitative analysis using topic modeling helped us identify the major topic themes of microlearning publications. The qualitative content analysis helped us conduct a more granular and detailed analysis to draw meaningful conclusions from these research themes. The study design is shown in Fig. 1. The search strategy, selection criteria, and selection procedure of publications are discussed below.

**Search Strategy: Databases and Search Keywords**

We collected the data for the bibliometric analysis of microlearning publications from the Scopus database toward the end of 2021. We used the following three sets of keywords as search terms: *micro learning* OR *micro-learning* OR *microlearning*. We chose the Scopus database because it has the largest number of journals in diverse subject areas such as Life Sciences, Health Sciences, Physical Sciences, Social Sciences, and Arts and Humanities. Additionally, Scopus provides a user-friendly interface with rich authorship information (Li et al., 2010). Though Scopus does not contain the oldest of the citation indexes compared to Web of Science (Ellegaard & Wallin, 2015), the number of records retrieved based on the search terms for this study resulted in only 90 publications compared to the 368 records from the Scopus database.
database. As such, Scopus is more comprehensive. Moreover, due to the difficulty of transposing data from multiple databases into a single format, it is common practice in bibliometric studies to use only one database (e.g., Cheng et al., 2014), and it is generally accepted that a subset of published literature from one database could be used for tentative generalizations (e.g., Phillips & Ozogul, 2020).

**Selection Procedure**

Table 1 shows the inclusion and exclusion criteria for the publications. We selected these publications based on Lee’s (2021) five steps. In step 1, we identified all the publications related to the search terms using keywords in the Scopus database (n = 368). In step 2, we identified the publications that met the eligibility criteria (inclusion criteria) (n = 320). In Step 3, we screened the initial set of publications for duplicates and excluded the publications with no abstract (n = 311); In step 4, we assessed the abstract of the publications to determine if they could help answer our research questions (Bano et al., 2018). Based on step 4, we excluded the publications that did not fit in the proposed definition of microlearning (n = 103). These included the publications that had duplicates and the term microlearning with different definitions, such as used in communities of practice (i.e., micro, meso, and macro learning) or in wireless sensors and security sensors, where they had a different meaning related to their discipline. In step 5, we finalized the list of articles that we deemed to fit the study’s purpose (n = 208).

To discover emerging research topics from the microlearning literature and aid our quantitative analysis, we relied on the Latent Dirichlet Allocation (LDA) algorithm. LDA is a generative probabilistic model where text sources are represented by a mixture of hidden topics over a distribution of words (Blei et al., 2003). LDA is one of the most powerful topic modeling techniques across multiple disciplines for data mining, latent data discovery, and finding relationships among data and text documents (Albalawi et al., 2020; Chen et al., 2020; Jelodar et al., 2019). We used the Gensim library in Python 3.7.7 to load LDA to generate word representations and probabilities using the bag-of-words (BoW) and Term Frequency-Inverse Document Frequency (TF-IDF) models (Rehurek, 2009). The BoW topic model measured the occurrence of words within the abstracts but did not provide information about the order or structures of words. We used the BoW topic model to generate a TF-IDF topic model to obtain the relevance of words based on the occurrences of each word and against the text sources. In TF-IDF, a word is considered relevant when it occurred in a few abstracts and low if it occurred in many abstracts.

We used a regular implementation of the algorithm with the LDA model to process the abstracts. The required parameters for LDA included corpus and id2word. The corpus parameter represented the text input that was represented in the form of a sparse matrix of words to allow for the discovery of emerging topics. The id2word parameter determines the vocabulary size of the text sources. The optional parameters in LDA included chunksize, passes, document-topic density (alpha), and word-topic density (beta) that required to be tuned. The chunksize parameter was set to process the entire text of abstracts all at once for training and testing. The pass parameter was set to 20 where LDA performed 20 iterations for training and testing purposes. Regarding the document-topic density (alpha) and word-topic density (beta) parameters, these parameters were set to ‘auto’ where the LDA algorithm estimated the document-topic and word-topic densities automatically.

LDA also required a specific parameter to determine the exact number of topics (n_topics) to achieve distinct and semantically coherent topics. This step was crucial because topic coherence measures the degree of semantic similarity between scoring words in the topic. For this corpus of publications (n = 208), the ideal number of topics parameter was performed several times with multiple parameters ranging from 2 to 20 until achieving the highest coherence (or C_v) value, to identify semantically coherent words with distinct topics. The highest C_v value was 0.267 as the designated topic parameter.

The TF-IDF topic model provided 13 topics as a better representation of words and topics in the first stage of label assignment. In this first stage, we noticed overlapping topic structures in (1) microlearning design in higher education, (2) implementation of microlearning for adult learning, and (3) evaluation of microlearning interventions. After

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**Table 1** Publications Inclusion and Exclusion Criteria

| Inclusion Criteria                                      | Exclusion Criteria                                         |
|--------------------------------------------------------|------------------------------------------------------------|
| Must be peer-reviewed and written in English           | Not peer-reviewed and not written in English               |
| Must be in one of the following formats: Articles, Conference Papers, and Book Chapters | Following formats: Reviews, Notes, Letters, Conference Reviews, and Books |
| Must include at least one of the keywords—microlearning, micro-learning, and microlearning | Without any abstract and keywords                          |
| Must have been published between 2005 and 2021. 2005 was chosen as the beginning year because it was the year that microlearning was more properly codified as a term for research | Published before 2005                                      |
| Must be indexed under the Scopus database               | Not indexed in the Scopus database                          |
inspecting these 13 topics, we merged them to create four major research topics from the microlearning publications as follows: (1) design of microlearning content; (2) implementation of microlearning as an instructional method, strategy, or intervention; (3) evaluation of microlearning approach; and (4) the utilization of microlearning for mobile devices. Table 2 describes the topic label assignments.

**Qualitative Analysis of Publications Using Qualitative Content Analysis**

In the second stage, we generated a list of codes from each of the four major research topics that aligned with each research topic. We considered the four major topics identified through topic modeling as the main categories that further needed to be distilled into specific codes. We met regularly to ensure a consistent interpretation of these publications. Through multiple coding cycles, we discussed our interpretation of these publications and the extent to which the LDA algorithm was accurate in proposing emerging topic themes and their respective contexts. We then used these topics to code the abstract of the publications and coded consistently among us. Our coding process consisted of two cycles. During the first cycle, each of us took part in the data and applied codes to each publication we were assigned to analyze. In the second cycle, we reviewed each other’s codes, asked questions, and sorted out our differences until we reached a consensus. We ensured that we had a collective understanding of the publications, the codes, and the four emerging topics that served as categories and themes. We ensured intercoder reliability through multiple meetings, discussing our coding work, and refining our coding in the second cycle. As a result, we improved our trustworthiness and reduced bias and subjectivity. We coded the articles based on the abstracts and high-level reading of the articles.

**Results**

In this section, we answer the research questions of the study based on the analyses we carried out, as described in the previous section.

**RQ 1: What is the Publication Landscape (Year-Wise Distribution of Publications, Authorship Patterns, Most-Relevant Sources, and Most Cited Publications) of Microlearning Research?**

As discussed, we analyzed a total of 208 publications from the Scopus database that met the inclusion criteria. The final set of publications included book chapters (n = 3), articles (n = 74), and conference papers (n = 131). We collected descriptive statistics on these publications to gain a preliminary understanding of the microlearning publication landscape. The following section outlines the publication landscape of the microlearning research literature in the Scopus database.

**Year-Wise Distribution of Publications**

The annual growth rate of microlearning publications is 33.5%. The earliest microlearning publication in the Scopus database was a book chapter titled *Integrated microlearning during access delays: A new approach to second-language learning* published by Gstrein and Hug in the area of user-centered, computer-aided language learning in 2005. The authors proposed a novel way of integrating language learning into a learner’s daily routine with the help of electronic devices. Since then, we have seen an upward growth in the publication trend of microlearning. Since 2019, microlearning has received increasing attention, and the growth rate has surged, as shown in Fig. 2.

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**Table 2  Topic Label Assignments**

| Topic | Stage 1 Label | Stage 2 Label                  |
|-------|---------------|--------------------------------|
| 1     | Microlearning design in distance learning | Designing of microlearning content |
| 2     | Microlearning design in the workplace | Implementation of microlearning as an instructional method, strategy, or intervention |
| 3     | Microlearning design in higher education |                                  |
| 4     | Microlearning design in higher education |                                  |
| 5     | Microlearning design as a teaching method, strategy, or intervention |                                  |
| 6     | Implementation of microlearning for professional development |                                  |
| 7     | Implementation of microlearning for blended learning |                                  |
| 8     | Implementation of microlearning for language acquisition |                                  |
| 9     | Implementation of microlearning for adult learning |                                  |
| 10    | Implementation of microlearning for adult learning |                                  |
| 11    | Evaluation of microlearning interventions | Evaluation of microlearning approach |
| 12    | Evaluation of microlearning interventions |                                  |
| 13    | Utilizing microlearning for mobile devices | Utilizing microlearning for mobile devices |
Authorship Patterns

We analyzed the authorship patterns to determine the percentages of single and multiple authorship and the most prolific authors publishing on microlearning. We found that most of the publications involved multiple authorship compared to single authorship. Authors per publication were 2.61, whereas co-authors per publication were 3.17, and the collaboration index was 3.01. We found a total of 543 contributors for 208 articles in these microlearning publications. Out of 208 articles, there were 174 multi-authored publications and 34 single-authored publications. TOMÁŠ Javorčík and Radim Polasek have contributed eight publications and seven publications, respectively; Jiayin Lin and Jan Skalka have contributed six publications each, whereas six other authors have a contribution of at least four publications. Table 3 shows the most prolific authors of microlearning publications ranked by total citations.

Most Relevant Sources

Our analysis showed that the conference proceedings are the most common publication outlet on microlearning. Out of 208 publications, there were 131 conference papers, three book chapters, and 74 articles. Lecture Notes in Computer Science was the most relevant source with nine publications, followed by Proceedings of the European Conference on e-Learning with seven publications. Three sources named ACM International Conference Proceedings Series, Conference on Human Factors in Computing Systems Proceedings, and Journal of Physics: Conference Series had six publications each. For journals, Advances in Intelligent Systems and Computing is the most relevant journal with five articles, followed by the International Journal of Emerging Technologies in Learning with four articles and the journal of Interactive Learning Environments with three articles. Table 4 highlights the influential journals and conference proceedings of the microlearning publications (sorted by publication number) along with their impact factors.

Table 3 Most Prolific Authors of Microlearning Publications Ranked by Total Citations

| Author          | Total Citations | Number of Publications | h_Index | Publication Start Year |
|-----------------|-----------------|------------------------|---------|------------------------|
| Bruck. P. A     | 96              | 4                      | 4       | 2012                   |
| Zhang. Y        | 26              | 5                      | 3       | 2016                   |
| Skalka. J       | 22              | 6                      | 3       | 2018                   |
| Lin. J          | 15              | 6                      | 3       | 2019                   |
| Cui. T          | 14              | 4                      | 3       | 2019                   |
| Li. L           | 14              | 4                      | 3       | 2019                   |
| Javorcik. T     | 12              | 8                      | 2       | 2018                   |
| Polasek. R      | 12              | 7                      | 2       | 2018                   |
| Drik. M         | 12              | 4                      | 3       | 2018                   |
| Lee. Y. M       | 11              | 4                      | 2       | 2020                   |

Most Cited Publications

The conference proceeding titled MicroMandarin: Mobile language learning in context authored by Edge et al. (2011) published in Conference on Human Factors in Computing Systems was the most cited publication with 83 citations. This publication was followed by an article authored by Fozdar and Kumar (2007) titled Mobile learning and student retention published in the International Review of Research in Open and Distance Learning with 55 citations. The articles authored by Nikou and Economides (2018) titled Mobile-Based micro-Learning and Assessment: Impact on learning performance and motivation of high school students published in the Journal of Computer Assisted Learning and the article authored by Kovachev et al. (2011) titled Learn-as-you-go: New ways of cloud-based micro-learning for the mobile web published in the Lecture Notes Computer Science had 54 citations each. Table 5 shows the most cited publications (sorted by the number of total citations) along with the source, authors, and total citations per year.
RQ 2: What are the Common Topics and Themes in Microlearning Publications?

As discussed earlier, we identified four major research topics and themes based on quantitative topic modeling and triangulated them with qualitative content analysis approaches. Table 6 outlines the distribution of the microlearning publications across these major topics and themes. Evaluating the effects and effectiveness of microlearning is the most researched topic (n = 64), followed by the design of microlearning (n = 52).

Evaluation of Microlearning

Evaluating the effects and effectiveness of microlearning as an intervention was the most common research topic (n = 64) with 30% of the total publications. The subtopics within this research topic included: (1) evaluating the effectiveness of microlearning regarding its opportunities and advantages from a student perspective (Aldosemani, 2019; Bowler et al., 2021; Brebera, 2017; Dixit et al., 2021; Dolasinski & Reynolds, 2020); (2) evaluating microlearning in relation to the learning process, learner outcomes, and learner performance based on learner satisfaction and perceptions (e.g., Inker et al., 2021); (3) evaluating learning and training needs (e.g., Yang and Xu, 2021); and (4) the usability of microlearning intervention during the COVID-19 pandemic (e.g., Goschberger & Anderst-Kotsis, 2019).

Design of Microlearning

Microlearning content design was the second most researched topic (n = 52), with 25% of the total publications. The sub-topics within this research topic included: (1) designing microlearning content based on best practices and technology (e.g., Alqurashi, 2017); (2) designing microlearning content for interactivity and game-based learning techniques (e.g., Dahlmans et al., 2020); (3) designing microlearning with social media (e.g., Greve et al., 2017); (4) designing microlearning content using Virtual Reality and Augmented Reality technology (e.g., Horst & Dörner, 2019); (5) designing microlearning content to reduce cognitive load (e.g., Lin et al., 2020); and (6) designing microlearning content for various subject areas based on expected learning outcomes (Inie & Lungu, 2021; Skalka et al., 2020; Zhao, 2021).

Utilization of Mobile Devices for Microlearning

Using mobile devices for microlearning was the third most researched topic (n = 47), with 22% of the total publications. The sub-topics within this research topic included: (1) utilizing mobile microlearning for language learning (e.g., Epp & Phirangee, 2019); (2) utilizing mobile microlearning to improve learning performance and learner motivation (e.g., Nikolaou & Economides, 2018); and (3) utilizing mobile microlearning to improve learner retention and learner engagement (e.g., Kadhem, 2017).

Implementation of Microlearning as an Instructional Method or Strategy or an Intervention

Implementation of microlearning as an instructional method, a strategy, or an intervention was the fourth most researched topic (n = 39). The sub-topics within this research topic included: (1) implementing microlearning to improve corporate training (e.g., Walaszczysz & Dingli, 2020); (2) implementing microlearning to improve language learning (e.g., Zhang, 2017); (3) implementing microlearning to improve learning efficacy (e.g., Lee et al., 2021); and (4) implementing microlearning to enhance student experience post-COVID-19 (e.g., Gill et al., 2020).
Study Contexts Reported in Microlearning Publications

Based on our qualitative coding analysis of 208 publications, we identified the following seven study contexts: (1) adult and continuing education, (2) higher education, (3) K-12 schools, (4) language education, (5) medical and health sciences education, (6) massive open online courses (MOOCs), and (7) organizational settings. Higher education was the most researched study context (n=55), followed by corporate training (n=28); almost 40% of the publications were based on these two settings. Similarly, K-12 school settings were the least researched study context (n=5) among the publications we analyzed. More than a quarter of the publications either did not report a context or had more than one context. The distribution of publications in each study context is shown in Table 7.

Discussion

The Outlook of Publication Landscape on Microlearning

The annual 33.5% growth rate of microlearning publications indicates that this topic is gaining momentum and does not appear to be a fading trend. As a topic of inquiry, microlearning...
seems to offer diverse research opportunities from multiple perspectives. Additionally, this increased attention to microlearning in instructional design and technology research could be explained by the changing perception of what educational stakeholders consider as valid and worthy learning formats—16-week courses or days-long training are not the only valid or worthy learning formats. That being said, we can reasonably suspect a steady increase in publication growth on the topic of microlearning in the next few years, given the challenges and the opportunities that the COVID-19 pandemic presented.

The authorship and citation patterns of microlearning literature seem to be different from other major research topics concerned with the subject of learning (e.g., authentic learning, problem-based learning, motivation design for learning, multimedia design for learning). Unlike these topics, literature on microlearning lacks a major referenced and widely celebrated and accepted work (e.g., authentic learning: Herrington & Oliver, 2000; problem-based learning: Hmelo-Silver, 2004; motivation design for learning: Keller, 2009; multimedia design for learning: Mayer, 2008). It does not seem that there is one major scholar or group of scholars who have an established theory and body of work on microlearning to the extent they have become a major reference or, at least, have a foundational theoretical work that rigorous scholarship must consider. In fact, the most active scholar publishing on microlearning (Javorcik, eight publications) has a comparatively low number of citations (12) compared to other active scholars listed in Table 3.

Further, as evident by the high number of conference proceedings in diverse academic disciplines, microlearning literature seems to be heavily suited in computer and medical sciences. This could be partially explained by the fact that these disciplines introduced learning formats that were found to be suitable to and compatible with the needs and demands of the subject areas taught within these disciplines. Computer science discipline in specific seems to offer diverse research opportunities from multiple perspectives. Additionally, this increased attention to microlearning in instructional design and technology research could be explained by the changing perception of what educational stakeholders consider as valid and worthy learning formats—16-week courses or days-long training are not the only valid or worthy learning formats. That being said, we can reasonably suspect a steady increase in publication growth on the topic of microlearning in the next few years, given the challenges and the opportunities that the COVID-19 pandemic presented.

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### Table 7 Study Contexts of Microlearning Publications

| Study Contexts                        | Number of Publications | Percentage of Publications |
|---------------------------------------|------------------------|---------------------------|
| Higher Education                      | 55                     | 26.44%                    |
| Did not report                        | 48                     | 23.08%                    |
| Organizational Training               | 28                     | 13.46%                    |
| Adult and Continuing Education        | 23                     | 11.06%                    |
| Medical and Health Sciences Education | 22                     | 10.58%                    |
| Language Education                    | 21                     | 10.10%                    |
| MOOCs                                 | 6                      | 2.88%                     |
| K-12 Schools                          | 5                      | 2.40%                     |

### Microlearning is an Effective Instructional Strategy or an Intervention in Diverse Contexts and Subject Areas

One of the key findings from this study is that microlearning as an instructional strategy or intervention is widely used across different contexts and disciplines, such as higher education (e.g., Dolasinski & Reynolds, 2021), corporate settings (e.g., Arnab et al., 2020), MOOCs (e.g., Zhang, 2017), K-12 schools (e.g., Nikou & Economides, 2018), language education (e.g., Khong & Kabilan, 2020), health sciences education (Smolle et al., 2021), and computer science programming (Skalka & Drlik, 2018, 2020). Specifically, our analysis of reviewed literature has shown microlearning as an effective instructional strategy or intervention in higher education (online, hybrid, and blended courses), corporate training, and K-12 teacher professional development. For instance, microlearning has been utilized in higher education courses for the following purposes: (1) to increase motivation and engagement with course content and activities through its flexibility (Aitchanov et al., 2018; Lee et al., 2021; Zhao et al., 2016); (2) to encourage self-regulated learning (Cheng et al., 2020; Hermann & Gruhn, 2018); and (3) to predict students' behavioral engagement in a course with the use of learning analytics (Wan Hamzah et al., 2021).

Likewise, microlearning has been utilized as an instructional strategy or intervention in a corporate setting in order to increase knowledge retention and provide “just-in-time” training to stay abreast on new knowledge and remain competitive (Walaszczyk & Dingli, 2020). In addition, microlearning has been discussed as a cost-effective strategy for corporate training (Beste, 2021). Further, microlearning has been used in K-12 settings for teacher professional development (Ma et al., 2021; Shamir-Inbal & Blau, 2020; Xiao et al., 2020). The key rationale for implementing microlearning in K-12 teacher professional development was to increase knowledge construction (Ma et al., 2021) and stimulate self-regulated learning (Shamir-Inbal & Blau, 2020; Xiao et al., 2020).

### Microlearning As an Instructional Strategy or Intervention During the COVID-19 Pandemic

Our analysis reveals another interesting finding: Microlearning as an instructional approach received wide attention during the COVID-19 pandemic (Dixit et al., 2021;
Gómez et al., 2021; Qian et al., 2021; Redondo et al., 2020; Smolle et al., 2021; Sözmen et al., 2021; Triana et al., 2021; Yarnykh, 2021). Some of the reported benefits of microlearning during COVID-19 were related to the flexibility of the microlearning format and its manageable small parts of educational content. This quality speaks to the importance of responsive, demand-oriented instructional design solutions that allow learners to quickly access learning materials and activities to gain needed knowledge and skills efficiently and readily apply them in their respective contexts. Importantly, the authors of these publications reported the importance of microlearning during COVID-19 to increase motivation for autonomous learning and enhance performance (Qian et al., 2021; Sözmen et al., 2021; Zandbergs et al., 2021). Using microlearning as an instructional strategy or an intervention during COVID-19 can be explained because social distancing measures prevented learners from being physically in the classroom or their organizations. Being physically present would allow for the opportunity to ask questions and receive answers and feedback immediately. However, an online learning environment has certain limitations, so learning materials and activities should be as clear and purposeful as possible, thus, micro-designed.

**Evaluation Studies are a Major Research Focus of Microlearning Publications**

Our qualitative analysis revealed that evaluation studies are the major research focus of microlearning publications. Notably, many authors emphasized evaluating microlearning in terms of its effectiveness as an instructional intervention (e.g., Aldosemani, 2019; Bowler et al., 2021; Polasek & Javorcik, 2019b), while others investigated the learner characteristics, such as motivation, engagement, satisfaction, and self-regulated learning strategies (e.g., Javorcik & Polasek, 2019; Shamir-Inbal & Blau, 2020; Yin et al., 2021). Even though most studies have taken place in the higher education context, we also saw some evaluation studies in other contexts, such as organizational settings, medical and health sciences education, and language education.

**Microlearning is Designed and Implemented in a Variety of Forms**

The findings from this study also revealed that microlearning is designed and implemented in various contexts in different ways. For example, microlearning can take the form of a game and can be called *gamified microlearning* (e.g., Arnab et al., 2020; Bruck et al., 2012). Microlearning can take the form of short educational videos (e.g., Rahman et al., 2021), and it can also be designed and implemented as targeted short activities, including quizzes (e.g., Triana et al., 2021). Social media, mobile technologies, and web-based modes are extensively used to implement microlearning, such as: (1) Twitter and Facebook (e.g., Kovacs, 2015); (2) mobile applications, such as WeChat (e.g., Zhang et al., 2019); and (3) chat-bot environment (Yin et al., 2021).

**Microlearning is Utilized Mostly in Higher Education and Organizational Settings and Not Utilized as Much in K-12 School Settings**

The findings from this study revealed that higher education and organizational settings are the most researched context in microlearning publications. Almost 40% of the studies were reported in those contexts, and these studies focused on all the five research themes. Higher education and business organizations increasingly value microlearning for various reasons. For example, the rationale behind using microlearning in non-degree seeking programs in business and corporate settings, such as in training programs or certificate programs, is evident. We posit that one obvious reason is the acceptance of the stackable credentials strategy that current learners and professionals opt for — it is no longer reasonable to expect that everyone has the affordability to dedicate three to four years of their lives to go through a degree-seeking intense educational and learning experience. In this respect, microlearning could be a valid path toward developing and earning stackable credentials through non-degree seeking programs. Also, business organizations, as a matter of default value to efficiency, value training experiences that are short and as needed and do not consume employees’ production time.

It is also important to emphasize that only a few studies have reported the application of microlearning in K-12 school settings. This finding leads us to speculate that this may or may not indicate the lack of the use of microlearning in the K-12 classroom. Thus, it leaves us with the following two questions: (1) Could microlearning be more appropriate for adult learners than K-12 students?; or (2) Could it be easier to conduct research in organizational and higher education settings compared to K-12 schools? We need more studies to either confirm or deny our speculation. Nonetheless, based on the described benefits of the microlearning approach in other contexts, K-12 students could benefit from targeted and micro-bit content, for instance, as supplementary materials. In addition, K-12 schools could leverage the microlearning approach in their online courses to increase engagement by decreasing the cognitive load of students who are not specifically used to the online format of delivery, especially during COVID-19.

**Is Microlearning Part of E-Learning or Mobile-Learning?**

Though mobile learning was not a predominant keyword we used, based on our qualitative and quantitative analysis, we see two dominant clusters that emerged from these publications—mobile-based microlearning and web-based or e-learning.
microlearning. For example, e-learning is the most frequently used keyword found in these publications (n = 208). Having said that, after 2019, where we see the plethora of microlearning publications, out of 119 publications, almost 33% (n = 39) discussed mobile-based microlearning approaches. That being said, it is very clear that there are two growing strands of research areas on microlearning focusing on these two areas. Mobile-based microlearning and web-based microlearning might appear as synonymous, and certainly there is an overlap in the characteristics of these two forms. However, the distinction is still needed because the HTML5 language—which affords the design and delivery of microlearning to be responsive to multiple mobile devices—was only introduced in 2019, whereas several studies we analyzed date back to 2005.

It appears that there is somewhat of a relationship in the microlearning literature between microlearning and the use of mobile devices. This relationship seems valid and logical given the affordances of mobile technologies to host and deliver microlearning experiences; small bits of learning experiences do not require large computing space. However, as a matter of caution, this relationship should not yield to the following accepted assertion: microlearning cannot take place without mobile devices. As stated in our introduction, we define microlearning as an instructional strategy, where the learning content is divided into small, focused activities and is delivered digitally in an easily digestible form that is outcome-oriented (Emerson & Berge, 2018; Grevtseva et al., 2017; Nikou & Economides, 2018). We consider microlearning a format of learning that leverages the use of technology (e.g., mobile devices) and not a technology-dependent format of learning.

**Study Implications**

This study has provided valuable insights into microlearning literature through analyzing the publication landscape, the common research, and the topics of the microlearning publications identified from the Scopus database. First, this study shows that microlearning publications’ annual publication growth rate is 33.55%. This finding illustrates that microlearning is set to become a major research trend, so researchers should consider microlearning as a promising research area (Leong et al., 2020). Second, the findings reveal that microlearning is receiving wide attention, specifically after the start of COVID-19. The interesting aspect is that microlearning allows learners to quickly access learning materials and activities to efficiently gain needed knowledge and skills and apply them in their respective contexts. In return, microlearning proved to be an effective instructional strategy to mitigate the effects of COVID-19. Third, based on our qualitative and quantitative analysis, we identify evaluation-related studies as the most commonly researched area, followed by studies on microlearning design. Future research on microlearning could further explore these identified themes of microlearning. Fourth, most microlearning studies are focused on adult learners compared to K-12 students. In fact, only 2.4% of the studies were conducted in K-12 school settings. Future studies should explore the application of microlearning in K-12 schools. Finally, our results show two dominant microlearning clusters—mobile-based and web-based microlearning. Even though e-learning was the most prominent keyword from the publications, we found a rising trend of mobile-based microlearning studies after 2019, and it is steadily growing.

**Study Limitations**

This study has a few limitations. The first limitation of this study was the number of publications (n = 208) and the single search database (Scopus) included in the final analysis. While this may mean the study is less generalizable to the entirety of microlearning literature, the Scopus database can generally make tentative generalizations to the larger microlearning literature. Additionally, we did not read every article closely. This was mandatory because it is not feasible to read every single article closely. Further, topic modeling requires data-cleaning steps to process figures and tables, and our analysis aimed to identify the high-level themes/topic of every article, as opposed to a close detailed content analysis of every article. Future research might also look at the identified research topics to investigate whether these research areas are truly distinct from each other or if researchers fluidly move between these topics, offering greater cohesion between the five research topics.

**Conclusion**

This study provides a bibliometric analysis of current literature in microlearning publications. We also conducted quantitative topic modeling to identify the dominant research topics from these publications and a qualitative content analysis to analyze research topics we identified from the topic models. We found that microlearning is steadily growing as a major trend with an annual growth rate of 33.55%. Based on the quantitative and qualitative analysis, we identified four major research topics from the microlearning publications as follows: (1) design of microlearning (2) implementation of microlearning as an instructional method, a strategy, or an intervention, (3) evaluation of microlearning, and (4) the utilization of mobile devices for microlearning. Evaluation of the effects of microlearning was the most researched topic, and higher education was the most researched study context from these publications. Our findings also revealed that microlearning research does not often occur in K-12 school settings and that more research is needed to validate these findings.
## Appendix A

Table 8  Final Set of Articles (N = 208)

| ID  | Author(s) (Year)                  |
|-----|-----------------------------------|
| 1   | Aigerim and Azamat (2014)        |
| 2   | Aitchanov et al. (2018)          |
| 3   | Aitchanov et al. (2013)          |
| 4   | Aldosemani (2019)                |
| 5   | Allela (2021)                    |
| 6   | Alqurashi (2017)                 |
| 7   | An and Quail (2018)              |
| 8   | Anand and Bonadei (2019)         |
| 9   | Arnab et al., (2020)             |
| 10  | Beste (2021)                     |
| 11  | Bischoff (2007a)                 |
| 12  | Bischoff (2007b)                 |
| 13  | Boomija and Suresh Kumar (2021)  |
| 14  | Bothe et al. (2019)              |
| 15  | Bowler et al. (2021)             |
| 16  | Boytchev (2013)                  |
| 17  | Brebera (2017)                   |
| 18  | Brebera (2018)                   |
| 19  | Bricon-Souf and Przewozny (2010) |
| 20  | Bricon-Souf et al. (2010)        |
| 21  | Bruck et al. (2012)              |
| 22  | Buhu and Buhu (2019)             |
| 23  | Busse et al. (2020)              |
| 24  | Butgeret (2016)                  |
| 25  | Cai (2015)                       |
| 26  | Cai et al., (2015)               |
| 27  | Cascio (2019)                    |
| 28  | Cates et al. (2017)              |
| 29  | Chai-Arayalert and Puttinaovarat (2020) |
| 30  | Chen et al. (2016)               |
| 31  | Cheng et al. (2020)              |
| 32  | Coccoli et al. (2011)            |
| 33  | Correa et al. (2018)             |
| 34  | Dahlmanns et al. (2020)          |
| 35  | de Medeiros et al. (2019)        |
| 36  | De Troyer et al. (2020)          |
| 37  | De Troyer et al. (2019)          |
| 38  | Dearman and Tuong (2012)         |
| 39  | Decker et al. (2017)             |
| 40  | Demmans Epp and Phirangee (2019) |
| 41  | Dessi et al. (2019)              |
| 42  | Diaz Redondo et al. (2020)       |
| 43  | Diaz Redondo et al. (2021)       |
| 44  | Ding et al. (2018)               |
| 45  | Dingler et al. (2017)            |
| 46  | Dixit et al. (2021)              |

Table 8 (continued)

| ID  | Author(s) (Year)                  |
|-----|-----------------------------------|
| 47  | Dolasinski and Reynolds (2020)    |
| 48  | Dolasinski and Reynolds (2020)    |
| 49  | Edge et al. (2012)                |
| 50  | Edge et al. (2011)                |
| 51  | Erradi et al. (2013)              |
| 52  | Fozdar and Kumar (2007)           |
| 53  | Franco et al. (2020)              |
| 54  | Friedler (2018)                   |
| 55  | Fu and Liu (2017)                 |
| 56  | Gao and Wang (2017)               |
| 57  | Gawlik et al. (2021)              |
| 58  | Gerbaudo et al. (2021)            |
| 59  | Gill et al. (2020)                |
| 60  | Gómez et al. (2021)               |
| 61  | Goodell et al. (2021)             |
| 62  | Goschberger and Anderst-Kotsis (2019) |
| 63  | Goschberger and Bruck (2017)      |
| 64  | Goschberger (2017)                |
| 65  | Gough et al. (2021)               |
| 66  | Grevtseva et al. (2017)           |
| 67  | Gross et al. (2019)               |
| 68  | Gstrein and Hug (2005)            |
| 69  | Halbach and Solheim (2018)        |
| 70  | Halbach et al. (2018)             |
| 71  | Wan Hamzah et al. (2021)          |
| 72  | Harriehausen-Mühlbauer (2012)     |
| 73  | Head et al. (2014)                |
| 74  | Hegerius et al. (2020)            |
| 75  | Hermann and Gruhn (2018)          |
| 76  | Hermann et al. (2019)             |
| 77  | Herrfer et al. (2016)             |
| 78  | Heydari et al. (2019)             |
| 79  | Horst and Dorner (2019)           |
| 80  | Horst and Dorner (2019)           |
| 81  | Horst et al. (2019)               |
| 82  | Hu and Liu (2020)                 |
| 83  | Huang et al. (2019)               |
| 84  | Hug (2010)                        |
| 85  | Inie and Lungu (2021)             |
| 86  | Inker et al., (2021)              |
| 87  | Isha et al. (2020)                |
| 88  | Isibika et al. (2021)             |
| 89  | Jahinke et al. (2020)             |
| 90  | Jaschke (2014)                    |
| 91  | Javorcik and Polasek (2018)       |
| 92  | Javorcik and Polasek (2019a)      |
| 93  | Javorcik and Polasek (2019b)      |
| 94  | Javorcik and Polasek (2019c)      |
| 95  | Javorcik and Polasek (2019d)      |
Table 8 (continued)

| ID   | Author(s) (Year)                      |
|------|--------------------------------------|
| 96   | Javorcik (2021a)                     |
| 97   | Javorcik (2021b)                     |
| 98   | Josiek et al. (2020)                 |
| 99   | Kadhem (2017)                        |
| 100  | Kamili and Sofianopoulos (2015)      |
| 101  | Khong and Hadi (2017)                |
| 102  | Lee et al. (2021)                    |
| 103  | Lee et al. (2019)                    |
| 104  | Lee (2021a)                          |
| 105  | Lee (2021b)                          |
| 106  | Lee et al. (2021)                    |
| 107  | Lee et al. (2019)                    |
| 108  | Li (2021)                            |
| 109  | Liao and Zhu (2012)                  |
| 110  | Lin et al. (2020)                    |
| 111  | Lin et al. (2020a)                   |
| 112  | Lin et al. (2020b)                   |
| 113  | Lin et al. (2020c)                   |
| 114  | Lin et al. (2019)                    |
| 115  | Liu et al. (2019)                    |
| 116  | Liu (2020)                           |
| 117  | Long et al. (2020)                   |
| 118  | Loong and Assier (2016)              |
| 119  | Ma et al. (2021)                     |
| 120  | Maity (2019)                         |
| 121  | Matthews (2014)                      |
| 122  | Matthews et al. (2013)               |
| 123  | Maushagen and de Troyer (2021)       |
| 124  | Mazohl et al. (2018)                 |
| 125  | Mitchell et al. (2017)               |
| 126  | Muhammad et al. (2021)               |
| 127  | Mujica-Luna et al. (2021)            |
| 128  | Muscat et al. (2021)                 |
| 129  | Nicholls and Restauri (2015)         |
| 130  | Nikou and Economides (2018)          |
| 131  | Norsanto and Rosmansyah (2018)       |
| 132  | Ohkawa et al. (2018)                 |
| 133  | Ortega-Morán et al. (2020a)          |
| 134  | Ortega-Morán et al. (2020b)          |
| 135  | Orwell et al. (2018)                 |
| 136  | Ossiannilsson and Ioannides (2017)   |
| 137  | Pajarito and Feria (2016)            |
| 138  | Park and Kim (2018)                  |
| 139  | Pascual et al. (2021)                |
| 140  | Petkov (2019)                        |
| 141  | Polasek and Javorcik (2019a)         |
| 142  | Polasek and Javorcik (2019b)         |
| 143  | Polasek (2019)                       |
| 144  | Prior Filipe et al. (2020)           |
| 145  | Putri Septiani and Rosmansyah (2021) |
| 146  | Qian et al. (2021)                   |
| 147  | Rahman et al. (2021)                 |
| 148  | Rick and Phlypo (2019)               |
| 149  | Rickardsson et al. (2021)            |
| 150  | Rusak (2017)                         |
| 151  | Sammour et al. (2020)                |
| 152  | Saparkhojayev (2013)                 |
| 153  | Semenova et al. (2020)               |
| 154  | Shamsin-Inal and Blau (2020)         |
| 155  | Shen et al. (2020)                   |
| 156  | Siminovich and Provost (2020)        |
| 157  | Simons et al. (2014)                 |
| 158  | Simons et al. (2015)                 |
| 159  | Skalka and Drlik (2020a)             |
| 160  | Skalka and Drlik (2020b)             |
| 161  | Skalka and Drlik (2018a)             |
| 162  | Skalka and Drlik (2018b)             |
| 163  | Skalka et al. (2021)                 |
| 164  | Skalka et al. (2020)                 |
| 165  | Smolle et al. (2021)                 |
| 166  | So et al. (2018)                     |
| 167  | Sözmen et al. (2021)                 |
| 168  | Steinbacher and Hoffmann (2015)      |
| 169  | Surahman et al. (2019)               |
| 170  | Tang (2017)                          |
| 171  | Tang and Young (2013)                |
| 172  | Tingjun (2016)                       |
| 173  | Tolstikh et al. (2021)               |
| 174  | Triana et al. (2021)                 |
| 175  | Trusty and Truong (2011)             |
| 176  | Walaszczyk and Dingli (2020)         |
| 177  | Wang et al. (2018)                   |
| 178  | Wen and Zhang (2014)                 |
| 179  | Xiao et al. (2020)                   |
| 180  | Yang (2020)                          |
| 181  | Yang and Xu (2021)                   |
| 182  | Yang and Lee (2018)                  |
| 183  | Yarnykh (2021)                       |
| 184  | Yarnykh (2021)                       |
| 185  | Young et al. (2019)                  |
| 186  | Zahirović Suhonjić et al. (2019)     |
| 187  | Zandi-bergs et al. (2021)            |
| 188  | Zaqoot et al. (2020)                 |
| 189  | Zhamanov and Zhamapor (2013)         |
| 190  | Zhamanov and Zhamapor (2013)         |
Declarations

Conflicts of interests and Competing Interests The authors declare no conflict of interest and no competing interests. This study did not involve human participants and/or animals.

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