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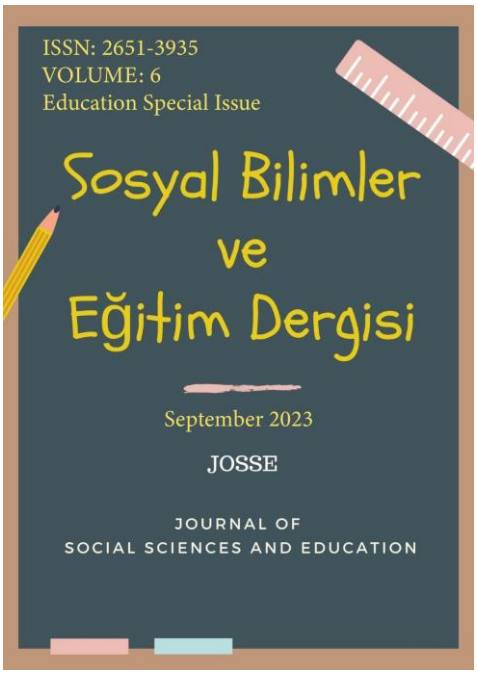

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Technological Approaches in Mathematics and Science Education: Microlearning [*–**]

** This research with the ID number 121G202 was conducted as part of the project titled "Detection and Elimination of Neuromyths in Biology Education: Developing and Evaluating Argumentation Contents with Digital Storytelling in an Educational Context."*

***The project was supported by Pınar Köseoğlu and funded by The Scientific and Technological Research Council of Turkey (TÜBİTAK) under the 3005 Program. The findings of this study were presented as a poster at the 15th Conference of the European Science Education Research Association (ESERA) in 2023, which took place in Cappadocia from August 28th to September 1st, 2023.*

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Technological Approaches in Mathematics and Science Education: Microlearning[*,**]

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ABSTRACT

Microlearning is regarded as a novel approach to meeting many learning demands, including individual learning, lifelong learning, and work-based learning. A learning strategy called microlearning focuses on giving students enormous amounts of (macro) material in manageable chunks over a little period of time. These little segments, also known as micro-content, help students retain the knowledge quickly without subjecting them to voluminous material. It is believed that breaking up the knowledge into manageable chunks helps learners better adapt to the information-processing process and acquire new material. With all of this in mind, it may appear that activities that allow students to actively engage in math and scientific studies, make connections to the real world, work in groups, support both their internal and external goals, and get lucid and insightful feedback are crucial. This study aims to investigate the design and implementation of microlearning, one of the technological approaches to math and science instruction, in informal, formal, and non-formal settings. It also explores the characteristics of micro content and how it relates to mobile learning using examples.

Keywords: Microlearning, micro content, mobile learning

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Introduction

The period in which educational activities were carried out within certain patterns has evolved into a student-centered learning process with the introduction of digital technologies. In the philosophy of lifelong learning, individuals in need of continuous renewal have become more accessible to knowledge by using open and distance learning systems. Education, with the presentation of instructional materials in digital formats, has transcended time and space constraints, turning learning into a regular process for the masses. In addition to the ease of access to content, new approaches have emerged to make learning faster and more efficient in a cognitive context. One of these approaches is called "microlearning." Microlearning is considered a new way to respond to various learning needs such as lifelong learning, work-based learning, and individual learning (Jomah, Masoud, Kishore, & Aurelia, 2016). Microlearning is an approach that centers on presenting large (macro) learning content in small chunks and within a short time frame. These small chunks, known as micro content, allow learners to absorb the presented information in a short period without overwhelming them (Hug, 2005; Bruck, Motivvalla, and Försler, 2012; Redondo, Kodriguez, Escobar, and Vilas, 2020). Presenting content in this way is believed to better align with individuals' cognitive processing of information and result in more effective learning (Bruck et al., 2012).

Although microlearning may seem like a new educational paradigm, its origins date back to the 1960s. However, it became widespread in the early 2000s with the emergence of Web 2.0 technologies that provided suitable platforms for creating, sharing, and using learning content (Redondo et al., 2020). Other factors contributing to the proliferation of microlearning include wireless network technologies that have changed individuals' interaction and communication methods (Coccoli et al., 2011) and, consequently, the increasing use of digital technologies that allow learning anytime and anywhere throughout their lives (Bruck et al., 2012; Wang et al., 2020). Additionally, microlearning has become more popular due to its learner-centered, cost-effective, and interactive features (Jomah et al., 2016).

In the delivery of microlearning content, besides traditional technologies like television, radio, and personal computers, today's portable (mobile) devices such as smartphones and tablet computers can also be used. Portable devices offer more accessible means of accessing content anytime and anywhere. From this perspective, it can be said that the microlearning approach is inseparable from mobile learning, which relies on the use of

portable devices for flexible and accessible learning on the go. According to Hug (2010), microlearning overlaps with the concept of mobile learning in theory and practice. Content designed using rich media formats can be delivered to individuals through different devices, providing just-in-time education. The microlearning approach can be considered an opportunity for individuals to use their "dead time," such as travel time, work breaks, more efficiently and effectively throughout the day without the need to create special time or preparation for learning. Based on this context, the study aims to investigate the design and implementation of microlearning, one of the technological approaches to math and science instruction, in informal, formal, and non-formal settings. It also explores the characteristics of micro content and how it relates to mobile learning using examples.

In this study, our primary objective is to delve deep into the design and execution of microlearning in various educational settings, namely informal, formal, and non-formal. Recognizing the intertwined nature of microlearning and mobile learning, particularly in the light of emerging portable devices, we emphasize the uniqueness and significance of this research. By analyzing the characteristics of micro content and drawing parallels with mobile learning through illustrative examples, we aim to highlight the transformative potential of leveraging "dead time" for efficient learning, specifically in math and science instruction. This exploration not only underscores the pivotal role of technology in contemporary education but also accentuates the untapped potential of intertwining microlearning with daily routines.

Background

Microlearning and Micro Contents

The microlearning approach aims to address the learning needs of individuals from all age groups and backgrounds within the framework of lifelong learning, and it can be applied in various formal, informal, and non-formal settings. Particularly in the 21st century, where knowledge continues to grow rapidly, individuals are required to adapt to new contexts and keep pace with the ever-evolving information landscape. Traditional education, with its lengthy and restrictive nature, may not always be suitable for meeting these learning needs (Souza et al., 2015; Redondo et al., 2020).

Today's education system often struggles to adequately meet the demands of the job market. As a result, individuals increasingly prefer immediate application and utilization of

knowledge and skills over passive learning or reading extensive textbooks. They seek opportunities for learning that are not confined to school hours or specific locations but are available anytime and anywhere. It is in light of these observations that the ability to learn and the pace of learning have become crucial factors, not only for students and adults but also for enhancing individual quality of life. In this regard, lifelong learning has become a characteristic feature of the knowledge society. It is essential to recognize that technologies are continuously advancing, learning never ceases, and individuals, whether students or professionals, constantly require new knowledge, filling knowledge gaps, and storing learning materials (Buhu & Buhu, 2019). Hence, the creation of learning environments that offer lifelong learning opportunities to individuals is of paramount importance. Informal learning environments that enable self-directed learning are gaining prominence beyond traditional structured learning methods. In these informal learning settings, individuals voluntarily engage in a learning environment based on their interests and needs (So et al., 2018). The microlearning approach aligns with the fast-paced and task-focused learning and working models of today, making informal learning possible through small, socially interactive steps and micro content units (Souza et al., 2015). Microlearning does not require separate learning sessions; instead, it integrates into individuals' daily activities. By breaking down long-term learning activities into smaller units, learning efficiency can be improved, and individuals can utilize their time outside of work or school more effectively. While microlearning may not be suitable for all forms of learning, it can be seen as complementary to other learning methods (Bruck et al., 2012).

In today's world, the widespread use of mobile devices, personal computers, and other technologies has led to an increase in the use of short-form content. Consequently, it is believed that people's attention spans have been decreasing, and their capacity to focus on a single topic has diminished (Redondo et al., 2020). Therefore, presenting information in small, digestible chunks has become increasingly important (Wang et al., 2020). Microlearning delivers information through micro content, as it is an approach that focuses on short-term learning activities. The first element in creating a microlearning environment is the content. When content is divided into smaller pieces, it is believed that individuals can learn more effectively (Bruck et al., 2012). Micro content is a small digital information unit, containing only limited but essential information, compared to regular content (Jonah et al., 2016).

To effectively facilitate learning, micro content needs to be designed meticulously. So et al. (2018) emphasize that designing micro content differs from traditional instructional design and content development. The nature of content delivered through microlearning tends to be dynamic, up-to-date, and focused on specific interests. The essential characteristics that micro content should possess can be grouped under six headings (Souza et al., 2015; Redondo et al., 2020):

- **Focus:** Micro content should concentrate on a single idea or topic.
- **Structure:** A micro content unit should comprise various metadata such as title, subject, authors, date, and tags.
- **Self-sufficiency (Autonomy):** Micro content should contain all necessary information without the need for additional information search and should be independent.
- **Indivisibility:** Micro content should not be divisible. In other words, breaking it into smaller pieces should not compromise its meaning.
- **Format:** Micro content should be designed in a short, easily perceivable format.
- **Ease of Access:** Micro content should be easily accessible and discoverable.

These characteristics of micro content enable it to be seamlessly integrated into individuals' daily activities and selected according to their specific needs and interests (Redondo et al., 2020). Micro content can be designed in various formats, including text, video, audio, images, infographics, and can be delivered in different environments.

Microlearning Approach and Its Application

It can be said that various Web 2.0 applications, such as social networks, microblogging sites, blogs, wikis, podcasts, video-sharing platforms, and news applications, predominantly offer micro content (Redondo et al., 2020). Web 2.0 environments have increased individuals' tendency to engage with micro formats by providing them with the opportunity to both create and consume content (Redondo et al., 2020). A prominent example of a microlearning environment accessible to everyone is Twitter, a micro-sharing platform. Twitter allows the sharing of not only 280-character text messages but also various media formats such as videos, audio, and images (Bruck et al., 2012), fostering a learning community around these contents (Aitchanov, Satabaldiyev, and Ututa, 2013). Sites like YouTube, TED, and Khan Academy can be regarded as microlearning platforms where videos are presented. YouTube enables individuals to create their own educational content when they want to quickly acquire new skills or knowledge (e.g., cooking, repairs, etc.). TED

is based on the web platform for short informative talks by international or local experts. Khan Academy, on the other hand, is a non-profit educational organization founded by Salman Khan, a graduate of MIT and Harvard University. Its primary goal is to provide structured information in the form of short lessons or presentations on specific topics (Redondo et al., 2020).

Regarding the duration of microlearning activities, there is no universally accepted criterion. Research tends to focus more on the duration of videos, suggesting that they should not exceed 15 minutes. Additionally, studies indicate that shorter videos tend to have higher viewership (Redondo et al., 2020).

The microlearning approach can be applied not only within the framework of lifelong learning but also in formal and non-formal settings, allowing individuals of all age groups to access content from various sources tailored to their needs. In these settings, the core idea behind microlearning is to present course materials in short, manageable, and easily accessible segments for students to consume. Microlearning pedagogy primarily focuses on short-term and informal learning activities or just-in-time learning when the learner needs information to solve a problem or perform a task (Bruck et al., 2012). The microlearning approach can be employed to guide students in self-directed learning, problem-solving, practical application of knowledge, or connecting with others according to their needs. It is often used to reinforce or complement formal learning environments, aiming to encourage deeper learning and engage students in thinking and working on course/content-related topics in their daily lives (Skalka & Drlik, 2020). By presenting information in small, digestible portions, microlearning helps make knowledge more permanent without overloading learners cognitively (Major & Calandrino, 2018). Microlearning has found extensive use in professional and higher education settings related to dentistry, pharmacy, epidemiology, psychiatry, and other healthcare services, as it sparks student interest and expands learners' cognitive boundaries in an innovative way (Wang et al., 2020).

When implementing the microlearning approach, the most crucial consideration is designing and creating an effective digital microlearning environment. The design and delivery of the microlearning environment should select the most suitable method based on the structure of the course. The more compatible and applicable the microlearning experience is with the learning objectives, the more effective and meaningful the students' experience becomes (Major & Calandrino, 2018). Accessibility of microlearning environments is essential, as a student should be able to access the microlearning environment or content

anytime, using any available device (Major & Calandrino, 2018). When considering micro content as part of the subject, it can be identified as educational micro content (Polasek & Javorcik, 2019). Educational micro content combines the bisectional nature, self-sufficiency of content, and the technologies that can produce and deliver sound, speech, graphics, drawings, photos, or audio and visual content, aiming to focus on specific learning outcomes (Souza et al., 2015). Preparing a learning scenario is the most critical step in the creation of microlearning. Deficiencies in content delivery can lead to student failure (Skalka & Drlik, 2020). In addition to designing educational micro content, attention should be paid to how content is sequenced and the design of microlearning activities. Contents should be provided to students gradually (Redondo et al., 2020). Moreover, delivering micro content to students at the right time is also a crucial aspect of microlearning design. Bruck et al. (2012) propose four key features for designing and developing microlearning solutions:

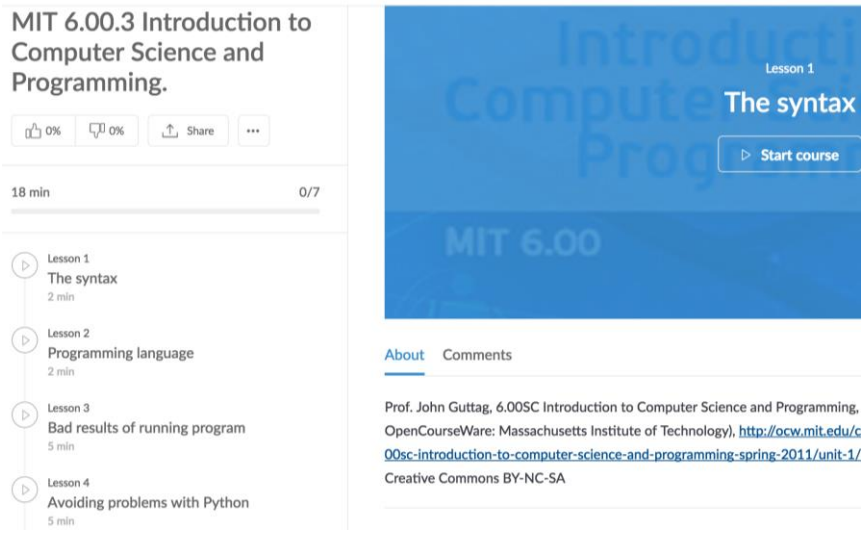
- Content repetition for learning retention.
- Continuity in repetition activities.
- Assessment before moving to the next unit.
- A well-structured and hierarchical content organization that supports information retrieval.

In the context of mathematics and science education, microlearning has emerged as a powerful pedagogical strategy, leveraging succinct content delivery to optimize learning outcomes. The evolution of specific platforms tailored to this approach, as discussed below, underscores its rising significance. In the realm of microlearning, selecting the right technological tool tailored to the nuances of microlearning is vital. Currently, popular microlearning platforms encompass Coursmos, Grovo, and Panopto.

Coursmos, as detailed in their 2017 release, stands out as an online hub facilitating the crafting of concise courses encompassing miniature lessons complemented by quizzes. As depicted in Figure 1, each course can host up to seven bite-sized lessons, each not exceeding 5 minutes. One of Coursmos' distinctive features is its intelligent course recommendation engine, suggesting courses authored by different educators that align with the user's current content. This platform weaves together various micro-courses to create a knowledge nexus and offers seamless sharing capabilities across social media platforms and websites. It's a nimble learning instrument, enabling students to swiftly navigate through lessons via their mobile gadgets, while granting educators the facility to monitor attendance and academic progression.

Figure 1

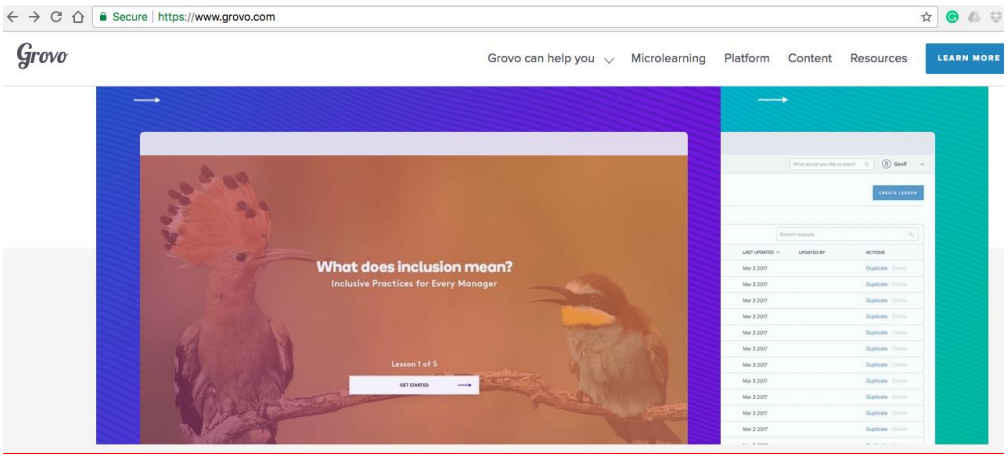
Coursmos



Grovo (Grovo, 2017), depicted in Figure 2, stands out as an online microlearning ecosystem where mini-lessons, typically no longer than 90 seconds, are designed to facilitate swift course completion. These lessons incorporate a blend of videos, gifs, quizzes, and other interactive elements to ensure sustained learner engagement. Notably, Grovo offers seamless integration with various Learning Management Systems (LMS) and boasts pre-fabricated templates for content creation. The platform empowers educators with analytical tools to monitor learner progression, spotlighting students potentially at risk, and visualizing data analytics via intuitive graphs.

Figure 2

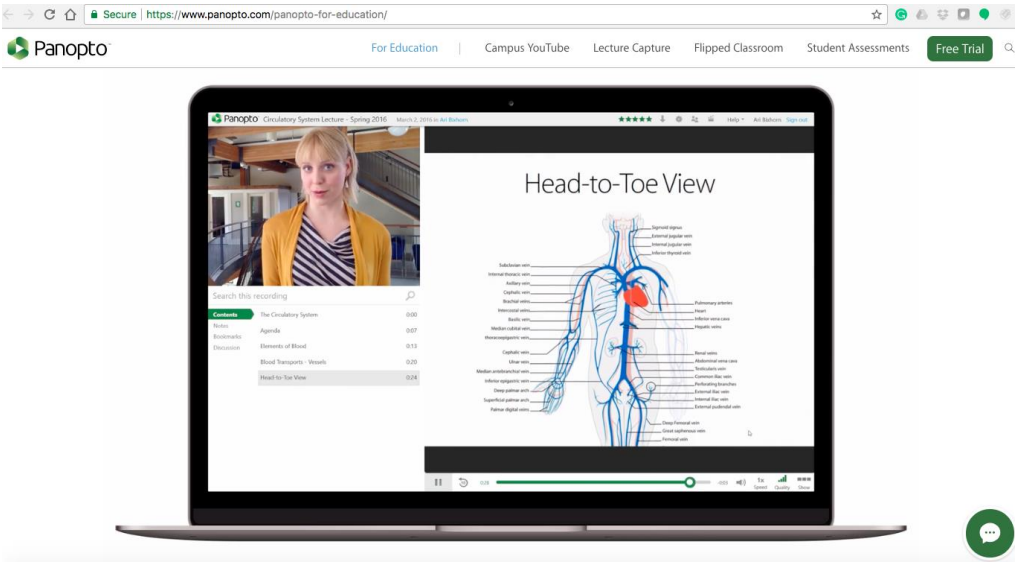
Grovo



Panopto (Panopto, 2017), illustrated in Figure 3, is positioned as a video-centric content management ecosystem. It furnishes features such as lecture capturing, screencasting, and dynamic video streaming, thereby curating a conducive microlearning ambiance. Panopto's framework integrates seamlessly with LMS platforms, facilitating both educators and students. Instructors can effortlessly transcribe their videos, enhancing accessibility, and craft interactive video quizzes. The platform's robust analytics provides insights into student engagement metrics and highlights areas commanding predominant student focus.

Figure 3

Ponopto



Today's classroom technology is increasingly gravitating towards mobile compatibility, reflecting the surge in students accessing course materials via handheld devices. Consequently, it becomes imperative for digital microlearning platforms to be mobile-responsive, catering to learners' propensity to engage in spur-of-the-moment learning sessions. Hug (2010) delved into the symbiotic relationship between mobile devices and microlearning. He accentuated several reasons underscoring the indispensability of mobile devices for microlearning: (1) these devices inherently display microcontent, (2) they cater to shorter attention spans and limited time slots, (3) their screen size, being smaller, demands concise content presentation, (4) they enable micro-staged learning in both formal and casual settings, (5) they metamorphose the learning environment into one that is mobile, tangible, and social, and (6) their inherent alignment with microplatforms.

Effectiveness of Microlearning and Its Implementation

Another essential aspect regarding the effectiveness of microlearning is the appropriate duration of activities. Cole and Torgerson (2017), as cited by Major and Calandrino (2018), recommend microlearning activities to be at least 2 minutes long, up to a maximum of 10 minutes. Redondo et al. (2020), on the other hand, suggest that microlearning sessions (micro content) should be designed by combining the introduction, activity, and outcomes, with each not exceeding 15 minutes. Microlearning activities should be designed to be directly managed by students, promoting their active participation. The materials used in microlearning should focus on very specific and clear aspects of the subject matter. Additionally, students should be encouraged to participate directly in the production of micro content. Platforms that allow the creation of micro content (such as YouTube, Twitter, etc.) can facilitate student-centered learning through students' own content creation (Senningson et al., 2015).

Various platforms and tools can be used to deliver microlearning activities. The selection of platforms or tools largely depends on the discipline to be taught and the learning objectives. The microlearning approach can be delivered not only through Web 2.0 technologies and social media but also within traditional learning management systems (LMS) (So et al., 2018). While acknowledging the presence of some autonomous solutions for student management and interaction with micro content, Redondo et al. (2020) emphasize the existence of an existing learning platform as a starting point and recommend the following as microlearning environments: (i) a widely used modular LMS like Moodle (https://moodle.org); or (ii) a Massive Open Online Course (MOOC) platform designed specifically for non-formal education and capable of managing a large number of students, such as Open edX (https://open.edx.org/). Advantages of using these learning platforms include user familiarity, the ability to maintain user profiles and other information, and the possibility of updates and improvements for security and functionality (Redondo et al., 2020).

Microlearning and Mobile Learning

Mobile technologies enable individuals to access any kind of information, person, place, data, event, and location directly. With a mobile device, individuals can actively participate in their learning processes and engage in experiential learning pedagogy (Semingson et al., 2015). As previously mentioned, microlearning holds great potential for learning on mobile devices. Most of today's technologies are mobile-compatible, and people

are increasingly accessing content through mobile devices. Therefore, microlearning environments should be mobile-friendly, allowing individuals to complete learning activities on the go (Alqurashi, 2017). Hug (2010) emphasizes the importance of mobile devices in creating microlearning environments as follows: (1) Content displayed on mobile devices is often in the form of micro content, (2) people's attention spans on mobile devices are relatively short, (3) the screen size of mobile devices is smaller than that of other devices, (4) mobile devices allow the design of micro steps in formal and informal learning environments, (5) mobile devices allow the mobile, physical, and social nature of the microlearning environment, and (6) mobile devices are often associated with micro platforms.

When designing and producing micro content within the scope of mobile learning and microlearning, the competencies and usability features inherent to mobile devices should be taken into account. In other words, features such as screen size, touch keyboard, lack of a mouse, connection speed, and connection cost should be considered (Souza et al., 2015). Nowadays, many popular platforms like YouTube, Twitter, Instagram, have mobile applications compatible with all mobile devices. Content created on these platforms can easily be accessed on mobile devices within the context of daily life. Additionally, numerous mobile applications suitable for the microlearning approach are also available (Semingson et al., 2015).

The Role of Technology in Microlearning

Technology plays a crucial role in microlearning. When used effectively, it can engage students outside of the classroom. However, one of the challenges of technology is that it is a rapidly growing industry. Sometimes, educators may find it challenging to keep up with all their non-instructional responsibilities. While this can be a technology challenge that comes with microlearning, it is considered to have great potential (Alqurashi, 2017).

Microlearning environments may need to be professionally organized and applied like a learning curriculum. Currently, online learning platforms like Khan Academy, Udemy, Coursera, and massive open online course (MOOC) providers like edX, created by the Massachusetts Institute of Technology and Harvard University, offer thousands of micro-courses from hundreds of partner institutions worldwide. Additionally, digital flashcards can be used to enhance knowledge transfer (Steinbacher & Hoffman, 2015).

In microlearning, the appropriate choice of technology is crucial for designing based on microlearning characteristics. Alqurashi (2017) introduces some of the most common microlearning tools used today as Coursmos, Cirovo, and Panopto.

- **Coursmos**: Coursmos is an online platform that allows the creation of micro-courses used to create mini-lessons and then conduct exams. Micro-courses can contain up to seven micro-lessons, each lasting up to 5 minutes. Coursmos has an intelligent and personalized course recommendation system that suggests other courses created by other instructors for learners to follow regarding their course content. It is a rapid learning tool that enables students to complete micro-lessons using their mobile devices, and instructors can monitor student engagement and learning progress.
- **Cirovo**: Cirovo offers micro-lessons typically lasting 90 seconds, allowing students to quickly complete a mini-course assigned to them. Each lesson combines videos, gifs, quizzes, and other engaging activities to keep students engaged. The platform can be integrated into various Learning Management Systems for easy access and includes ready-made templates for creating micro-content. Instructors can track student progress and identify at-risk students.
- **Panopto**: Panopto is a video content management system that provides recording, screen capture, and video streaming for creating a microlearning environment. The system integrates with Learning Management Systems for both instructors and students. Panopto enables turning videos into text with a single click, making them accessible and allows the creation of interactive video quizzes. It also provides detailed reporting on student progress and performance, identifying how much time students spend reviewing content (Alqurashi, 2017).

Additionally, **Voscreen** (Voscreen, 2021) is another microlearning platform that focuses on improving English language skills with short videos, aiming to be both free and fun. This application offers playlists with customizable playback modes for registered users. It creates a social environment where progress of the added friend group is observed, including socialization. Dictionary platforms like Reddit or Ekşisözlük can also be considered as microlearning environments where registered users share knowledge through various media such as text, audio, and video, and non-registered users acquire information through search methods, with short content predominating.

Advantages and Limitations of Microlearning

With the increasing use of technology in education, learning approaches have started to change and evolve. Each new discovery aims to make learning more lasting and the process easier and more accessible. Microlearning has emerged as a learning model that can provide support in transferring knowledge to learners with the help of technological devices.

Microlearning can be distinguished from traditional e-learning in three main ways (Bruck et al., 2012). Firstly, it involves reducing the volume of content and presenting information in small units. This method, also known as microcontent, is a didactic approach that allows learners to access information more easily. Microlearning focuses on short and visually interactive content, enhancing the level of engagement in the learning experience (Kedondo et al., 2020). The second aspect is the redesign of learning processes and environments according to the paradigm of small learning units (Bruck et al., 2012). This model not only benefits the learners but also instructors and content creators by requiring fewer resources and less time during the content development process. For example, translating and adapting a small amount of data into different languages can be done in less time. Additionally, the ease of updating the curriculum can be considered another advantage. Microlearning environments provide a flexible content development power for both learners and content designers (Redondo et al., 2020). The third aspect is that learners can progress at their own pace, choosing the time, place, and speed of their learning (Bruck et al., 2012). It is unlikely that a learner would remain indifferent to a platform that caters to their learning needs.

Microlearning has been observed to be a common approach for formal education systems, where learners drop out, fall behind, or disconnect from the system (Redondo et al., 2020). However, this situation should not only be considered for formal education but also for informal or non-formal platforms that provide learning environments. Microlearning helps keep individuals actively engaged in the lifelong learning process and ensures that the learning process remains continuous without disconnecting from the context. By designing microlearning environments that meet the needs of working individuals or those with learning requirements, learning can become more enjoyable and fun (Surahman et al., 2019). When considering the non-formal trend model, microlearning is more suitable for non-formal learning, where individuals seek to acquire new skills and keep their knowledge up-to-date in their free time, rather than aiming for comprehensive knowledge in a discipline (Souza et al., 2015).

Microlearning attracts students' attention through its focus on smaller and specific learning objectives. The short-term microlearning content reduces the mental fatigue caused by longer lessons (Shail, 2019). Since microlearning activities are consistent with short-term memory, which is estimated to manage no more than four elements simultaneously, they support learning and retention. Providing time for the material learned to be processed and indexed in long-term memory, microlearning tends to make students complete the entire course faster as they interact more with the content. In short, microlearning prevents central nervous system fatigue or mental fatigue, also known as central fatigue (Shail, 2019). Microlearning is compatible with learning techniques that emphasize intermittent repetition at an adequate frequency, various formats and contexts for the same concepts and elements, and the blending of different elements to facilitate the transfer and acquisition of new knowledge (Redondo et al., 2020). It is also believed that microlearning content not only expands short-term memory capacity but also easily captures learners' attention and motivates them to learn (Lopez and Ruiz, 2018).

However, despite all these advantages of microlearning, there are limitations. Even if micro content is designed and made available according to its purpose, it may not be suitable for all learning environments, especially when the concept to be learned is complex. Microlearning activities are more suitable for strengthening skills through repetition and practice. Additionally, for learners who believe that microlearning activities need to be blended, it can be misleading. This is because the purpose of microlearning is different. It should be noted that completing all the activities of a micro lesson may not directly affect the acquisition of concepts, just as in all other teaching techniques. Despite many advantages, it is stated that microlearning does not perform well in learning complex and abstract concepts and in multidisciplinary fields (Redondo et al., 2020). Since each individual's brain works at its own pace for learning and cognitive processing, it cannot be said that there is a specific time for learning. Therefore, individuals with learning difficulties or those with psychological and psychiatric disorders may not benefit from all the advantages of microlearning (Shail, 2019).

Discussion and Results

When examining the academic literature in Alanya, it is evident that the majority of studies related to microlearning focus on theoretical, conceptual, and technical developments

(So et al., 2018). There are relatively few studies that assess the effectiveness of microlearning. In this section, we will provide an overview of a few of these studies.

Bruck et al. (2012) conducted a study where they developed microlearning applications for mobile devices in the context of microlearning and investigated student satisfaction. To achieve this, they utilized the KnowledgePulse (KP) system, which provides micro content on mobile devices, enabling learning anytime and anywhere. The results of the study indicated that this system had a high adoption rate among students, and they expressed a high level of satisfaction.

Aitchanov et al. (2013) examined the use of Twitter as a microlearning technique for educational purposes. This study was conducted in the context of the CS205 Advanced Programming C++ course at Süleyman Demirci University in Kazakhstan. Data collected from students showed that students enjoyed learning when course materials were presented in small portions via Twitter.

Kedondo et al. (2020) conducted a study to assess the views and approaches of distance education experts and professors in higher education institutions regarding microlearning. In their survey-based study, participants generally believed that microlearning could complement face-to-face learning and be beneficial for both undergraduate and lifelong learning, as well as corporate training. Participants also thought that the microlearning paradigm could be used for instructional activities and considered it a suitable approach for students. Most participants believed that microlearning could enhance student engagement, knowledge accumulation, and self-assessment. However, they also identified the preparation of new content, visuals, videos, interactive materials, etc., as the primary challenge in adopting this new paradigm.

So et al. (2018) investigated the perceptions of adult students in the fields of technology and science regarding microlearning. According to the study's results, there was no common definition of microlearning from the perspective of adult students. However, small-sized content characterized by quick access and currency was considered the most critical feature of microlearning.

Polasck and Javorcik (2019) presented the results of a pilot microlearning course designed for students in the Faculty of Humanities' Information and Communication Technologies Department at Ostrava University. The effectiveness of this microlearning course, conducted over a semester, was evaluated by comparing an experimental group with access to the microlearning version of the course materials to a control group with access to

traditional electronic course materials. The results of the pre-test indicated no statistically significant difference between the experimental and control groups. However, the post-test results at the end of the semester showed that the experimental group, with access to the microlearning version of the course, performed significantly better than the control group with access to the original course materials.

In conclusion, learning activities have evolved into a process that transcends the constraints of time and space. Alongside traditional methods of acquiring knowledge, functional digitized approaches have emerged, introducing various learning paradigms. Microlearning is one such paradigm that offers affordable, convenient, enjoyable, and enduring learning experiences at a micro level. It has become a necessity for learners to access information at their own pace, place, and through their preferred sources, rather than a luxury. Consequently, finding professional solutions to meet this need has become a fundamental task for institutions, companies, and educational providers (Dolasinski and Reynolds, 2020).The concept of accessing information from a single device or portal has become a thing of the past. Microlearning aligns with these expectations by breaking down learning into manageable fragments, whether through textual, auditory, or video materials, thus ensuring micro-content delivery. Microlearning offers several advantages, including cost-effectiveness, content availability, and the removal of time and space constraints, particularly in employee training.

In the context of math and science education, the microlearning framework ensures sustained engagement with digital content beyond the confines of the traditional classroom. While its efficacy in fostering concentrated learning for easily distracted learners is evident, there remains a need for further research to discern its implications on perceived learning outcomes and overall satisfaction. As educators adopt this approach, it's paramount to view microlearning not in isolation but within the broader educational landscape, ensuring seamless integration between out-of-class micro-content absorption and in-class application and knowledge synthesis. By holistically embracing the trifecta of microlearning components - content, pedagogy, and technology - the potential to amplify student engagement, elevate satisfaction levels, and enrich the overall learning journey is considerable.

Recommendations

1. **Promotion of Microlearning Effectiveness Assessment:** Given the scarcity of studies assessing the effectiveness of microlearning, there is a clear need for further research in this area. Academic institutions, educational researchers, and policymakers should encourage and fund studies that specifically investigate the impact and outcomes of microlearning. These studies should encompass various subject areas, learner demographics, and delivery methods to provide a comprehensive understanding of microlearning's effectiveness.
2. **Integration of Microlearning in Educational Practices:** The positive outcomes observed in the study by Bruck et al. (2012) regarding the use of microlearning applications for mobile devices suggest that educational institutions should consider integrating microlearning into their teaching practices. Educators should explore how microlearning can enhance the learning experience, improve student satisfaction, and promote engagement. Workshops and training programs can be organized to educate educators about effective microlearning design and implementation.
3. **Exploration of Alternative Microlearning Platforms:** Aitchanov et al. (2013) highlighted the use of Twitter as a microlearning technique. This opens the door to explore various social media platforms and emerging technologies as potential tools for microlearning. Educational institutions should invest in research and development to identify innovative platforms and technologies that align with microlearning principles and can cater to diverse learning needs.
4. **Support for Distance Education and Lifelong Learning:** Kedondo et al. (2020) emphasized the potential of microlearning in complementing face-to-face learning and supporting both undergraduate and lifelong learning, as well as corporate training. Educational institutions, particularly those offering distance education and professional development programs, should consider incorporating microlearning strategies into their curricula. These strategies can cater to the needs of diverse learners and enhance their learning experiences.
5. **Professional Development for Content Creation:** As highlighted by participants in Kedondo et al.'s study, content creation is a significant challenge in adopting microlearning. Institutions should invest in professional development opportunities for educators and instructional designers to create effective microlearning content. This

includes training in designing visually engaging materials, interactive content, and concise yet informative resources.

6. **Exploring Microlearning in Formal Education Settings:** Polasck and Javorcik (2019) demonstrated the effectiveness of a pilot microlearning course in higher education. Educational institutions should consider conducting similar experiments to assess the suitability of microlearning in formal education settings. Comparative studies can help evaluate the impact of microlearning on student performance and engagement.
7. **Embracing the Advantages of Microlearning:** As concluded in the discussion, microlearning offers several advantages, including cost-effectiveness, content availability, and flexibility. Educational institutions, organizations, and training providers should actively embrace these advantages and incorporate microlearning into their strategies for employee training, professional development, and education delivery.

In summary, the adoption and exploration of microlearning should be an ongoing priority for educational institutions and organizations. This includes supporting research efforts, providing professional development opportunities, and adapting to the evolving landscape of educational technology. Microlearning's potential to enhance learning experiences, improve knowledge retention, and overcome traditional constraints of time and space make it a valuable asset in contemporary education and training contexts.

Compliance with Ethical Standard

Ethical approval of the research was granted by Hacettepe University Ethics Committee on April 17, 2023, E-35853172-000-00002802182. It was taken as a result of the decision no. Hacettepe University, 17 April 2023, No: E-35853172-000-00002802182.

References

Aitchanov, B. H., Satabaldiyev, A. B., & Latuta, K. N. (2013). Application of microlearning technique and Twitter for educational purposes. *Journal of Physics: Conference Series, 423*(1). https://doi.org/10.1088/1742-6596/423/1/012044

Alqurashi, E. (2017). Microlearning: A pedagogical approach for technology integration [Special issue]. *Turkish Online Journal of Educational Technology*, *2*(7), 942-947.

Bruck, P., Motiwalla, L., & Forster, F. (2012). Mobile Learning with Micro-content: A Framework and Evaluation. *Proceedings of the 25th Bled e-Conference*, Bled, Slovenia, 527-543.

Buhu, A., & Buhu, L. (2019). The applications of microlearning in higher education in textiles. *Proceedings of the 15th International Scientific Conference on Learning and Software for Education*, Bucharest, 373-376.

Coccoli, M., Mercurio, M., Torre, I., & Torsani, S. (2011). Design of a Framework for Personalized Microlearning. *Proceedings of the LADIS International Conference e-Learning 2011*, Rome, Italy, 2, 171-175.

Dolasinski, M. J., & Reynolds, J. (2020). Microlearning: A New Learning Model. *Journal of Hospitality & Tourism Research*, *44*(3), 551-561. https://doi.org/10.1177/1096348020901579

Hug, T. (2005). Micro learning and narration: Exploring possibilities of utilization of narrations and storytelling for the design of "micro units" and didactical microlearning arrangements. *Proceedings of Media in Transition*, MIT, Cambridge, MA.

Hug, T. (2010). Mobile learning as 'Microlearning: Conceptual Considerations towards Enhancements of Didactic Thinking. *International Journal of Mobile and Blended Learning*, *2*(4), 47-57. https://doi.org/10.4018/jmbl.2010100104

Jomah, O., Masoud, A. K., Kishore, X. P., & Aurelia, S. (2016). Microlearning: A modernized education system. *Broad Research in Artificial Intelligence and Neuroscience*, *7*(1), 103-110.

Lopez, L., & Ruiz, C. (2018). Micro and mastery learning. Bite-Sized content for deeper and wider knowledge. *Proceedings of Edulearn 18. 10th International Conference on Education and New Learning Technology*, Palma, 8772-8778.

Majör, A., & Calandrino, R. (2018). Beyond chunking: Microlearning secrets for effective online design. *FDLA Journal*, *3*.

Polasek, R., & Javorcik, T. (2019). Results of pilot study into the application of MicroLearning in teaching the subject Computer Architecture and Operating System Basics. *2019 International Symposium on Educational Technology (ISET)*, 196-201.

Redondo, R. P. D., Rodríguez, M. C., Escobar, J. J. L., & Vilas, A. F. (2021). Integrating micro-learning content in traditional e-learning platforms. *Multimedia Tools and Applications, 80*(2), 3121-3151. https://doi.org/10.1007/s11042-020-09523-z

Semingson, P., Crosslin, M., & Dellinger, J. (2015). Microlearning as a tool to engage students in online and blended learning. In D. Rutledge, & D. Slykhuis (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 474-479). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Shail, M. S. (2019). Using micro-learning on mobile applications to increase knowledge retention and work performance: A review of literature. *Cureus, 11*(8), e5307. https://doi.org/10.7759/cureus.5307

Skalka, J., & Drlik, M. (2020). Automated Assessment and Microlearning Units as Predictors of At-Risk Students and Students' Outcomes in the Introductory Programming Course. *Applied Sciences, 10*(13), 4566.

So, H., Roh, S., Oh, J., Lee, H., Lee, J., & Ji, S. (2018). Adult learners' perspectives about micro-learning: Implications on the design of bite-sized content. *Proceedings of the 26th International Conference on Computers in Education*, Philippines: Asia-Pacific City, 488-493.

Souza, M. I. F., Torres, T. Z., de Carvalho, J. R. P., Evangelista, S. R. M., & do Amaral, S. E. (2015). Non-Formal Education for Technology Transfer in Embrapa: Microlearning, Microtraining, and Microcontent by Mobile Devices. *Proceedings of the 7th International Conference on Education and New Learning Technologies, EDULEARN15*, 5728-5736.

Steinbacher, H. P., & Hoffmann, M. K. (2015). Applied Microlearning in Blended Learning Scenarios. *Proceedings of the 8th IADIS International Conference Information Systems 2015, IS 2015*.

Surahman, E., Ulfa, S., Husna, A., Slamet, T. I., Qolbi, M. S. U., Setiawan, A. B.,... & Diana, R. C. (2019). The Effect of Blended Training Model to Improving Learning Outcomes: A Case in Micro Learning Object Training. *In 2019 8th International Conference on Education and Technology (ICET)*, 33-38.

Voscreen. (2021, Nisan 28). VoScreen. [URL: https://www.voscreen.com/]

Wang, C., Bakhet, M., Roberts, D., Gnani, S., & El-Osta, A. (2020). The Efficacy of Microlearning in Improving Self-care Capability: A Systematic Review of the Literature. *Public Health, 186*, 286-296.