Microlearning as a Facilitator of Learning Delivery

Turcu Cristina[1], Turcu Cornel[1], Gherman Ovidiu[1]

(1) Ştefan cel Mare University of Suceava,13, University Street, Suceava, RO-720229, ROMANIA, E-mail: cristina[at]eed.usv.ro

Abstract

Students use different learning styles and technologies. The development of new skills and knowledge requires a variety of teaching methods and learning strategies, adapted to students. Previous research has shown that the millennial generation of university students needs new pedagogical strategies and new ways of learning. Therefore, in order to create an effective learning environment, teachers must use teaching methods that are appropriate to the needs of these students of the new tech-savvy generation. Now, more than ever, these can be supported by a multitude of emerging technologies, some of them already having a profound impact on the education process. In line with this trend, this paper aims to give insight into the concept of microlearning, as a new approach added to traditional ways of learning, based on the learning and retention habits of the millennials and the subsequent generations. The paper also describes the results of the research investigation for a case study in higher education. Thus, implementation and content aspects, as well as microlearning activities used in a computer graphics course are presented. The evaluation of the effect of microlearning activities, based on a comparison of the educational outcomes measured by the student grades, revealed the microlearning benefits in facilitating learning delivery.

Keywords: Microlearning, Higher education, Computer graphics

1 Introduction

Adults use different learning styles and technologies. Moreover, previous research has shown that the millennial generation of university students needs new pedagogical strategies and new ways of learning. The multitude of emerging technologies supports the development and adoption of teaching methods and learning strategies, adapted to current students.

According to the Forgetting Curve described by Hermann Ebbinghaus in 1885 as an exponential relationship between memory retention and time, adult learners forget a high average percentage of what they have learned, as we can see in Table 1 (Ebbinghaus, 2013). Of course, some people remember more or less, but, in general, the situation is well described by the forgetting curve.

Although the forgetting curve is a natural process, there are various solutions in order to change this curve and help learners to retain much of the information they needed later. One of the recommended solutions to slow down forgetting and to increase long-term retention is spaced repetition (repetition based on active recall). Reviewing the previously studied material ensures an increase in knowledge retention at higher levels.

Table 1. The average percentages of new information that is forgotten

Elapsed time since learning	Forgetting (average percentage)
1 hour	50%
24 hours	70%
30 days	80%

In order to implement a strategy that would reduce the level of forgetting in the learning process, but that would use emergent technologies, we chose the concept of microlearning. Microlearning, based on short learning content and short activities, could bring many benefits to all actors in education (e.g., teachers and learners). According to researchers, although microlearning addresses the learning and retention habits of the millennials and the subsequent generations, it's not the best solution for every learning need. However, in some cases, to address certain issues, course designers could take advantage of microlearning.

1.1 Paper Contributions

This paper aims to answer the following research questions:

- What is microlearning?
- How does microlearning help learning?
- How can microlearning help teaching?
- What are the results of using microlearning in teaching an academic discipline?

In order to answer these questions, the paper continues with presenting some definitions of the microlearning concept, followed by a literature review of the use of microlearning. Section 3 envisages a situation frequently encountered in higher education and a possible solution described in a case study for a computer graphics course, a specific academic discipline offered by most of computer science faculties. Section 3.1 provides the empirical evaluation results for the proposed approach. Finally, we present some directions for further research and conclusions.

2 Literature Review and Related Work

Following the research questions previously mentioned, we conducted a scientific literature review. Some of the obtained results are presented below, following a few definitions of the microlearning concept.

2.1 Microlearning Definitions

Nowadays, there are many definitions for microlearning, but none of them is widely acknowledged. For example, microlearning, sometimes referred to as micro learning or micro-learning refers to short-term learning activities on small learning units (Kovachev et al, 2011).

According to (Job & Ogalo, 2012), microlearning "is based on the idea of developing small chunks of learning content and flexible technologies that can enable learners to access them more easily in specific moments and conditions of the day, for example during time breaks or while on the move".

According to (Semingson et al., 2015), through the use of short videos, context-awareness, distributed and mobile delivery, microlearning principles overlap with "technology-assisted learning (e.g. mobile devices) and ubiquitous learning (e.g. any-time, anywhere learning)". Thus, through microlearning, anyone could open, at any time, from anywhere, any short and focused learning content to which they have access.

2.2 Related Work

Worldwide were developed Massive Open Online Course (MOOC) platforms that can be accessed anytime, by anyone, from anywhere. For example, several such platforms can be mentioned, such as, Coursera, edX, Udemy, etc. Using MOOC platforms, various learners (students, employees or other types of adults) are able to incorporate learning modules into their daily routine, especially if they are microlearning (Gross, 2019). We can also mention multimodal resources that are widely available through open repositories and cloud-based sharing platforms.

In the last years, the number of publications related to microlearning topic has been increasing at a fast pace. The basic systematic literature review we have conducted in different electronic databases summarised, among other things, the number of publications presented in Table 2.

Table 2. The Number of Scientific Publications on "Micro-learning" OR Microlearning

Database	Number of papers
IEEE	63
ScienceDirect	94
Springer Link	487
Web of Science	231

Google Scholar	6310

Various research papers and studies focused on this concept and its features and highlighted the impact that microlearning has, and will have, on adult learning, training, and continuing education. Moreover, the benefits of microlearning for learning architects and developers could be mentioned. Thus, according to various researchers and learning architects, by creating microlearning, the cost of learning development could be reduce by 50% and the speed of development could be increased by 300% (Jimenez, 2006).

Although higher education and lifelong learning have many common features, because of space limitations, this paper addresses microlearning only from the perspective of higher education.

2.3 Microlearning in Higher Education

Microlearning is a concept that is already applied in the IT training for business, although, nowadays, it is not a widely adopted practice in education. Nonetheless, it can be seen that microlearning is constantly gaining attention in higher education due to the number of benefits offered to students. Thus, a research study revealed that the use of micro-learning units increased the learning and retention of course material by 18% (Mohammed et al, 2018). According to (Shail M. S., 2019) and to the findings of other authors, microlearning, viewed as "a multi-platform educational teaching tool", "juxtaposed with the Primacy and Recency Effects, can facilitate the movement of learned material from short-term to long-term memory", facilitating the increase of retention in learners.

The application of microlearning to higher education was investigated in (Shatte and Teague, 2020). This scoping review "aimed to synthesise the literature on technology-based microlearning in the context of higher education, highlighting current research and applications in the classroom and online". The results of another systematic search of the literature on microlearning, but in health profession education, conducted "to identify key concepts, characterize microlearning as an educational strategy, and evaluate pedagogical outcomes experienced by health professions students" were presented in (De Gagne et al, 2019). According to the authors, microlearning is endorsed by health professions educators as "a response to the novel methods that students learn, socialize, and communicate", being able to "facilitate and enhance student learning".

There are also other scientific publications that analyse the impact and effectiveness of microlearning adoption in higher education and estimate that it will continue to evolve.

According to the results revealed by various scientific papers, using microlearning determines: easier and faster learning; higher student retention rate; student engagement; teacher satisfaction, etc. Some of the limitations of microlearning are related to the complexity of the topics that would be suitable only for this form of learning. In addition, adopting microlearning requires time-consuming and labor-intensive course planning. The implementation and effective use of mirolearning are not without challenges. But, because of space limitations, this paper does not address the issues related to the microlearning adoption in higher education. To demonstrate the microlearning benefits we have highlighted above, we considered a case study where we integrated the microlearning concept into the overall learning strategy created for our students.

3 Case Study: Using Microlearning in Computer Engineering Faculty

To illustrate some benefits of microlearning in higher education, we consider, as a case study the Elements of Computer Graphics (ECG) course, provided in the first semester of the 3rd year in the curriculum of the Computers undergraduate study program, in the field of Computers and Information Technology at the Faculty of Electrical Engineering and Computer Science from Ștefan cel Mare University of Suceava.

At the beginning of each academic year, the course syllabuses for all the disciplines provided in the curriculum of each active study program must be elaborated. For the engineering field,

according to the standards of Romanian Agency for Quality Assurance in Higher Education (ARACIS in Romanian), the syllabus must include a set of minimum information, such as the elements for identifying the discipline in the curriculum (year of study, semester, discipline category, number of hours for course/ laboratory/ project, number of allocated credits, assessment type), as well as the teaching staff of the course and of the applied activities, respectively, the specific competencies accumulated, the objectives of the discipline, the basic thematic content, the distribution of the number of hours of course and applied activities on topics, student assessment system, minimum bibliography. To these may be added, where appropriate, information on curriculum prerequisites. The prerequisites of a course refer to courses that must be completed with passing grades before taking the current course. The prerequisites of the ECG course are courses of mathematics and introductory programming. However, even though the students passed these required courses, unfortunately, sometimes there are students with poor knowledge of mathematics, and/or with limited programming skills, respectively. This low level of specific knowledge is one of the reasons why some students fail to fully achieve the learning outcomes and to be able to satisfy assessment requirements of this computer graphics course.

Therefore, we tried to find solutions, but without relying solely on formal training. We tried to take advantage of the fact that all students have mobile devices, which they use, among other things, to access the Internet. We developed microlearning units as a way to help students to recap and solidify the knowledge they need. Thus, in order to fill knowledge gaps and to reinforce their math knowledge needed for a computer graphics course, we added to this course some properly designed microlearning units with the following objectives: Providing easy access to clear, relevant and concise content; Engaging students through various challenges; Ensuring quick access to reports on students' results; Providing a user-friendly learning experience through the use of diverse content formats: slideshows, video, quizzes, games, etc., optimized for all devices (desktops, tablets, and mobile phones).

At the beginning of the semester, we clearly specified the prerequisites for the computer graphics course and we invited students to take an anonymous test in order to assess their prerequisite knowledge. Thus, they were able to easily identify their knowledge gaps. Next, we wanted to enable students to control their own revision process. But, in order to help students to fill their knowledge gaps, we provided them with various microlearning units designed for the reviewing of important topics needed to understand elements of computer graphics. Each microlearning unit also offers information about the applicability of the reviewed concepts in the computer graphics context. In order to allow students to understand the importance of those concepts and the relationships between various content areas, information about the necessity of the considered concepts was presented as a knowledge map. Some examples of math prerequisites for ECG are analytic and differential geometry, linear algebra (such as, vector, matrix, dot product, cross product, matrix multiplication, normal vector, transformations), etc. In fact, the course ECG is, among other things, a way to show students how to apply maths in practice.

We organised the content of the microlearning units by defining logical categories. These categories could include various content types, presented through different file types, such as, PDF, PPT, DOCX, MP4 video, MP3 audio and images. Some of these were created by us, but we also included various free materials, selected from the Internet. We tried to provide the appropriate amount of content necessary for a subsequent application of the concepts in the computer graphics context. Students can also access a category that includes additional relevant materials. In order to facilitate understanding, we provided a glossary with definitions of required terms. These were not the only resources to foster students' knowledge.

Each microlearning unit ends with a short quiz in order to ensure students' understanding of reviewing outcomes. In order to identify skills gaps and properly address reviewing needs, random questions of different types and time limit are used for each quiz. A student could take any quiz at

any time, even without going through the microlearning unit for revision. But if students failed a quiz, they had to follow the microlearning unit in order to refresh their knowledge. Even if students passed the quiz, they were able to decide to emphasize some aspects. In order to help students to practice as much as they liked without depending on teachers, we created some self-grading quizzes, which provided students with immediate answer feedback. We used various online tools to assess students' progress, such as auto-grading Google Quizz and Moodle. But, in order to keep students engaged and attentive we used various methods, even the power of gamification. For example, we used Quizziz. We designed various quizzes, with or without figures, and we challenged the students to compete with each other. In order to drive more meaningful outcomes, we gave feedback for any submitted assessment or test.

3.1 Results

Students were able to access any microlearning unit by themselves, any time and from anywhere. Consequently, they were not limited by a class timetable or classroom location. Thus, students were able to access learning contents on their own schedule and to work in their preferred time and rhythm. In fact, the students were co-creators of their learning path. The students appreciated the revision as easier and faster than that which did not involve microlearning and they reported microlearning integration was useful in their learning process. Although students enjoyed this solution for knowledge reinforcement and the full control of the content, time and location of their revision, they found it challenging.

The evaluation of the effect of microlearning activities on the successful completion of the course was made by analyzing the results obtained by the students, expressed by the marks obtained in the final exam. For comparisons the results obtained by students in 2018-2019 and 2019-2020 academic years were considered. In 2019-2020 academic year, unlike the previous year, students used microlearning in the learning process. Students using microlearning demonstrated statistically an improvement in the educational outcomes for the ECG field (Table 3).

Table 3. Statistics

Grades	**2018-2019**	**2019-2020**
<5	38.46%	8.74%
=5	1.28%	1.94%
=6	23.08%	28.16%
=7	12.82%	28.16%
=8	3.85%	15.53%
=9	3.85%	7.77%
=10	1.28%	0.97%

We have to mention the involvement of some students in making contributions to the extending of microlearning units. Thus, they sent us various proposals for relevant materials specific for different topics. They also proposed new questions for the quizzes at the end of a unit.

As teachers, our role was simplified. Namely, we made available the guidance for the necessary subjects and provided appropriate microlearning units. Therefore, benefiting from increased access and the capability to review materials repeatedly, students were better prepared in terms of prerequisite knowledge and it was easier to remember the information needed for a new particular topic. In this way, we had the opportunity to focus on how to apply this knowledge in the context of new information specific to the computer graphics course. Taking into account the fact that the learning process involving the use of microlearning was appreciated as deeper and richer for students, next year we will use all these micro-learning units. But, following the

feedback received from students, some microlearning units will be updated. We will also try to add new ones for other topics.

The use of microlearning in the right context and properly made could play a significant role in building knowledge, but in order to enhance the way the teaching is performed, further research is needed.

4 Future Work

Analyzing the results obtained in these two years, we can conclude that microlearning could be very effective in facilitating learning and also teaching. But, for microlearning to be effective, it must adapt in real time to what each individual student knows or does not know. This type of microlearning could benefit from the new development in machine learning and artificial intelligence. Thus, in order to be able to close each student's learning gaps and to adapt to different students' specific needs and profiles, adaptive microlearning facilities should be used. For example, adaptive microlearning enables tailoring of delivered content according to the student. Also, it could help students to take recommended actions for continuous improvement. In fact, adaptive microlearning can build a personalized, individual learning journey for each student.

In order for microlearning to be implemented in higher education, it is necessary that the different learning and teaching strategies it involves be accepted and adopted in higher education.

5 Conclusion

Given the increased use of mobile devices both among students and teachers, new opportunities for teaching and learning are opening up. However, in the educational process, in addition to the tools that allow easy access to the learning content, it matters how this helps students to retain and retrieve knowledge and information. Microlearning represents a solution that allows the retrieval of the right information by the right students on the right device, at the right time.

In order to analyse the effect of microlearning activities, the present paper focused on a situation which has been frequently encountered in higher education. Thus, a course provided in the curriculum of a study program may require knowledge which has been introduced by other previous disciplines. Yet, there are cases, in which, unfortunately, even if a student took part and even passed those disciplines, he/she does not remember the appropriate information. This low level of specific knowledge is one of the reasons why some students fail to pass a course that requires knowledge from the previous disciplines.

The identification and the implementation of solutions for this situation call for a holistic perspective. In this paper as a case study we focused on a microlearning-based solution for the ECG course. In order to facilitate students' understanding and the use of the graphics concepts, during the last two academic years, the ECG course has been extended with properly designed and constantly updated microlearning units. The analysis of the students' activity and of their results both at the evaluations performed during the semester, and in the final exam, highlights the microlearning's contribution in facilitating the learning delivery. Moreover, according to students' feedback, they have had a positive perception regarding the microlearning units. This paper can help teachers in making the decision to incorporate microlearning-based review in their classroom.

References

De Gagne, J. C., Park, H. K., Hall, K., Woodward, A., Yamane, S., & Kim, S. S. (2019). Microlearning in Health Professions Education: Scoping Review. JMIR medical education, 5(2), e13997.

Ebbinghaus, H. (2013). Memory: A contribution to experimental psychology. Annals of neurosciences, 20(4), 155.

Gross, B., Rusin, L., Kiesewetter, J., Zottmann, J. M., Fischer, M. R., Prueckner, S., & Zech, A. (2019). Microlearning for patient safety: Crew resource management training in 15-minutes. PLOS ONE, 14(3).

Jimenez, Ray. (2006). 3-Minute eLearning: Rapid Learning and Applications, Amazingly Lower Cost and Faster Speed of Development. Vignettes for Training. ISBN-10 : 0979184703

Job, M. A., & Ogalo, H. S. (2012). Micro learning as innovative process of knowledge strategy. International journal of scientific & technology research, 1(11), 92-96.

Kovachev, D., Cao, Y., Klamma, R., & Jarke, M. (2011). Learn-as-you-go: new ways of cloud-based micro-learning for the mobile web. In International conference on web-based learning (pp. 51-61). Springer, Berlin, Heidelberg.

Mohammed, G.S., Wakil, K., & Nawroly, S.S. (2018). The effectiveness of microlearning to improve students' learning ability. International Journal of Educational Research Review, 3(3), 32-38. DOI: 10.24331/ijere.415824

Semingson, P., Crosslin, M., & Dellinger, J. (2015). Microlearning as a tool to engage students in online and blended learning. Society for Information Technology & Teacher Education International Conference, 474–479

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.

Shatte, A. B. R., & Teague, S. (2020). Microlearning for improved student outcomes in higher education: A scoping review. https://doi.org/10.31219/osf.io/fhu8n