Microlearning in the Education of Future Teachers: Monitoring and Evaluating Students' Activity in a Microlearning Course

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Abstract: Microlearning has become a promising modern and effective approach to the education of various groups in recent years. In order to be able to further develop microlearning and consider student individualities it is necessary to map their passage through a course in detail. The article presents the conclusions of a research carried out at the Faculty of Education of the University of Ostrava. The aim of the research was to find out whether there are differences in approaches of studying a microlearning course. A microlearning course focused on teaching future teachers was created for the purposes of the research. The aim of the course was to present to students the possibilities of using digital technologies in the educational process. The research was conducted in the winter semester of the academic year 2021/2022. A total of 378 students participated in the study in the first phase (precourse survey) and subsequently 156 students in the second phase (analysis of course participants' behavior). Student activity was monitored during the study through learning analytics tools. Time of study, the number of realized events, the number of registrations, etc. were recorded for each student with these tools. The obtained data were analyzed using cluster analysis. Total of six different approaches that led to the successful completion of a microlearning course were described based on this analysis. The approaches can be used to describe a successful strategy to go through a microlearning course including the extreme ones. An interesting fact is that the choice of strategy is not influenced by the student's gender. The only parameter where significant differences were found was the number of days to finish the microlearning course. In addition, the article describes the behavior of students in the course, the types of learning materials, devices from which they logged in the course and list of the most used course components. This part of the data was recorded via heatmaps. A detailed description of students' study strategies within microlearning courses can improve the effectiveness of microlearning also in connection with the personalized passage and thus improve the quality and efficiency of the educational process of future teachers.

Keywords: Online learning, Microlearning, e-Learning, Learning analytics, Future teachers

1. Introduction

Active teachers, pupils, and students notice new trends that can have a positive impact on the education process. It can be assumed that those involved in education want to teach and be taught using modern approaches that reflect the latest trends, including teaching aids and technology. When integrating modern educational resources, such as digital technology, into the education process, they are often rejected by teachers and parents, which may be caused by various factors (lack of information, bad experience, fear or prejudices against digital technology, lack of support from the school). To change this attitude and to make the teacher want to use it in their courses (or transform them – or part of them – into e-learning courses), digital technology needs to be used in a way that makes the education process more effective.

One way to catch the attention of those who support the integration of digital technology into the education process as well as those who are against it is to further develop e-learning and adapt it to meet the demands of today's world. This does not necessarily mean finding a new method or education model that will result in better knowledge and retention and skill acquisition, but rather trying to look for more effective teaching methods, e.g., shortening the time required to learn new information, improving the activation and motivation of students, as well as their attention span. Those are the key factors in today's world.

In today's technology-centered world where the majority of children and adults check notifications on their smartphones every 30 minutes (Gausby, 2015), keeping students' attention is a difficult task. According to

Reference this paper: Javorcik, T., Kostolanyova, K., and Havlaskova, T., 2023 Microlearning in the Education of Future Teachers: Monitoring and Evaluating Students' Activity in a Microlearning Course, *The Electronic Journal of e-Learning*, 21(1), pp 13-25, available online at www.ejel.org

Sternberg R. J. and Sternberg K. (2011), it is the attention that has a direct impact on long-term memory, improving students' knowledge retention and building links between new information and their existing knowledge base. According to Microsoft Research (Gausby, 2015), one of the biggest factors that impacts the ability to concentrate is technological development, which, since 2000, has led to a decreased attention span (from 12 to 8.25 on average) in the age group of 18 – 55+. Research conducted by Bunce, Flens and Neiles (2010) shows that students do not pay attention for 10-20 minutes during a lecture. This time is spread out during the entire lecture, alternating between periods of paying and not paying attention (those cycles become shorter and shorter as the lecture progresses). This study also suggests that students are more focused if a teacher uses nontraditional methods, such as demonstration or groupwork. This result confirms well-established findings that students are more engaged and attentive when they are doing something other than listening to the teacher lecture. The same applies to online lectures that are often conducted through video conferencing platforms. Regardless of the duration of a lecture, the engagement time has been determined to be 6 minutes at most (Lagerstrom, Johanes, and Ponsukcharoen, 2015). Engagement time can be improved by implementing interactive elements (questions, quizzes, etc.). Geri, Winer and Zaks (2017) argue that the average engagement time can be increased by more than 20 %. The aforementioned studies show that students would prefer the education content to be divided into small segments, which they could go through at their own pace. They would also prefer interactive elements such as questions, quizzes, fill in blank questions, etc. This concept is used by the following two models: Programmed Instruction Educational Model (Molenda, 2008) and Mastery Learning (Joyce, Weil and Calhoun, 2017). Both models are based on the idea that the student manages their own learning, which is then examined by a test. If unsuccessful, the student can repeat the unit and retake the test.

A decrease in attention span may be caused partly by today's stressful world, which also affects education. Technology forces us to multitask, i.e., to divide our attention between learning and our smartphone, which is online all the time. Speed is important also in education, for a variety of reasons. People do not want to spend a lot of time studying. They want to study in an effective manner (at their own pace, if possible), anytime and anywhere. Because of the COVID-19 pandemic, it can be assumed that online learning will become much more popular in the future. Multiple studies on online learning during the pandemic have already been published (Mulla et al., 2020; Naddeo, Califano and Fiorillo, 2021). Today, quickly finding the information one is looking for appears to be more popular than studying a comprehensive course, in which students encounter information they already know from start to finish (Miller, 2019). The same is true of the professional world where companies do not want to spend much time educating and training their employees – they would prefer it if they educated themselves on-the-go, and were able to adapt to market changes and customer needs (Martins, Zerbini and Medina, 2019).

When discussing students' requirements on the structure and quality of the education process, one must not forget the teachers. According to the survey conducted by the British Department of Education (Walker, Worth and Den, 2019), teachers' working hours have not been reduced (they still work approximately 1,700 hours a year), despite the implementation of educational technology. When combined with the average class size (21 pupils in primary school and 23 pupils in secondary school) and curriculum size, teachers' workload is too high. Regarding innovating the education process, one needs to consider teachers' workload and therefore all the proposed changes should be aimed at making the education process as time efficient as possible.

Current trends in using digital technology for educational purposes, expectations of students, teachers' workload, and the demands of today's world have encouraged the authors to explore the use of digital technology in education that would reflect the current trends. In their research, the authors focused on e-learning, with which they have a wealth of experience as it is used at their workplace, both in formal and nonformal education. The authors' the research was aimed at the courses available in the Moodle Learning Management System (Moodle LMS), which, as the authors have discovered, students do not study continuously but rather all at once at the end of the semester/course (Polasek and Javorcik, 2020). That is why the authors set out to transform the courses, so they could be studied continuously, anytime and anywhere.

Microlearning appears to be a worthy successor to e-learning, which meets the demands of today's world (it needs to be available anytime and anywhere, not overwhelmed with information, be interactive, offer diverse learning objects, allow students to study at their own pace, etc.). In their research, the authors focused on the impact of microlearning in different variations on different target groups. The research should provide answers to the following questions:

Q1: What is the level of students' digital technology skills, especially considering they are studying to become teachers?

Q2: Can different approaches to studying a microlearning course be identified?

Q2.1: Are there significant differences between men and women in their approach to studying a microlearning course?

Q3: Which parts of a microlearning course are most/least used by students?

The authors used two different research methods to answer the aforementioned questions. A questionnaire survey, which is a quantitative research method, was used to determine the level of students' digital technology knowledge and skills (Lee, Jahnke and Austin, 2021), while learning analytics was used to record students' behavior in a microlearning course (Song, 2018).

2. Types of Microlearning

From a global perspective, microlearning is not a new term. However, in the Czech educational system it is not as common as mobile learning. According to Buchem and Hamelmann (2010), the rise of microlearning was heavily influenced by technological and economic changes, which were so significant that they increased the demand for new educational concepts and strategies that would be different than the ones used today. The most significant is the fact that learning is no longer tied to a particular time and place as it can occur anytime, anywhere, and during almost any activity.

Microlearning is a comprehensive approach to education based on using web content in activities that are short in time (Singh, 2014). Giurgiu (2017) adds that that these short activities should be independent but should also build on each other (which is essential as it allows the learner to put information into context). The authors often refer to these short learning units as microlearning units (MLU) or short information units (SIU).

Microlearning is closely associated with the following concepts (Buchem and Hamelmann, 2010):

- MicroContent – defines the ideal duration and form
- Web 2.0 – MLUs can be created, aggregated, and used (repeatedly)
- Social software – an integral part of students' lives; it makes it easier for them to communicate while studying
- eLearning 2.0 – using Web 2.0 technology for educational purposes
- Personal Learning Environment – creating and using micro content in informal learning
- Informal learning – short MLUs can be integrated into everyday activities
- Work-based learning – using MLUs for employee education

From a theoretical perspective, microlearning was described by Hug (2005, 2012) and others (Lindner, 2007; Mathy and Feldman, 2012; Souza and Amaral, 2014). Hug (2005, 2012) defines the following MicroLearning characteristics:

- Time: relatively easy, short
- Content: small units
- Form: fragments, episodes
- Focus: separate, integrated activities, maintain attention
- Mediality: various media – printed, online multimedia
- Learning method: repetition, constructivism, connectivism, etc.

Bersin (2017) argues that microlearning has evolved from eLearning. If we are to accept this notion, we need to compare microlearning and e-learning and define the differences between them. The main difference is in the course layout and the duration of its individual parts, through which educational content is presented to students.

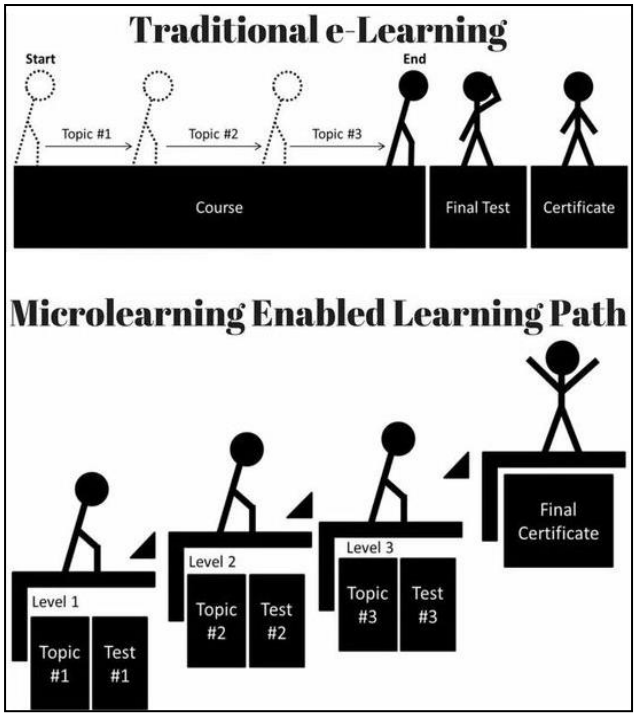

Figure 1: Graphic comparison of eLearning and microlearning (Bersin, 2017)

The individual levels (Level 1, Level 2, etc.), as seen in the picture above, are represented by the so-called microlearning units, which can be represented by any learning object (text, presentation, video, audio, animation, infographics, etc.). According to literature (Buchem and Hamelmann, 2010; Lindner, 2006; Hug, Lindner and Bruck, 2006), it takes 2 to 15 minutes to learn the content.

As far as the time and content scope is concerned, learning objects can be divided into Micro level, Meso level and Macro level (Hug, 2005). The individual levels (including examples) are described in the following table.

Table 1: Relation of micro learning, meso learning and macro learning to different areas (Hug, 2005)

	Example 1 Linguistics	**Example 2 Language instruction**	**Example 3 Educational content**	**Example 4 Course structure**	**Example 5 Classification of competencies**	**Example 6 Sociology**
Micro level	Individual letters	Words, phrases, sentences	Educational objects, micro content	Educational objects	Students' or teachers' competencies	Individualized learning
Meso level	Words, combination of signs and numbers, sentences	Situations, episodes	Sub-topics, content-limited topics	Topics, lessons	Lecture proposal	Group instruction or organized learning
Macro level	Texts, conversation	Socio-cultural specifics, complex semantics	Topics, subjects	Courses, structure of educational plans	Proposing learning plans	Generational learning, social learning

The term "microcontent" is inherently linked to microlearning (Souza and Torres, 2015). Even though it was originally associated only with Web (Dizon and Tang, 2017; Clark and Paivio, 1991), Lindner (2007) describes microcontent as "all kinds of micro-chunked digital content: very small texts, pictures and graphics, and combinations thereof; links; short low-resolution audio or video clips", and introduces the term "micromedia" (stressing the use of different content mediality). There are also other forms of microcontent, such as podcasts or microblogging (Lindner, 2007; Salomonsen, 2018).

Many authors have written about microlearning (both directly and indirectly). They have focused on the following topics:

- Nursing education (Bian et al., 2014)
- Medical training and health professions (Simons, Foerster, Bruck, Motiwalla and Jonker, 2015)
- Language training (Fang, 2018)
- Engineering topics (Zheng et al., 2019)
- Programming skills (Skalka and Drlik, 2019)

Research showed that microlearning helps improve students' motivation, participation in instruction and performance.

Jahnke et al. (2020) provide an extensive overview of microlearning research. This study also outlines how microlearning will evolve in the future, particularly when used along with mobile learning. There are already 25 platforms that allow microlearning content to be mediated through mobile technology (e.g., EdX, Lynda.com or Skillshare).

Recent psychology findings on memory, learning or capturing and maintaining students' attention also prove the effectiveness of microlearning. The so-called Miller's magical number, which argues that the number of objects an average human can hold in short-term memory is 7 ± 2 (Miller, 1956), can serve as an example. If we consider the learning theory and Miller's magical number, a short attention span when it comes to learning, the need to revise information stored in short-term memory, their retention (in order to learn), and today's fast-paced world, microlearning appears to be the clear choice. Since they reflect the existing knowledge on attention span, the learning process characteristics and memory stages, MicroLearning Units (MLU) may be an appropriate alternative (Morris et al., 2005; Salomonsen, 2018; Schmidt, 2007; Wissman, Rawson and Pyc, 2012).

In general, a learner's attention span corresponds to their age. If the attention span increases, it leads to so-called information overload, i.e., isolated and unconnected knowledge which leads to not understanding the presented curriculum (Skoda and Doulik, 2011).

3. Design of Microlearning Course

A microlearning course with the aforementioned characteristics was created to verify the authors' assumptions and answer the research questions. To maintain scientific objectivity, the authors selected the course "Information Technology in Education". The goal of this course is to show the students (future teachers) how to use digital technology in education. The course is mandatory for all future teachers studying at the Pedagogical faculty of the University of Ostrava. Hence, the course was taken by students with different digital technology knowledge and skills, with the conditions being the same for everyone.

The microlearning course consisted of 5 chapters:

1. Working with text and creating worksheets
2. Working with images and graphics
3. Multimedia
4. Online tools and sharing
5. Mobile technology and applications

Each chapter was designed to show the students how beneficial digital technology can be if used properly and with a specific educational purpose. The chapters included MLUs in the form of short text, videos, video tutorials and other interactive elements. A H5P module (HTML5 Package) was used to create the interactive elements. At the end of each chapter, the students were required to design and create a product that could be used in instruction (according to their specialization). In doing so, the students put the newly acquired information to good use. The Moodle LMS was chosen for course creation and administration.

4. Methods

Research occurred during one semester from September to December 2020. 378 teacher students from the Pedagogical Faculty of the University of Ostrava participated in the research study. The students studied in programs aimed at different subjects (Czech language, music, arts, computer science, mathematics, etc.). Before the start of the semester, each participant received an email with course specifications (requirements, assignment submission guidelines, etc.). The email also included information about research participation. The

students were then enrolled in the microlearning course. Those who did not agree to participate in the research study were enrolled in the same course, but were not asked questions or monitored.

The research study was divided into two stages. In the first stage, after logging into the microlearning course, the students filled out a precourse survey that consisted of 23 questions aimed at demographic information (e.g., gender, grade, age, etc.), their specialization, attitude toward digital technology and its use in the education process and subjective evaluation of their digital technology skills (e.g. text processing, working with images, creation of video tutorials, tests or online courses). This part of the study was aimed at determining, through self-assessment, the students' existing digital technology knowledge and skills, particularly with respect to their future role as teachers. The authors assume that the students are able to accurately assess their digital literacy (Porat, Blau and Barak, 2018). Based on the survey data, the microlearning course was adapted to better suit the students' needs. Selected topics were expanded while others were simplified, to allow the students to pay more attention to the chapters they needed to improve in. However, no chapter was left out.

The second stage was aimed at the participants' behavior. Since the authors were interested in identifying different approaches to tackling the microlearning course, the second stage included only those participants who successfully completed the course – the research sample was selected using stratified sampling by gender (N = 156 students). The goal of this stage was to determine the behavior of microlearning course participants through web analytics. The results allowed the authors to identify different approaches of microlearning course participants. The website analytics tool Smartlook was used to monitor the behavior of course participants (https://www.smartlook.com/).

The following parameters were monitored:

- Learning days (time between the first and last login)
- Number of events (number of clicks, text written and other student input)
- Total number of visits
- Length of each visit
- Type of device (smartphone, tablet, desktop computer)
- Course components used by students

Cluster analysis was used to analyze the collected, aggregated and standardized data to determine groups of students with similar behavior.

5. Data Analysis

The first stage of research – the precourse survey – was conducted in September 2020, before the start of the semester. Of the total 469 students enrolled in the course Information Technology in Education, 378 participated in the precourse survey (80.6 %).

Table 2: Pre-course survey – research sample

n		Age	
Female	**Male**	**Avg.**	**SD**
262 (69.31 %)	116 (30.69 %)	23.71	7.661
378			

In the first part of the questionnaire, the respondents were asked to assess their attitude toward digital technology and their digital skills. The majority of respondents reported a positive attitude toward digital technology, with the average score on a five-point scale (1-positive, 5-negative) being $\bar{x} = 2.25$ ($\tilde{x} = 2$). The answers the students gave when asked to evaluate their own knowledge and skills on a five-point scale (1-excellent knowledge, 5-lack of knowledge) prove that they have not yet mastered all the skills and knowledge a teacher should possess. Based on their answers, the respondents believed they were the most skilled at text processing, creating presentations, information seeking and email management. On the other hand, they were less confident about their skills required to create educational animations and video tutorials or create and manage websites and e-courses. Tables 3 and 4 provide a detailed summary.

Table 3: Student self-assessment of their digital skills – basic use of digital technology

Basic use of digital technology	$\bar{x}$	$\tilde{x}$	Absolute frequency					Relative frequency [%]				
			1	2	3	4	5	1	2	3	4	5
Text processing	1.992	2	102	192	71	11	2	26.98	50.79	18.78	2.91	0.53
Data processing	2.791	3	35	113	146	64	20	9.26	29.89	38.62	16.93	5.29
Use of images	2.280	2	78	166	90	38	6	20.63	43.91	23.81	10.05	1.59
Use of photography	2.526	2	67	129	109	62	11	17.72	34.13	28.84	16.40	2.91
Sound recording and editing	3.368	3	22	56	120	121	39	5.82	14.81	31.74	32.01	15.61
Creating presentations	1.915	2	138	163	57	11	9	36.51	43.12	15.08	2.91	2.38
Creating animations	3.566	4	11	61	111	93	102	2.91	16.14	29.37	24.60	26.98
Creating video tutorials	3.791	4	16	38	89	101	134	4.23	10.05	23.54	26.72	35.45
Use of applications or educational purposes	2.780	3	45	118	125	55	35	11.90	31.22	33.07	14.55	9.26

Table 4: Student self-assessment of their digital skills – online environment

Online environment	$\bar{x}$	$\tilde{x}$	Absolute frequency					Relative frequency [%]				
			1	2	3	4	5	1	2	3	4	5
Information seeking	1.479	1	231	127	11	4	5	61.11	33.60	2.91	1.06	1.32
Email management	1.563	1	215	132	17	9	5	56.88	34.92	4.49	2.38	1.32
Use of cloud services	2.757	3	50	117	118	61	32	13.23	30.95	31.22	16.14	8.47
Creating online forms	3.061	3	36	97	107	84	54	9.52	25.66	28.31	22.22	14.29
Creating online documents	2.976	3	41	106	106	71	54	10.85	28.04	28.04	18.78	14.29
Creating online tests	3.270	3	25	84	109	84	76	6.61	22.22	28.84	22.22	20.11
Creating websites	3.746	4	18	37	100	91	132	4.76	9.79	26.46	24.08	34.92
Creating e-courses	3.921	4	9	31	90	99	149	2.38	8.20	23.81	26.19	39.42

The majority of respondents (n=318; 84.13 %) reported they intended to improve the aforementioned skills. The remaining respondents either stated that they were satisfied with their level of skills and knowledge (n=23; 6.08 %) or that they had yet to discover their own potential (n=37; 9.79 %).

The second part of the questionnaire was aimed at learning the students' opinions on the integration of digital technology into the education process. The participating future teachers have a positive attitude toward integrating digital technology into instruction ($\tilde{x} = 2$; 1-positive attitude, 5-negative attitude).

The results show that future teachers intend to use digital technology in their classes – 342 respondents (90.58 %) intend to use digital technology in their classes, with the majority of respondents reporting that they are not stressed at all or only slightly stressed (n=238, 62.96 %) about using it. As far as teaching stages are concerned, the students intend to use digital technology during the motivation (n=304) and application (n=242) stages. 136 respondents selected the motivation stage as the only option out of the five presented (motivation, exposition, retention, diagnostic and application) while 30 respondents selected all five options.

The majority of respondents would use digital technology to present the curriculum (n=331, 87.57 %); 126 of them would use it exclusively for this purpose. The remaining respondents chose different combinations of the

available options (to present the curriculum, for modeling/simulation, testing, to record students' grades/performance). 58 respondents chose all available options.

A closer look at the collected data shows that the students approached the microlearning course differently. The average learning time was 59.15 days (time between the first login and the final assessment given by the tutor). During this period, the actual time spent studying was also measured (i.e., the time the students were logged into the course – which was 3.31 hours on average). During this period, the students performed 813.77 actions (events) in 56.99 logins on average. The average length of one login was 3.31 minutes. The standard deviation values for monitored characteristics (Table 5) indicate large differences between students' strategies in terms of how they approach the course.

Table 5: Aggregate data acquired by recording student activity in the microlearning course

	Learning days	Number of events	Time (hours)	Number of logins	Number of events per day	Length / login	Length / event	Time per day (minutes)	Number of logins per day
Avg.	59.15	813.77	3.31	56.99	16.17	236.68	23.06	4.05	1.16
SD	30.14	902.78	2.76	36.36	15.19	204.40	52.17	3.07	1.00
Median	61.00	608.00	2.74	49.00	11.04	197.64	14.89	3.10	0.90

If one were to divide the research sample by gender, one would find further differences in approaching the course. Due to the nature of the data, a Mann-Whitney U-test was used to determine statistically significant differences in behavior in the microlearning course between male and female students. Of all the data recorded by the web analytics tool, the only statistically significant difference was in the time spent studying (p-value 0.014), with men studying longer (more days) than women. Even though there were differences in other monitored data, none of them were statistically significant. The results, including the calculated p-values, are presented in Table 6.

Table 6: Behavior of students in the microlearning course by gender

Monitored data	Avg. women (N=102)	Avg. men (N=54)	P-value
Learning days	53.422	68.87	**0,0135**
Number of days	709.71	1008.4	0.40868
Total learning time (seconds)	11.140	13.408	0.997
Number of logins	53.842	62.889	0.52673
Number of events per day	15.554	17.334	0.33165
Length/login (seconds)	255.88	200.77	0.22155
Length/event (seconds)	22.499	24.123	0.39916
Time per day (seconds)	253.89	222.44	0.1794
Number of logins per day	1.1331	1.2167	0.60296

Cluster analysis was used to provide a more accurate picture of the collected data, allowing the authors to identify common features across the research sample. Using cluster analysis (Euclidean distance in particular), clusters with common features were identified (the results are presented in Table 7).

Table 7: Characteristics of identified clusters determined through Euclidean distance

Cluster	n	Learning days	Number of events	Time	Number of logins	Number of events per day	Length /login	Length / event	Time per day	Number of logins per day
1	18	63.17	1002.00	5.09	90.00	16.33	3.60	20.33	5.00	1.47
2	61	70.33	663.01	2.55	52.44	9.55	3.04	15.63	2.23	0.76
3	18	25.39	372.00	1.32	26.83	22.70	3.96	43.91	4.69	1.46

Cluster	n	Learning days	Number of events	Time	Number of logins	Number of events per day	Length /login	Length / event	Time per day	Number of logins per day
4	12	108.08	1827.00	7.87	110.50	18.87	4.15	17.26	4.90	1.15
5	23	42.13	482.13	2.26	35.74	12.85	6.47	39.89	4.37	0.91
6	19	28.53	591.00	2.66	43.89	29.62	3.83	15.47	7.15	2.18

Using cluster analysis, the authors identified 6 groups of students (based on how they approached the course). Cluster 1 students (n=18) logged into the course often and their time spent studying was above average. Their number of logins per day was also above average. Cluster 2 (n=61) includes the largest number of students. This group of students spent the shortest amount of time studying per day. Their other values were average. Cluster 3 is a perfect example of cramming. This group spent the shortest overall time studying; they tried to perform as many actions (events) per day as possible. This group's goal was to complete the course in the shortest time possible. Cluster 4 students spent the most time studying, performed the most actions (events) and studied the course the longest. It can be assumed that this group included students with low digital literacy and students who did not find this type of learning appealing. Cluster 5 students approached the course in a similar way to Cluster 3 students, the only difference being that they did not log into the course as many times a day, but tried to accomplish as much as possible during one visit. Cluster 6 is another example of cramming. When compared to Cluster 3, this group's approach was even more extreme, with a higher total number of logins, time spent studying and number of events per day. This group's goal was to minimize the time spent studying.

The website analytics tool heatmap was used to determine which parts of the course the students used the most often. It provided information about the number of clicks on the particular parts of chapters. The data on student activity in the individual course chapters are presented in Table 8.

Table 8: Student activity in the individual chapters of the microlearning course

	No. of displays	No. of clicks	Type of device	
			Computer / laptop	Smartphone / tablet
Introduction	769	651	726	43
Topic 1	1,836	1,196	1,806	30
Topic 2	1,185	876	1,168	17
Topic 3	634	392	618	16
Topic 4	891	493	878	13
Topic 5	1,173	550	1,134	39

The table shows that the most visited chapters were Topic 1 (Working with text and creating worksheets), Topic 2 (Working with images and graphics) and Topic 5 (Mobile technology and applications). Working with text and creating worksheets chapter also had the most clicks. The individual chapters differed in the total number of clicks, which was caused by the fact that the students did not always use all the available study materials. As far as educational materials are concerned, the students preferred videos and video tutorials to text materials. The amount of used educational materials in the chapter was influenced by its thematic focus. When working with common apps (e.g., MS Word, MS PowerPoint or Google cloud tools), the students did not use many materials. In these chapters, they chose educational materials aimed at using those tools for educational purposes. When working with less common apps, however, the students used the majority of available materials, including additional information and external links.

Heatmaps were also used to determine the type of device the students accessed the course from. The majority of students accessed the course from a desktop computer/laptop. Only a minority of students accessed it from a mobile device (a smartphone or a tablet).

6. Discussion

The presented results allow the authors to answer the aforementioned research questions. Those were:

Research question 1: What is the level of students' digital technology skills, especially considering they are studying to become teachers?

Conducted before the start of the microlearning course, the pre-course survey showed that the students were confident about some of their skills (text processing, creating presentations, information seeking, and email management) and less confident about others, which a future teacher should have (creating video tutorials or creating online tests). The results prove that to make the education process more modern and effective, future teachers need to constantly develop their knowledge and skills on the use of digital technology in education. According to the authors, students' input knowledge needs to be monitored constantly. When compared with a similarly focused study on the digital literacy of elementary school students, the results are similar (despite the significant age difference among respondents). The fact that university and elementary school students have a similar level of digital literacy may be caused by the high (and ever-growing) digital literacy of young students. The ITFitness survey results support this argument (Kucera and Jakab, 2020).

Research question 2: Can different approaches to studying a microlearning course be identified?

Data acquired through web analytics showed statistically significant deviations, which means there were different approaches to studying the microlearning course, and with different results. If we focus on the differences between men and women in how they approach the course, we will learn that the only statistically significant difference was in the time spent studying, with men studying longer (more days) than women ($p=0.01$). Data from previously published studies reveal several reasons why men take longer to complete the course than women. Women tend to login into the Moodle LMS more often and can organize their online learning more efficiently. On the other hand, men tend to find the Moodle LMS difficult to navigate (García-Martín and García-Sánchez, 2017). Moreover, women are also more productive in an online environment than men (Caspi, Chajut and Saporta, 2008). However, it needs to be said that their cultural background may also have an impact on the differences (and their extent) between men and women (Li and Kirkup, 2007). Even though it took men more days to complete the course, they did not spend more time doing so ($p=0.997$). They only spread it out over more days.

Using cluster analysis, the authors identified 6 groups of students (based on how they approached the course). There were students who used a cramming strategy, there were students who studied continuously and then there were students who completed the course, but it took more effort and time. Since there are multiple ways to successfully complete a microlearning course, there might be a connection between the student's learning style and their strategy in regard to working their way through the course. The course components (types of educational materials) used by the student might be an important guide (Ocepek et al., 2013).

Research question 3: Which parts of a microlearning course are most/least used by students?

The website analytics tool heatmap was used to determine which chapters and their parts the students accessed the most often and which had the most clicks. The most visited chapters were those aimed at working with text and creating worksheets, working with images and graphics and mobile technology and applications. It is unclear whether this activity was caused by students' interest or the chapter's difficulty level. The number of events (clicks) corresponds to the number of used materials. Regarding chapters with a higher number of clicks, it can be assumed that some students either kept coming back to the same educational materials or needed to go through more materials to be able to complete the course. As far as particular parts of the individual chapters are concerned, the heatmap data show that the students preferred the multimedia content (video, animations and interactive elements). The fact that in e-learning students tend to prefer multimedia to text supports this argument (Lam et al., 2014). Text materials were used sporadically, especially in chapters aimed at less traditional tools that the students were not familiar with, and which required more studying (i.e., they needed to consult more materials). The popularity of video, multimedia and other interactive elements is documented in other published studies written by authors with different cultural backgrounds (Afacan Adanir et al. , 2020; Muthuprasad et al., 2021).

The assumption that in e-learning and microlearning students mostly used mobile devices to access the course content was not confirmed. The majority of students accessed the course from a desktop computer/laptop. Only a minority of students accessed it from a mobile device (smartphone or tablet). The results of this study contradict the results of other studies published both in the Czech Republic and other countries where the use of mobile devices for educational purposes is more pronounced (Klimova, 2017, Muthuprasad et al., 2021).

Research could be made more accurate by using Eye-Tracking, which would allow the authors to monitor students' attitude toward individual materials and compar

e it with similarly focused studies (Conley, Earnshaw and McWatters, 2020; Copeland and Gedeon, 2014).

7. Conclusion

Future teachers have different input knowledge and skills. Such education should aim to produce teachers with identical input knowledge, which would allow them to use digital technology in an effective and useful way, regardless of the subject.

One of the ways to achieve this goal is to incorporate microlearning into the education of future teachers. The authors chose microlearning because its positive impact on learning has been described in recently published studies, and the sheer volume of available materials that they wanted to include in the microlearning course. The main goal of the study was to prove the students use different learning approaches and to identify the parts of the course that are accessed more often than others. By analyzing data acquired through web analytics, the authors identified 6 groups of students (based on how they approached the course). These groups differed in terms of how long (how many days) it took them to complete the course, the number of events, total learning time or the number of logins. Using these factors, the authors described each of the six groups.

It is interesting that aside from the time spent studying, there was no statistically significant difference in behavior in the microlearning course between male and female students, with men studying longer (more days) than women. The website analytics tool heatmap was used to determine which parts of the course the students used the most often. As far as educational materials are concerned, the students preferred videos and video tutorials to text materials. The amount of used educational materials in the chapter was influenced by its thematic focus. When studying topics they were not familiar with, the students used the majority of available materials. Students used mobile devices to access the course much less often than the authors expected.

The authors feel that findings of the study may contribute to incorporating microlearning into the education of future teachers and to revealing appropriate strategies in navigating this type of course. Based on the presented results, such courses can be adapted to those strategies and therefore make students' learning more effective. This study also opens new possibilities for further research.

With respect to the aforementioned findings, in future research the authors would like to focus on students' learning styles and their impact on learning new information in microlearning courses. Designing a personalized version of the microlearning course for every student based on their learning style (which would meet the conditions of learning style variability according to the VARK test or Kolb's experiential learning cycle) appears to be an appropriate idea.

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