Microlearning: Innovative Digital Learning for Various Educational Contexts and Groups

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Abstract: Microlearning brings a number of advantages that make it an attractive tool for education. Short and clear lessons minimize the risk of information overload, promote better understanding of the material, and enable quick and easy retention of information. The relevance of microlearning lies in its ability to respond to current educational needs and trends. Microlearning is considered to be a flexible, effective and innovative approach to learning that can be successfully applied in different learning environments, for different learning content and to different target groups. The aim of the research is to describe the impact of microlearning modules on the level of learning outcomes and perceived effectiveness in different target groups. Our research focuses on examining the effectiveness of microlearning on lower secondary school pupils, secondary school students and librarians. In the context of lower secondary schools, specific microlearning units thematically focused on programming and working in Scratch will be presented. This part of the research was carried out using an experiment and a questionnaire survey. In the experiment, the effectiveness of this type of teaching and digital learning materials was investigated. The experiment was conducted in parallel classes of a lower secondary school, and the participants were pupils aged 11 to 12 years old. The aim of the questionnaire survey was to find out the probands' opinions about microlearning. In the context of secondary schools and learning librarians, we conducted a survey of available materials and microlearning modules. In this paper we will introduce general concepts and strategies, with more detailed descriptions of specific modules to be published later. This paper aims to contribute to the growing awareness of the importance of microlearning as an effective educational tool and highlights its potential in different educational settings, especially lower secondary schools, thus providing useful material and inspiration for educators. The results suggest that the implementation of microlearning in lower secondary school settings has led to improved student learning outcomes.

Keywords: Microlearning, Lower secondary school, Pupils, Programming, Experiment

1. Introduction

Since the beginning of the 21st century, there has been an immense increase of the use of digital technologies in education. Developing of new technologies and methods in teaching has been significantly influenced by outbreak of the Covid-19 pandemic in 2020. During the precipitous situation in spring 2020, teachers as well as pupils were pushed to distance learning, which led to use of various platforms providing suitable educational environment. In the Czech Republic, MS TEAMS, Google Classroom (GSuite) and Zoom were used the most, considering the first two as the main environments, because they allow creating individual groups, online blackboards, assigning and evaluating tasks, bult-in applications etc. (Ferdiánová et al. 2021).

Using these platforms both in synchronous and asynchronous teaching appears to be one of the elements in the process of individualizing education needs. For teachers, it is sometimes difficult to cover the diversity of learning needs of all pupils during the problem-solving process. However, general curricula documents in the Czech Republic, e.g. Framework Educational Programme for Basic Education or Framework educational programme for Secondary General Education, demand that teachers should consider specific needs and potential of each pupil, apply differentiation and various patterns of the educational process when achieving the objectives of the given level of education. (MŠMT 2023; MŠMT 2007) These principles thus should be followed when preparing any learning unit.

Moreover, when preparing any learning unit, each teacher, regardless of the subject he or she teaches, should choose such methods and ways which are the most effective and time efficient. As the various educational platforms can be considered as didactic aids which allow us to distribute visual media easily, based on Petty

(2006) visualisation seems to be an effective way for supporting required differentiation. He states that our brain receives 87 % of information by visual perception, 9 % by hearing and 4 % are left for other senses. He also mentions that visualisation is beneficial because it draws attention, supports understanding and remembering.

It is also important to consider the amount of information a teacher wants to address to pupils. As the attention span descends with the duration of the activity, the best option is to use only a small amount of information. Thus, a microlearning can be offered as an effective option.

1.1 Microlearning

Nowadays new teaching strategies and instructional design can assist teachers in teaching and align with students' and pupils´ (learners´) learning preferences at all levels of schools (Rotellar and Cain 2016). From this point of view, microlearning draws upon several theoretical frameworks, including cognitive load theory (Sweller 2011), spaced repetition (Piche 2019), and constructivism (Bransford and Schwartz 1999). The teaching method of microlearning provides learners more regularly the learning task with small, manageable chunk of information (Aldosemani 2019).

According to Maddox (2018) is microlearning

- an approach to learning that process the information about a single, specific idea in a compact and focused manner,
- and also, the learning technique that operates within the learner's working memory capacity and attention span, providing just enough information to allow the learner to achieve a specific, actionable and reachable goal.

According to Leong et al. (2021) microlearning enables learners to gain new knowledge or skills just in time to meet their immediate needs in this fast-changing world; in addition, microlearning can also help these learners to achieve a specific, actionable task.

Microlearning uses in the educational process short learning activities with microcontent (Hug 2007). This art of teaching and learning is realized through small learning units and short-term educational activities. In some organisations microlearning modules are used to deliver just-in-time training on specific tasks or procedures (Kapp 2012). Microlearning belongs to research paradigm intended to explore new ways of responding to the increased need for self-directed, lifelong, and informal learning based on learning on demand. Microlearning was developed for the purpose to focus less on new technologies themselves and more on individual needs of learners (Buchem and Hamelmann 2010). According to Taylor and Hung (2022) along with the interest in microlearning is the assumption that creating more microlearning courses will address challenges in education in educational institutions of all stages. They argue also that the assumed reasoning is that by providing shorter and more focused content according to need, the information is easier to consume and retain from the learners´ perspective. Kapp and Defelice (2019) suggest that microlearning offers numerous benefits, including increased learner engagement, improved knowledge retention, and greater flexibility in learning delivery.

This paper is one of three parts of a larger research project supported by the University of Ostrava. The aim of the full project is to map in detail the effect of microlearning on three different target groups: lower secondary school students, secondary school students and adults in the form of library staff. This paper shall present the section focused on lower secondary school schools. The topic of teaching programming with a focus on working in Scratch was chosen for this part.

1.1.1 Microlearning in lower secondary schools

Microlearning has not been extensively researched in lower secondary school settings, with most of the research primarily being focused on university settings. With the new era of modern technology and the modernisation of teaching at all levels of education, but especially the impact of the Covid-19 pandemic, elements of microlearning are also appearing in lower secondary schools. Therefore, we decided to explore this area, to test the potential of microlearning and the possibilities of its use in the lower secondary school environment.

Prior to the Covid-19 pandemic, this area was addressed by Mohammed et al. (2018). The study concluded that students using microlearning had 18% better learning results compared to regular classes. Since then, however, the situation has changed somewhat and, e.g., videos with a maximum length of 6 minutes, as reported by Mohammed et al. (2018), are already considered long by today's standards, and students cannot keep their attention focused on one video for such a long time. ALshammari (2024) in his study about teaching programming argues, that teachers who use video-based microlearning can expect to see their students develop better programming skills and have a more positive attitude towards learning. It is important to note that the

effectiveness of microlearning may vary depending on the type of microlearning used, the students‘ learning style and the way that microlearning is integrated into the curriculum.

1.1.2 Microlearning in secondary schools

Microlearning in secondary schools (as well as in primary schools) is not a common way of transferring knowledge and skills, and its effect on this target group is not described in detail. However, there are studies that look at the effect of microlearning on students' motivation and learning outcomes in science, but not in the form of a sub-continuous course (Nikou and Economides 2018). With regard to the ongoing trends of digitisation and the introduction of new computer education and building digital competences at all levels of education, the use of appropriate software also has the great advantage of increasing the clarity and dynamism in solving a given problem and the related increase in the knowledge level of pupils and students. The aim of the microlearning course will be to create and validate complex problem sets of selected topics in geometry at secondary school based on the principle of microlearning (i.e. covering a specific need in a short time). The contribution of such tasks will be evaluated in relation to e-learning and traditional teaching without the dominant role of digital technologies.

1.1.3 Microlearning in librarian education

The Standard for a Good Library (Národní knihovna České republiky - Knihovnický institut 2020a) emphasises the need for continuing education for librarians, but according to Pillerová (2022), the current supply of educational programmes lags behind, especially in the area of new technologies. With the transformation of libraries into learning centres (Národní knihovna České republiky – Knihovnický institut 2020b), the requirements for librarians' competencies are increasing, which has led the American Library Association (2017) to define the concept of the ‘teaching librarian’ – a librarian with tutoring knowledge and skills and the ability to transfer knowledge to different target groups. The National Library of the Czech Republic is responding to these challenges by building a team of learning librarian-internal tutors who focus on developing digital and tutoring skills. The upcoming microlearning course aims to strengthen these competencies and support the role of librarians in educating library users.

2. Methodology

We decided to primarily design our research as a quantitative research and chose the method of pedagogical experiment. In the experimental groups, we used a questionnaire survey to investigate the students’ opinion about microlearning and the evaluation of experimental learning. Our research sample consisted of students in one lower secondary school aged 11 to 12 years. Specifically, we worked with three parallel classes. One class served as a control; here we refer to it as the CON group (17 students). The other two classes were experimental – we used a created infographic and a quiz as microlearning elements. The goal of the infographic was to make the material visually appealing and allow students to learn at their own pace. The purpose of the quiz was not only to motivate the students, but above all to contribute to a greater learning of the material through repetition and thus extend the memorisation time. In the first of the experimental groups, the pedagogical experiment was conducted for four lessons. We shall refer to this class as group EX1 (23 students). In the second class, the pedagogical experiment took place in only two lessons, this class will be referred to as group EX2, with a total of 16 students present. This pedagogical experiment was implemented during the second semester of the 2023/2024 school year.

For our research we set four research questions:

RQ1: Does teaching with microlearning elements lead to better learning outcomes than traditional face-to-face teaching?

RQ2: Does the duration of teaching with microlearning elements have an impact on student achievement?

RQ3: What is the students’ opinion on the use of microlearning elements in the classroom?

RQ4: What is the opinion of the students about the implemented microlearning?

The third and fourth questions are descriptive, so we have not set any hypotheses here. The first two questions are causal and we established the following hypotheses based on them:

> *H1: Teaching with microlearning elements does not lead to better learning results than traditional face-to-face teaching.*

H2: The duration of teaching with microlearning elements does not affect the students' learning outcomes.

2.1 Apps Used

To design and implement our pedagogical experiment, we primarily worked with four main applications and platforms. The first was the Google Classroom application, which was used to organise our lessons. The second application we worked with was Scratch, an application that allows students to learn the basics of programming. This application was primarily used by students, where they had to create a program according to a task. For review and practice purposes, we created a quiz in Blooket consisting of 32 questions. Using Canva, we created a total of four infographics representing the overarching theme of programming, three of which are shown in Figure 1.

The first infographic contained theoretical information related to algorithmisation and programming, explaining the concepts and differences between them. The second infographic contained brief instructions for students on how to register for the Scratch platform. Screenshots directly from this application were used. The third infographic was a description of the Scratch user interface. The fourth infographic contained 5 basic activities that can be used in Scratch. This infographic was made up of five short videos that served as a simple guide for the students.

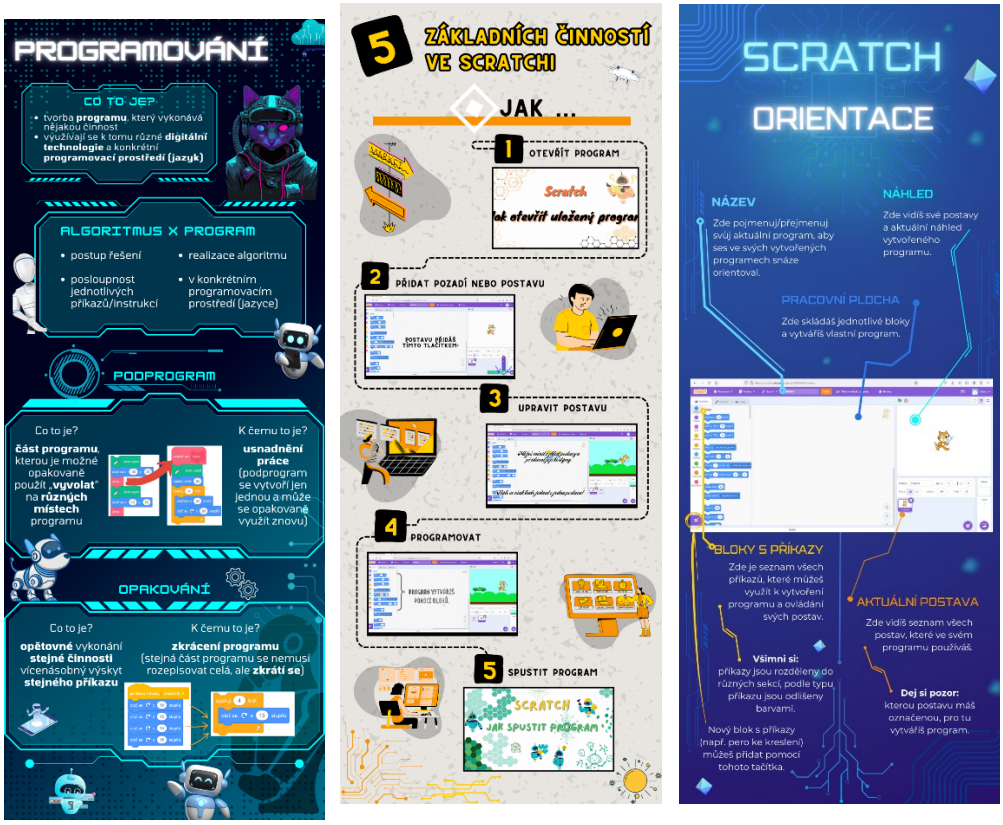

Figure 1: Samples of three infographics

The acquired knowledge was measured via a pre-test and post-test. In terms of the type of questions, we chose mostly closed-ended questions with one correct answer. One question contained a choice of four answers, four questions contained a choice of three answers, and four questions contained a choice of two answers, where students were asked to determine whether the answer was true or false. One question contained an open-ended answer.

At the end of the experiment students completed an evaluation questionnaire. Each questionnaire contained five separate questions comprising four open-ended and one closed-ended question with the possibility of marking multiple answers. In addition, the evaluation questionnaire contained 10 Likert scale questions for the students. In the case of the teacher evaluation questionnaire, it contained 13 Likert scale questions.

2.2 The Course of the Pedagogical Experiment

The implemented pedagogical experiment took place in the EX1 group during four lessons and comprised two two-hour teaching blocks. In the CON and EX2 groups, it took place in only two lessons. One lesson was 45 minutes long. Each lesson was conducted in a computer lab using tandem instruction, which is common in these classes.

Classes in group EX1 started with completing the pre-test. Then the infographics were shared with the students via Google Classroom. Students registered for Scratch and learned about its features at their own pace. At the beginning of the second lesson, the students were given a simple task to add characters, change the background, costume and create a movement program for each character. Thanks to the infographics, each student could choose their own pace, order of learning and completion of tasks. The third lesson involved a summary. The students then practised their knowledge using the Blooket app. The game Fishing Frenzy was selected and the time set to 7 minutes. They were then given a new task (to draw geometric shapes). To conclude, they completed a post-test and an evaluation questionnaire.

Teaching in the EX2 group was carried out in a similar way. In the first lesson, students completed a pre-test and were provided with infographics. Students registered for the application and familiarised themselves with how it works. In the second lesson, the students were given an assignment. This was followed by a retake using Blooket, completing a post-test and an evaluation questionnaire.

In the CON group, the teaching was carried out in a traditional way. After the completion of the pre-test, there was an explanation of the material, followed by an introduction of the Scratch application. Students then registered for the application and worked on the task. Finally, students completed a post-test.

3. Results

If we compare the work in the classroom and the activity of the students between the different groups, the use of the created microlearning materials leads to greater independence of the students. Students in the experimental groups were less likely to ask teachers if they did not know and much more likely to look up the information themselves in shared infographics. The students were also interested in the topic itself and in all groups they tried to discover the features offered by Scratch. In the control group, the students were less focused during the explanation of the material, as a result of which they remembered less of the material.

3.1 Comparison of Study Results

In order to compare the effectiveness of our proposed microlearning materials, we used knowledge-based pre-tests and post-tests. These tests were identical in all groups studied. In Figure 2 you can see the comparison of pre-test and post-test results in all three groups according to the number of points obtained by a given number of students in one group.

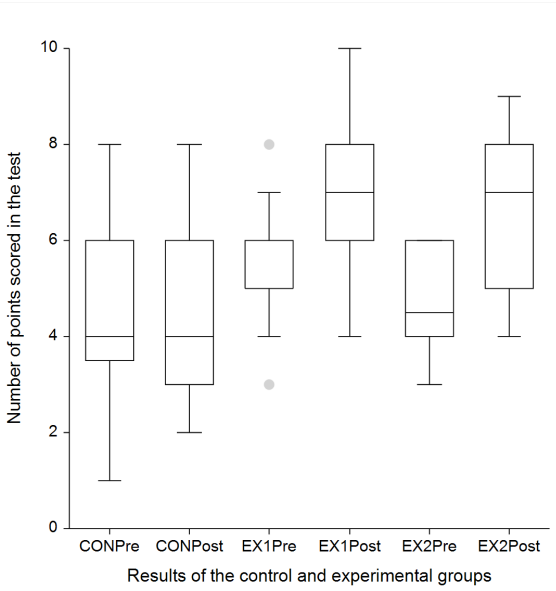

Figure 2: Comparison of pre-tests and post-tests of all groups (CON-control group, EX-experimental group, Pre-pre-test, Post-post-test)

The pre-tests confirmed that the students had not encountered the topic of programming and working in Scratch before. Pre-test success rates were relatively low. When we asked the students afterwards, they confirmed that they had just guessed the questions, so the actual success rate was even lower. Only one student from the CON group stated that he already knew how to use Scratch and one student from the EX1 group had partial knowledge of programming. In Table 1 it is possible to see an illustrative comparison of the characteristics of the data obtained from the pre-tests and post-tests in all three groups studied.

Table 1: Characteristics of the obtained data

Statistic	CONPre	CONPost	EX1Pre	EX1Post	EX2Pre	EX2Post
Count	17	17	23	23	16	16
Mean	4.588235	4.764706	5.478261	7.173913	4.75	6.6875
Standard Deviation	1.804814	1.75105	1.238385	1.40299	1.125463	1.662077
Standard Error	0.4377317	0.424692	0.2582211	0.2925435	0.2813657	0.4155193
Shapiro-Wilk W Normality Test (p-value)	0.8076	0.2348	0.2587	0.1259	0.0065*	0.1248

*) Significance level $\alpha = 0.05$

Table 2 summarises the results of the statistical tests for H1 and H2. The first hypothesis had to be split into two sub-calculations due to the existence of two experimental groups. For both comparisons of the post-test results of the control group (CONPost) with the post-tests of the experimental groups (EX1Post and EX2Post), a statistically significant difference was found using a two-sample t-test. The difference between the post-test results of the experimental groups is not statistically significant.

Table 2: Two-sample t-test

Hypothesis	Representation of the hypothesis	p-value
H1	CONPost – EX1Post	.00002*
	CONPost – EX2Post	.00292*
H2	EX1Post – EX2Post	.32991

*) Significance level $\alpha = 0.05$

3.2 Comparison of Student Motivation

Based on the evaluation questionnaires, we also obtained feedback from the students on the developed microlearning materials, see Table 3. Both experimental groups rated the microlearning materials as easy to understand and partly attractive in appearance. In both groups the opinion that this way of teaching was more enjoyable than classical teaching was clearly prevalent. Students also often reported that the materials they created contributed to a greater understanding and better retention of the material.

Table 3: Students' opinions on the implemented microlearning

Evaluation of microlearning elements by students	Definitely agree	Partially agree	Can't decide	Partially disagree	Definitely disagree
The created materials contributed to a greater understanding of the subject matter than in regular teaching.	15.4%.	53.8%.	20.5%.	5.1%.	5.1%.
I enjoyed working with the created materials more than in regular teaching.	33.3%.	33.3%.	20.5%.	10.3%.	2.6%.
The materials contributed to better retention of the material than in regular teaching.	28.2%.	30.8%.	25.6%.	10.3%.	5.1%.
I found the created materials easy to understand.	23.1%.	28.2%.	23.1%.	15.4%.	10.3%.

Evaluation of microlearning elements by students	Definitely agree	Partially agree	Can't decide	Partially disagree	Definitely disagree
I found the created materials visually appealing.	33.3%.	28.2%.	28.2%.	5.1%.	5.1%.

Evidence that this activity was highly motivating to the students is the fact that the entire class required repetition of the activity after the activity was completed, in both experimental groups. On the other hand, in the control group, students were not very interested in the theoretical part of the curriculum. There was also a lack of a section to practise the material, which was highly motivating in the experimental groups, but above all contributed to a better retention of the material. As for the feedback from the CON group, 6 students did not enjoy the lessons, 8 found them challenging.

3.3 Student and Teacher Views on Microlearning

In the groups studied, we wanted to know the students' opinion about this form of teaching. Most of the students liked this way of teaching more than regular teaching and would like to use it more often in computer class and other subjects. They expressed similar views on the use of these types of educational materials in teaching. Some students also said that this way of teaching helped them to understand the material better. Some students reported that they liked the microlearning because they did not have to make notes in their exercise books, some reported that they understood the material more, it was easier for them, they learned more material in less time, it was more comfortable and fun for them, and they appreciated the smaller amount of text and practice. Other students saw the positive side of microlearning as the actual use of technology in teaching. We were also interested in what type of educational materials the students prefer. Most students (29) chose the option of educational games, followed by pictures (25) and 21 students chose short videos. Surprisingly, 19 students found the traditional text to be suitable, provided it is concise and clear. 22 students chose quizzes and 12 students chose other educational applications. Only 10 students chose audio (podcasts) and 5 students chose infographics.

We also received feedback from two teachers present at these lessons. Both of them are experienced teachers who have been teaching at this school for many years. They evaluated the microlearning materials as understandable and engaging in appearance, but at the same time they wondered whether the graphic elements could distract students from the substance of the material if used excessively. They also felt that the microlearning elements used could have contributed to a greater understanding of the material and its easier retention. They generally deemed microlearning a good way to enhance learning and motivate students, but they also stated: "It should not be used in every lesson so that there is a change of methods and forms of teaching." They consider short videos, educational games and concise and clear text to be the most effective types of educational materials in microlearning. They also added: "The text should be short and clear." They cited the baby-steps-style process as the biggest advantage of microlearning. This principle of teaching was well-received by both teachers. They mentioned geography and science as other subjects suitable for this type of teaching.

4. Conclusion

The biggest problem that teachers in the selected lower secondary school encounter across all forms is low reading literacy, which is confirmed by the results of the Czech School Inspectorate survey (2024) and international PISA surveys (Boudová et al. 2022). Students do not only read assignments and other materials available to them in computer science classes. Therefore, it was important to overcome this problem for the implementation of our pedagogical experiment and to constantly refer students to these materials. It is therefore important not to overwhelm students with a large amount of text. The graphic aspect of the materials created, whether it is an infographic or a classic presentation, is the fundamental motivational element; this was confirmed by the students themselves.

Based on the data obtained, we could reject the null hypothesis H1: Teaching with microlearning elements does not lead to better learning results than traditional face-to-face teaching. At the same time, we cannot reject the null hypothesis H2: The duration of teaching with microlearning elements does not affect the students' learning outcomes. Thus, microlearning leads to better learning results than traditional face-to-face teaching and the length of classes does not affect student learning results. Microlearning can therefore not only be used effectively in universities but also in lower secondary schools, as we have verified in our pedagogical experiment. Many different elements of microlearning can be integrated into face-to-face teaching. Its undeniable advantage lies in its motivational effect. It is essential to engage the students and structure the learning experience so that the students have fun while also learning something. One of the best ways is to harness their competitiveness

and incorporate quiz games into the classroom. For this purpose we have found the Blooket app to be very useful, as it is not only based on the principle of competition, but also contains game and graphic elements that motivate students much more. The app also has the advantage of a greater variety of different game types available, allowing you to vary the activities while keeping the same questions created. However, it should be kept in mind that the methods and forms of teaching should be varied and alternated. These activities should not be involved in every lesson so that students do not get bored and have something to look forward to.

Teachers who participated in our pedagogical experiment decided to continue using Blooket to practise various curriculum topics. They also want to use the Canva app at this school, not only to prepare study materials for students, but also for activities and tasks that students could do using the app.

In our further research we will look in detail at the remaining two target groups, for whom we will create new microlearning educational materials and conduct independent pedagogical experiments. We will focus on microlearning in secondary schools and in librarian education.

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