

# Development opportunities for mobile and ICT learning in teacher education

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**Abstract.** Learning is nowadays a continuous intellectual readiness to be able to cope with the current needs of the world of work. Students' knowledge must be adapted accordingly and they must be capable of continuous development throughout their lives [8]. Changes in teaching-learning habits have already been observed at the beginning of the 21st century and those involved in education need to adapt to these changes with the appropriate transition to digital education what is more important today than ever before. We asked our teacher-candidate students in an online questionnaire at the beginning and at the end of the “Teaching Methods in Mathematics” course. Our non-representative survey provided valuable data for course development. The aim of the survey was to find out students' perceptions of the methods and tools they had learned in education. In the questionnaire at the beginning of the semester, we inquired our students about the types of work and methods they were familiar with, and then they gave their opinions about the different ICT tools, educational programmes and applications and how they were used. At the end of the semester, we interviewed them again whether they still held similar views on the subject or they had managed to change their views during the course.

*Keywords:* ICT, teacher training, Mathematics, educational environment

*AMS Subject Classification:* 97U10, 97U50, 97U60

## 1. Introduction

In this paper, we aim to show how the changing teaching-learning culture has influenced the structure of education of Mathematics and teaching methods in the teacher training programme in Széchenyi István University Győr. We have experienced the reduction in the number of lessons and the changes in the attitudes

of students as a challenge. These are the problems that everyone has faced in education in Hungary. In Győr we have tried to do our best. In these changes, we have also taken into account the applications of new information and communication technologies (ICT) but we have not neglected to present well-established manipulative tools and their potential use in teaching. Our previous research and publication have presented ideas on how to strike a balance between traditional and ICT-enhanced visualisation [3, 13]. The aim of our methods is to increase students' motivation and change their attitudes towards learning in a positive way. After a theoretical introduction the results of our online questionnaire and the conclusions are presented.

## 2. Theoretical framework

### 2.1. The generation growing up in the 21st century and the way they acquire knowledge

Growing up in the digital age is characterised by the need to acquire knowledge quickly and in the age of the Internet students get their knowledge from the information space. Their social relationships and social interaction habits have changed and they find a sense of belonging to a community through social portals, blogs, networking games [17].

They have no problem with navigating in parallel, side-by-side, so-called multitask applications. They expect instant, fast access to programs, quick reinforcement and rewards in solving tasks. However, during training, we need to make sure that they have the right ICT competences and are not only familiar with information-sharing applications on social networking sites. We need to build on their existing ICT skills to create the most appropriate learning environment for them.

### 2.2. Learning process in the 21st century

Learning involves modelling the outside world. In the course of education, we can shape and change this representation, forming a world view. Throughout history there have been several educational paradigms. Some have emphasised the direct transmission of knowledge, others the demonstration, and still others the action. Different pedagogical trends have alternated and complemented each other and have given rise to new theories, such as behaviourism, cognitivism or even constructivism. The process did not stop there, as new arenas of knowledge flow and knowledge sharing emerged with the rise of digital culture and digital education. The latest network-based forms of learning such as connectivism, adapt to students' forms of knowledge acquisition and their community organisation [11]. The focus is not only on acquisition but also on knowledge creation and sharing, where learners participate in the creation of collaborative content. It requires cooperation between all those involved in education. Of course, this also requires that students

receive as broad methodological training as possible on the opportunities of using ICT tools and teaching methods [6]. The attitude of students to Science as a subject cannot be described positive nowadays which is why the teaching of these subjects requires even more the implementation of a high level of demonstrations and developments.

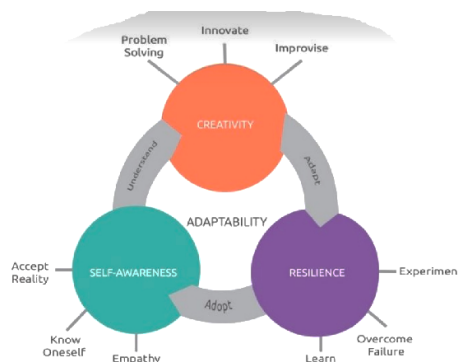
### 2.3. Expectations and skills in the 21st century

In addition to learning methods, another important factor is the need to change the educational environment as soon as possible. These are the expectations in the workplace. The only way to prepare students for their future professions is to develop 21st century skills and competences. Several educationalists and researchers have attempted to study these skills and competences, and although there are differences on a few points, the main features are the same.

Taking the ITL (Innovative Teaching and Learning) research as a starting point, we have the following classification:

- *knowledge building*
- *problem solving and innovation*
- *communication skills*
- *collaboration*
- *self-regulation*
- *ICT use* [16]

The graph (Figure 1) shows the parts and conditions of knowledge applicability: self-expression, creativity, continuous readiness for self-development, flexibility to react to problems are definitely needed.



**Figure 1.** The metaskills we need to thrive in the 21st century [18].

Anyone who reads carefully the skills listed above will see that the traditional frontal classroom work, lecturing and explanation are no longer effective as methods. Changes in students' learning habits, the rise of digital tools and 21st century guidelines have made it necessary to change traditional teaching methods in higher education. Collaborative learning, problem-solving methods and the education in the use of ICT should be promoted. Our previous research, cited several times in this paper confirms the need for these changes [13, 14].

### 3. Methods used in the course

After describing the new generation's learning processes and expectations, we will now give some ideas on the methods we use in our teaching and which were also asked about in the above mentioned questionnaire. Overall, we found the methods described below to be appropriate for achieving the objectives we set ourselves in the development of the subject.

#### 3.1. Flipped classroom

The flipped classroom model is a kind of inversion of traditional education. It is a learning management solution where students can watch at home the lecture prepared by the instructor and individually study the recommended teaching aids and online resources [7]. The flipped classroom is an engaging and student-interest based method where students' passivity is transformed into activity. In this learning management process, students are more independent and interested in the activity and know that there will be time for questions and discussion. In contrast to traditional lectures, the emphasis here is on practice rather than frontal teaching, according to the students' own needs. During or after the lecture, for example, students are asked to complete a test as feedback, and the results are known within a short time. Homework is done in the classroom, where the focus is usually on interactive activities and collaborative work. The flipped classroom is not an online course, the video is not a substitute for the teacher. The students not only work independently in front of the computer but also prepare themselves to work together with the teacher.

The advantages are that during the contact lessons, based on the students' prior preparation, we can answer their questions, organise group work, implement many activities that make the class interactive and allow the students to be active participants in the learning process. It can be effective in cases of lack of motivation or discipline [1, 15]. Students can take responsibility for their own learning and progress at their own pace, according to their own timetable. The content created can be archived and retrieved, so that no absences are missed. The downside, however, is that we need to be sure that students completed the tasks at home during the pre-learning stage, i.e. they watched the videos posted by the instructor. In the context of the flipped classroom method, the video is not just a resource, but the basis for all subsequent work. Before introducing this method, it is necessary

to discuss with the students what they need to pay attention to, and what will make the collaborative activities work well [10].

### **3.2. Gamification**

In today's education, face-to-face teaching is becoming less important, and computer-networked forms of training are now available, which can be used to effectively support the teaching-learning process and to acquire the necessary knowledge with the right methods of knowledge transfer and learning. New technologies can be used to encourage multichannel, collaborative learning. More interactive technologies can increase students' control and provide more opportunities for repetition in the learning process. This can be helped by gamification, an English term first used by Nick Pelling around 2002, so we can see that as a term it has been known for less than two decades. A relatively all-encompassing definition of gamification is: gamification is a strategy in which game elements are used in a non-game environment to move some behaviour in a positive direction. This definition can be used in higher education because gamification is a way of solving a problem if students have not done something before then we try to encourage them to do it so it can help with motivational problems. This is the role of gamification that we want to exploit in our courses [5].

In preparing teacher-candidates for their future profession, in line with the new learning theories, we aim to reduce the number of frontal lectures and develop new activities in which the whole educational process is guided from outside by means of assigned tasks. A kind of asynchronous teaching and learning is achieved, be it through ICT or through manual demonstration, action and experimentation. This type of learning provides the learner with a direct experience of success, which strengthens motivation to learn and thus encourages independent learning. When designing a course based on gamification, the learning material needs to be structured in modules and easily learnt. The student is an autonomous learner and therefore the learning material should be sufficiently motivating. However, this form of learning also requires tasks that can be completed together. In an online, group-editable submission, everyone can contribute to the creation of the product. Communication, working together, also develops human relationships. This model combines traditional classroom teaching with the opportunities offered by the internet and digital media [12]. Previous research has shown that students do not yet rank cooperative working as a top priority. We would definitely like to change this during their studies, as we have seen in the list of 21st century skills that communication and collaborative working will be needed in the future [14].

### **3.3. Project work**

In the general approach, the aim of a project is always to create something new and socially important. The aim of a pedagogical project is: the learners want to produce the final result defined in the project. However, given that the project is subordinate to educational objectives, from the definition of the theme to the

presentation of the final result, an important objective is also the result of the educational process that is the outcome of the activity, which can be of many kinds, such as posters, oral or written reports, blueprints, exhibitions.

Project-based education must meet a number of criteria. For example, the starting point should be the pupils' question and the design should be a collaborative process. The solution of the project should be achieved through activities, but there should also be opportunities for individual and group work, reinforcing communication and the development of cooperative skills. It covers a longer learning period, during which students will also be exposed to situations outside school, in a spirit of interdisciplinarity. Partners with different competences work together to achieve success and students are responsible for their own decisions, while the teacher is only a trainer or mentor in the learning process. It has the advantage that there are no major risks if it is not used carefully. The expected consequences for the students are increasing motivation, autonomy, self-awareness, self-esteem and self-esteem. Cooperation with peers improves and creativity develops. Of course, project work also has prerequisites without which it cannot work. These include the teacher's openness to working with students and the students' readiness for independent and cooperative learning, and whether the institutional framework is appropriate for this type of education [9].

The advantage of this method is that students have a responsibility to complete their work. Disadvantages include the difficulty of finding balance between teacher direction and student autonomy [4].

After presenting the main methods used in our courses and the questionnaire, we will now describe the course organisation, our research and its results.

## 4. Course organisation

In the first term of 2021/2022, two methods were used simultaneously in the teaching of the subject: Teaching Methods of Mathematics. One of these methods was the "mirrored classroom" method and the other was gamification. The mirrored classroom method was used to highlight the frontal teaching by means of pre-recorded videos. This served two purposes. One was saving time. This was emphasised due to the reduction in the number of lessons, and this enabled us to achieve the other objective, giving students the opportunity to practice and do more teamwork and projects. The other method that was introduced was gamification. The term was divided into blocks and within these blocks students had to solve tasks both collectively and individually. The tasks that could be completed during the lessons included some theoretical knowledge and a lot of practice through exercises, solving problems and their methodological analysis. The videos with the necessary theoretical material had to be previewed by the students before the lessons so that they could test their knowledge each time using the Kahoot! application. This was a feedback for the students and for teachers too on which topics were difficult for the students to complete. It also created a competitive environment for the students as they could compete with themselves and their

classmates without any fear. Other work that was given to be done was “tool making”: e.g. cubes, octaeders etc. It is very important that students must be aware of how to motivate children with less abilities and what tools can be used to help the pupils understand. For this reason, manipulative tools were also created. They had to prepare a project on a topic too. In this term, they had to work cooperatively to create a multi-curricular project for Animals’ Day, combining Maths, Reading, Science, Environmental studies and other subjects. In this way, they practised cooperative work, document creation, editing and information retrieval using ICT tools. They also explored the possibilities of using ICT tools. The LearningApp, Genially and many other apps and web applications for textbooks were presented. Students learned to produce their own lesson plans using online interfaces. We tried to do all this with as little frontal teaching as possible. They could choose the tasks freely and students were given pre-defined prompts for each topic. The evaluation was continuous so students could check their progress lesson by lesson. In this way, they were also able to get their final grade, avoiding the so called campaign learning that leads to quick forgetting after finishing the exams. With this learning organisation and the ‘mirrored classroom’ method, students could do more work at home and allocate their time more easily. Because they were free to choose which tasks to do we tried to encourage them to learn. Those who did all the tasks in each section and got the maximum scores got a good mark. We were able to do this in this system because if the student completes all the assignments it means that they have studied continuously during the whole course.

An important question arises as this method puts a lot of work on the instructor. Of course, this method needs a lot more in preparation but we have to find the “golden mean” because if we don’t change anything, the student’s knowledge and attitude will not change either. Making videos and online surveys is a lot of work at first and later the lecturer always have to make corrections. We hoped that the positive change in the attitude of the students that we expected would take place and that they would be successfully prepared for their future profession.

## 5. Questionnaire

### 5.1. The context of the study

An online questionnaire was conducted at the beginning and at the end of the course in the subject of Teaching Methods in Mathematics. Out of an already small number of students (34) only 18 responded at the beginning and even fewer (13) at the end of the semester. Therefore we cannot call our survey representative, but we have extracted valuable data for future course development. The questionnaire included open-ended, expository questions and questions on the 5-point Likert scale. Our aim was to assess students’ perceptions of the methods and ICT tools they had learned in education. In the first part of the questionnaire they were asked about the known forms of teaching, methods and their frequency of use, followed by their opinions about different ICT tools, educational programmes and

applications and their use by the students. At the end of the semester, we wanted to know whether they still held similar views on the subject or whether they had managed to change their views.

## 5.2. Research questions, theses

At the beginning of the term, we assumed that the students would prefer traditional, frontal forms of teaching work as this was what they had mostly encountered. It was hoped that there would be a change in their minds and that their future careers would include forms of teaching that were appropriate to 21st century skills. We also assumed that they would learn how collaborative working and collaborative document editing could help the learning process through the opportunities they would learn during the course.

## 6. Outcomes

### 6.1. Results for the questions on working methods

The questionnaire was completed by 18 students at the beginning of the semester: 53 percent of the students. At the beginning of the questionnaire we asked if the students would like to use a mobile device for learning purposes in the course.

There were 15 yes and 3 no answers to this question. The positive answers were supported by the following comments:

- *I think that nowadays most children in primary school have a mobile phone and it is difficult for them to break away from it. I think it would be easier to teach with the cell phones using their advantages than to wean them off.*
- *A more practical, quicker, more informative outline could be made.*
- *I wonder how it could be used for a maths subject.*
- *I think in today's world it is necessary to get acquainted with such content, it can make the lessons we will have in the future more colourful.*
- *In my opinion, it would make the lessons more exciting and interesting.*
- *Because learning is much easier and more effective.*
- *If it makes the curriculum more understandable, then yes.*
- *Due to the fact that a mobile device can illustrate certain topics better than paper.*
- *This would make the course more varied.*
- *A test could be used to check the mastery of the course material. This would provide quick feedback. Textbooks could be opened in digital format.*



- *Because I want to learn how to use my mobile phone for learning purposes.*
- *If there is any useful information about mathematics, I would like to know it, it can only benefit learning.*
- *It is often useful in today's world to access information quickly, and as a student, this means searching for it in a matter of seconds instead of learning a lot of material.*

And those who do not, gave the following reasons for their opinions:

- *It distracts from the essential things while surfing*
- *I do not want to completely lose the school experience.*

It is natural that there are always people who are afraid or do not want to change certain old things or perhaps do not want to break away from previous habits. But constantly choosing between different methods and applying them to the right part of the curriculum tends to move the learning process forward. This is why teacher candidates need to learn as many ICT tools and methods as possible, so that they can apply them correctly in different situations. In our courses, we also try to show the positive side of the different opportunities to those who are doubtful and possibly reluctant.

At the end of the term, we asked students again about their views. 13 students responded to our questionnaire and 84.6 percent of them liked this type of education.

Some of the students' answers are the followings:

- *The competitive spirit of Kahoot! increases performance.*
- *The introduction of technology makes the class interactive. It is much more enjoyable and exciting to complete a test using a mobile phone and apps that instantly grade assignments. Interactive tasks can be very motivating for students.*
- *Because we learned a lot of new things and because the phone is always at hand, it was a good idea to incorporate them during the lesson.*
- *Today's generation is attached to the phone anyway, so at least we could put it to good use.*
- *It made the class more varied, I felt more active and I learned more than if I had just taken notes.*
- *The competitive experience of the playful tasks made learning and revision exciting.*
- *Because it was much easier.*

- *It was simpler that way.*
- *It made learning playful and 21st century. For example: the Kahoot tests did not have that typical test feel, more like a playful quiz. So I was not stressed and I could think with a cool head. I learned to give a quick and accurate answer, which I think is good.*
- *It made the lesson more interesting and exciting.*
- *It made the lesson more interactive and exciting.*
- *There was constant repetition and no paper to use and less stress.*

The downside of the method, noted by one student, was that the wifi connection was not always good. We tried to eliminate this by telling them that if they lost the connection, they should write down the answer quickly on a piece of paper. Unfortunately, technical problems can always arise, but as the above comments show, the new methods were generally well received.

In this section we also asked the teacher candidates which teaching methods they would like to use in their work and how often. At the beginning of the semester the traditional forms of work – lecture, explanation, individual work – were the most prominent. All the things that the students already have experienced of, having encountered them during their studies. Cooperative work, online tests and the project method, which can be used continuously in teaching.

Students are curious about working with ICT tools but they were unsure in using them according to the survey at the beginning of the semester. They have a desire to learn and they do not completely reject working with modern tools but they are not convinced that completely online education could be a successful and effective way of learning. They also consider essential to familiarise children with ICT tools in order to achieve educational goals more effectively.

The question asked at the beginning of the term was also asked at the end of the semester. We were curious to know how much they would use the methods and forms of work they had learned during the course in the future. We can only look at the changes in general, not individually because the questionnaire was anonym. The answers were then quantified and subjected to a statistical test. The graph below shows the use of methods at the beginning and end of the semester.

What can be seen very clearly is that the formerly usual frontal teaching was replaced by teamwork and online tests, which may even facilitate continuous accountability, and the mirrored classroom has become one of the more frequently used methods. These responses illustrate our view that students' attitudes towards different forms of work and methods could be changed and that we can move from frontal teaching to teamwork, that makes stronger the development of the ability to work together.

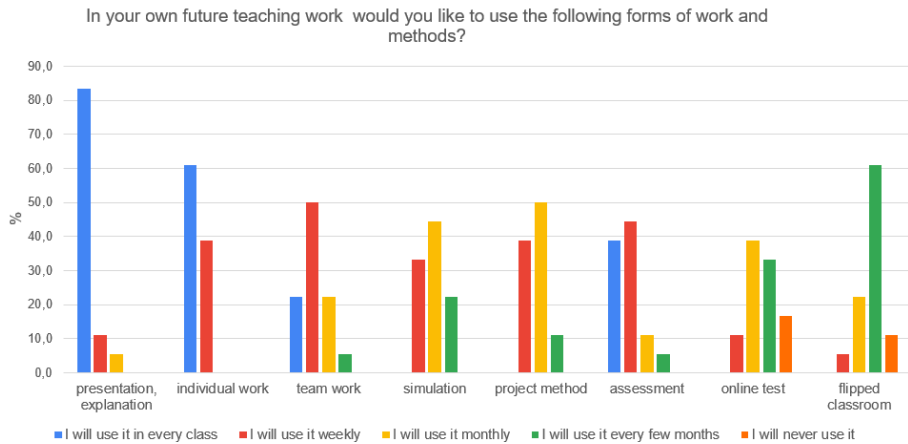


Figure 2. Methods at the beginning of the semester.

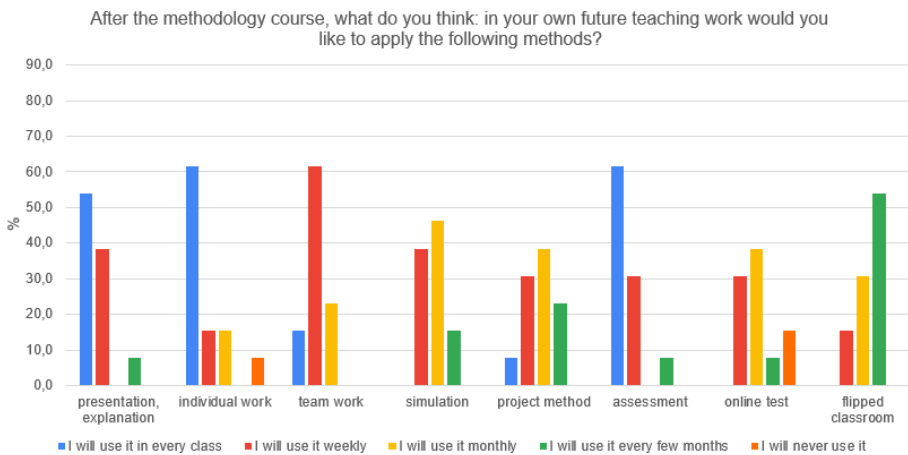
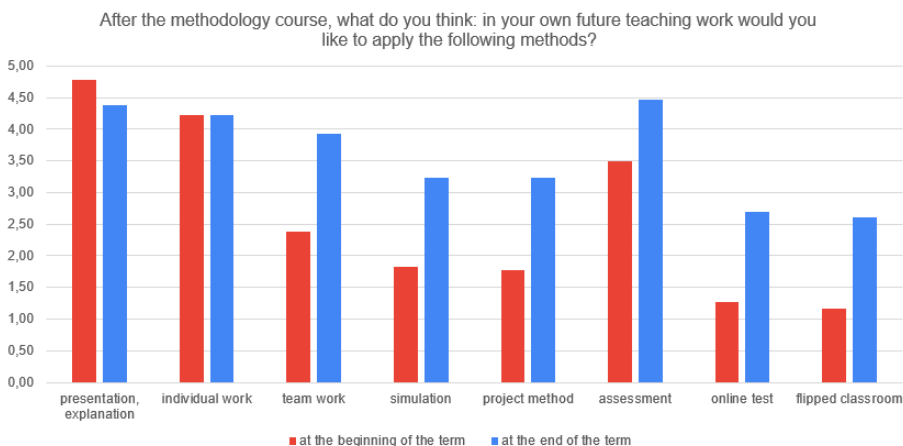


Figure 3. Methods at the end of the semester.

Using a hypothesis test, it was quantifiably shown that there was a change of students’ opinion about the methods they had learned (Table 1). The responses were scored on the 5-point scale and then subjected to a t-test (level of significance 95 percent). In all cases, there was evidence of a change in students’ attitudes towards the new methods. Students’ attitudes toward the new ICT supported methods changed significantly in each case. The result of the t-test shows that there is no change in the individual work but the value of the t-test of the lesser-known methods exceeds the value in the table in absolute value. The results of our study show that students’ attitudes moved towards collaborative methods during the term. They have learnt and hopefully will apply these educational innovations

to start developing 21st century skills in future generations.



**Figure 4.** Comparison of methods at the beginning and end of the semester.

**Table 1.** Result of t test.

		presentation, explanation	individual work	team work	simulation	project method	assessment	online test	flipped classroom
at the beginning of the term (n=18)	average	4,78	4,22	2,39	1,83	1,78	3,50	1,28	1,17
	deviation	0,84	1,19	0,62	0,70	0,89	0,84	1,02	0,74
at the end of the term (n=13)	average	4,38	4,23	3,92	3,23	3,23	4,46	2,69	2,62
	deviation	0,53	0,92	1,34	1,01	1,13	0,90	0,65	0,50
F-test ( $F_{table}=2,6$ )		2,46	1,68	0,21	0,47	0,62	0,88	2,46	2,18
Independent-samples t-test ( $t_{table}=1,699$ )		1,60	-0,02	-3,85	-4,29	-3,84	-3,02	-4,71	-6,52

## 6.2. Testing the use of ICT tools

It was important for us to find out when our students had used ICT tools. This was the basis for designing the course and applying the different ICT tools and methods. In the graph below (Figure 5 and 6), you can see that the different tools are used more for monitoring social media, not really present in the learning-teaching process. It is important to make teacher candidates aware that there are lots of complex possibilities. For example, learning together with peers, editing different documents online and collaboratively, developing animations that can be used for teaching, working in a team on a project or doing tests, homework, creating reports.

By the end of the term, we had the following results:

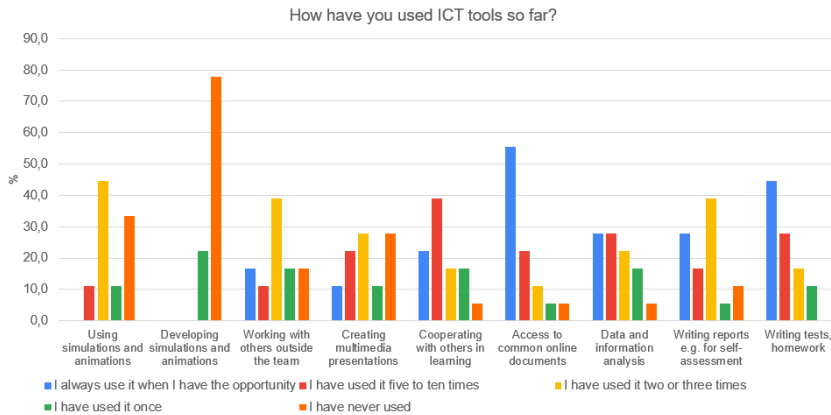


Figure 5. Use of ICT tools at the beginning of the semester.

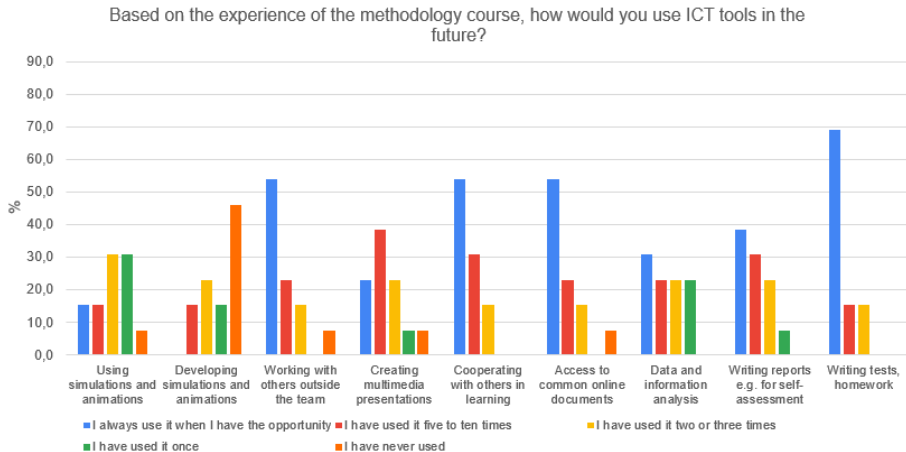


Figure 6. Use of ICT tools at the end of the semester.

## 7. Conclusion

The information technology revolution and changing learning habits have challenged teachers, lecturers and educational institutions as well. The growing body of knowledge and changing educational needs have made it necessary to find the new ways of teaching and to introduce new methods [2]. The information technology revolution has brought not only problems but also a range of possible solutions. By the 21st century some researchers have recognized that motivating methods in the recent development of gamification can be successfully applied in education too.

Our research shows that even at the beginning of their studies the teacher

candidates are not excluded from using ICT but they are not using it consciously although social networking sites are always present in their daily lives. Later in their works they are going to use ICT mostly in traditional ways – for example PowerPoint for explanations. During their university studies they should be aware of the ICT supported appropriate methods and they should be shown that there are many other ways in which they can apply digital tools successfully: organising a diagnostic survey, online tests for competitions or creating a collaborative online product and document.

Gamification does not mean the use of games in teaching but the integration of game mechanisms into everyday practice of teaching work processes or into the preparing for lessons. For the “digital generation” which is socialising and growing up nowadays it is highly important being familiar with ICT.

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