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The use of interactive, networked learning-supporting methods and technologies in education, their effect on student performance, with particular regard to LearningApps

Doctoral dissertation thesis booklet

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Dissertation topic and contextualization

In recent years and decades, we have witnessed the rapid development of IT. The computer has become a part of our everyday life, it has gradually transformed our life, it is present in all its areas, it has become an indispensable tool in the teaching-learning process. According to Leinonen, the use of ICT tools, including computers, in classrooms has undergone huge changes in recent decades (Leinonen, 2005).

At first, the tool used almost exclusively for teaching programming has now developed into a Web 2.0-based, social learning support technique (Leinonen, 2005).

In Hungary, the importance of spreading ICT tools in education was formulated already in the 90s by the education management. Thanks to the EU tenders of recent years, ICT tools have appeared in more and more fields and in more and more diverse forms in the world of schools.

The youngest citizens of the information society handle technical devices at a skill level and these devices are a natural part of their everyday life (Pongrácz, 2019).

According to Schmidt, children growing up in the digital age are no longer satisfied with traditional education, their lives are determined by digital devices and technology. Parents of digital natives tell us that young children handle smartphones much more skillfully than their grandparents (Schmidt, 2019).

According to György Molnár (2008), as a result of the explosive development of the 1990s, the integration of the fields of telecommunications and IT led to the emergence of Information and Communication Technologies, which radically changed the teaching-learning process, the forms of work, and the way of life as well. (Molnár, 2008)

Zoltán Szűts and Zsolt Námesztovszki also draw attention to the inclusion of Web 2.0 tools in education and the importance of their use. In the opinion of Zoltán Szűts: *"for the sake of successful education, Web 2.0 tools must be included in teaching: "which can be used to create effective online learning systems. Through Web 2.0, with the help of new information technology achievements, Internet users turn from consumers to service providers. Apps facilitate the sharing of content between users and participants, changing the way images, text, links, videos, events and connections are shared, created and used. Web 2.0 applications are based on community, i.e. users create content together or share information with each other."* (Szűts, 2014a, p. 20).

In addition to the advantages of ICT tools, it is important to highlight their disadvantages as well. Unfortunately, we experience more and more that the control of our students slips out of our hands thanks to the excessive use of digital devices. It is increasingly difficult to achieve results with the well-proven, usual methods (Szabó Ládiné, 2018c). The problem can be seen in all areas of education, teachers and trainers report the negative effects caused by the use of digital devices. Some non-exhaustive examples:

Today's generation is not disciplined enough, they cannot pay attention to their tasks, they are unable to concentrate on their school tasks. During the lesson, they deal with many other things that hold their interest much more. The authors Sántha and Polonyi quote János Ollé as saying that this comes from an increased need for communication and division and that they are characterized by a kind of networking. They can't wait for the breaks after classes, they can't wait to share the events and experiences of the day with their friends, peers, and parents (Ollé, 2013; Sántha-Polonyi, 2017).

András Lénárd shares similar thoughts in his methodology manual: *"In the last few years, we can experience more and more that the methods, textbooks, compulsory readings, task types, and stories that have been thought to have worked until now have a completely different effect on children. Those stories that have been loved so far are nowadays disinterested. The types of tasks that motivated students very well until now are not "working" these days. The games and stories with which we have always been successful seem to be failing these days, and more than once they make the students smile rather than enchant them."* (Lénárd, 2019, p. 9).

György Molnár's opinion is the same regarding this topic, according to which: *"In our fast-paced and rapidly developing environment, due to the information load on us, it is increasingly difficult to arouse the interest of the students, to focus their attention on one problem at a time, to highlight the emphasized parts and centers of gravity, and to encourage them to work in depth ."* (Molnár, 2008, p. 274).

In his summary, he draws attention to the sources of danger caused by the Internet and social media: " *Based on generational theories (Tapscott, Prensky, 2001), the influence of the Internet and social media, which hides many sources of danger, can be strongly felt and is valid in the digital generation. Let's think here about the manipulation of news and facts (hoaxes), life-threatening games (blue whale), or questions about the authenticity of information."* (Molnár, 2017, p. 982).

In her study published in 2019, Viktória Kövecsesné Gősi presents a comprehensive picture of the problem appearing at several levels of the school system based on information received from teachers. The problem is the same at all levels of the system, teachers, university lecturers, kindergarten teachers, teachers face the same difficulty. The teachers reported that the children's interests and motivation have changed, the stimulus threshold has shifted, the perspectives and goals have changed or are missing, and they are characterized by inattention, distraction, and lack of communication. According to their experience, the quality of human relationships has changed, and the children are characterized by a low level of emotional intelligence. Learning and behavioral disorders are occurring at an increasing rate. Unfortunately, many of the colleagues report that they cannot find the way to the students. (Kövecsesné Gősi, 2020)

Zsolt Námestovszki traces the lack of motivation among students to two reasons. One reason is that the school does not encourage students to be independent. There is a lack of independent study material processing. Most of the time, knowledge is acquired through the teacher's presentation and the reading of the course material. Another shortcoming is the frequent lack of feedback, which means that children do not receive immediate feedback on how they have mastered the given subject matter. We do not inform them of the results of their activities. (Namestovsky, 2013)

Today, we cannot prevent the harmful effects of the Internet, but we can try to guide our students in the right direction and help them during their studies. (Szabó Ládiné, 2017). In order to solve this problem, the Tankockakör - of which the author has been a member since the beginning - started its national development work around the LearningApps Web 2.0 application.

The ideas in András Benedek's 2007 study helped me a lot in achieving my goals. According to András Benedek**:** *"young people like to use digital technology, which is also illustrated by the popularity of computer games. If they are applied during education, it will attract the students' interest and engage them, as this system is interactive and gives room for creativity."* (Benedek, 2007, p. 1159)

History of the research

In order to have a more comprehensive view of the presented research, it is important to get to know the antecedents more thoroughly:

As a member of the Tankockakör - in cooperation with my colleagues - I have been working as a Hungarian developer of LearningApps for several years. I have been participating in the work of the Tankockakör for years, through my knowledge-sharing activities in the Complex Basic Program, a whole country got to know LearningApps, known as the tankocka in Hungarian. In the research related to the dissertation, of course, my personal experiences and lines of research will also appear.

Years ago, one of the most important targets of research was ICT equipment provision, ICT attitude, computer, Internet access, and research related to Web 2.0 applications in Hungary was negligible. Seeing this, I set myself the goal of conducting an individual research that is methodologically sound and produces reliable results. My choice of topic in 2016 was motivated by my personal interest and professional commitment, which was supported by the management of the EKKE Doctoral School of Education from the beginning.

With this research, my main goal is to provide a new, innovative, immediately usable, unsaid results for the science of education, and for the biggest representatives of this field, such as **Dr. Iván Falus**, professor emeritus, university professor, doctor of the Hungarian Academy of Sciences.

My research work - placed between the sciences - is located in the triangle of educational science, IT and school practice, which is why it is highly interdisciplinary in nature. For the last six years, I have been interested in the research questions formulated in the dissertation, which are grouped around the following problems:

Are students who regularly use LearningApps to learn mathematics more interested in the subject than students who use the app only occasionally?

Does the students' self-reported progress show a higher level for students who use the application regularly than for students who use it only occasionally.

Does the willingness to learn and the difference in math knowledge among group members decrease if the students regularly solve tasks with the help of brain teasers?

Does continuous use of the application significantly improve student performance?

Using the tankocka application, is the teacher able to achieve a positive attitude in students who like the given subject less?

To what extent does the tankocka encourage the 9 - 18-year-olds (lower, upper and high school) to acquire knowledge and study independently? Is there a difference between each age group?

Regarding the frequency of use and content of the tankocka, can a significant difference be detected between the individual age groups?

Has the role of the platform, the number of teachers using the application, and the number of lessons created by users increased during digital education, and to what extent?

Is there a connection between the professional qualifications and education of the teachers and the use of the tankocka and the frequency of use?

The structure of the dissertation

The work has a complex structure, the acknowledgment is followed by the actuality of the topic, putting it into context, and the antecedents of the research. After formulating the research goals, methods, tools, and activities, the review of the literature closely related to the research topic covers several chapters.

In the literature collection, we first touch on the information society from a technological approach and then highlight the characteristics of the constantly changing learning environment. The most important concepts related to the research are also explained. After describing the Internet, Web 2.0 applications, interactivity, network learning, online communities, and changed teaching methods, we present the LearningApps application in detail, touching on the concept of digital curriculum. We discuss the application's role in the Complex Basic Program, highlighting its use during education.

We summarize the various ideas of learning theories related to the research topic and touch on the development of digital competence, the changed knowledge transfer, and the changed roles of teachers and students. In addition, we will review generational theories, after which it will be possible to present international and domestic research conducted in a similar field and topic. Summarizing the results of the research, I made the following conclusion: Web 2.0 applications, including the use of LearningApps, can have both positive and negative effects on the school performance and motivation of our students, depending on the situation, the amount and quality of use, and age characteristics. We try to discuss these effects separately for easier transparency. This is followed by a detailed presentation of the hypotheses and investigations related to the topic, which includes: research methods, tools, expected schedule - sampling, data collection - analysis, data interpretation - drawing conclusions. The following part consists of the summary and drawing of final conclusions - shortcomings and uncertainties during the research - tables, diagrams - appendix - bibliographic data of the works - in alphabetical order by author - primaryations related to the topic of the dissertation.

My research hypotheses

H.1. The students' self-reported progress shows a higher value for students who use the application regularly.

H.2. Between the members of the group that uses LearningApps continuously (10 tasks twice a week), the difference in learning ability and the difference in math knowledge decrease.

H.3. Continuous use of LearningApps significantly improves student performance

H.4. Students who use LearningApps are more interested in the content of the mathematics subject than their peers who do not use the application.

H.5. A significant difference can be detected between the individual age groups in the frequency of use and content of LearningApps.

H.6. In the course of digital education, the role of the platform, the number of teachers using the application, and the number of tips created by users have increased.

H.7. A clear correlation can be shown between the professional qualifications and education of the teachers who use them and the use and frequency of use of the tankocka.

H.8. By using the application, the teacher is able to achieve a positive attitude among students who are less fond of the given subject.

H.9. LearningApps encourages a significant part of the 9-18-year-old age group in independent knowledge acquisition and self-study.

The planned examination stages of the research - research objectives, used methods, tools, research participants, activities

The goals formulated on the basis of the research questions *were achieved in one preparatory and four examination stages.*

The preparatory stage consisted of 2 parts:

Preliminary research I. - Use of LearningApps - Data collection among teachers who use the application

Preliminary research II. - Measuring the climate of the Faculties of the two groups participating in the research

The four test stages are:

Test phase I - Student ability measurement and related tests

Test phase II - Processing of units of measure and fractions topics and the related examinations

Test phase III - Interest and attitude test

Test phase IV - Online questionnaire examination during digital and attendance education

Target group of the research

- *teachers (*the teachers who use the application - the faculty of the institutions of the two groups participating in the tests and the teachers who fill out the online questionnaire posted on the LearningApps.org interface during digital education*)*

- *student groups (*1st group - Tankocka group - Eger 1st Primary School and 2nd group - not Tankocka group - Eger 2nd Primary School*)*

- *students (*junior, upper and high school students*)*

The participants of the research and their associated examinations are listed in *No. 1. table* contains:

RESEARCH PARTICIPANTS	EXAMINATIONS BETWEEN TEACHERS	EXAMINATIONS BETWEEN STUDENT GROUPS	EXAMINATIONS BETWEEN STUDENTS
NAME OF EXAMINATIONS	Using LearningApps	Ability measurement - Examining students' self-reported progress	Examining the attitude towards the subject
	Measuring the climate of educational institutions	Ability measurement - Examining the difference in learning ability	Examination of independent knowledge acquisition and independent learning
	Examination of Tankocka usage frequency and age	Processing of units of measure and fractions topics - Pre - and post-test - Knowledge level measurement	
	Platform (LearningApps) role, Tankocka number and user growth investigation	Examination of end-of-year grades in mathematics (p. 3-4)	
	Examination of the frequency of use of teacher qualifications	Unit of measure, processing of fractions topics - Mathematics difference in knowledge examination	
		Measurement of attitude towards the subject of mathematics	
		Measuring interest in subjects	

No. 1 table The participants in the research and the planned examinations related to them

The definition of the goals related to the research is closely related to the fact that in 2017 the processed research area still had *a unique topic*. Domestic *literature* related to the use of LearningApps did not yet exist and *research results related to ICT applications* were also available in a limited number.

Based on these facts, our goal was to conduct a preliminary research consisting of two studies in order to reveal data.

Preparation of our research - Preliminary research I and II

The group of people involved in the preliminary research: teachers

Preliminary research I. and II. to carry out the measurements, we involved the teachers of the 2 student groups participating in the research (group 1 - faculty of Eger 1st Primary School and group 2 - faculty of Eger 2nd Primary School).

Goals, methods, tools, participants, activities related to preliminary research

Preliminary research I - Data collection on the use of LearningApps

The first objective of the preliminary research was the collection of data related to the application, which related to the use of the application, the frequency of use, the advantages and disadvantages experienced during use.

Data collection was carried out using an individual unstructured interview. We sought answers to how teachers use the application and how they feel about the educational aid.

The analysis of the individual unstructured interview was analyzed using the descriptive statistics method. We used the Microsoft Excel spreadsheet program to perform the calculations and prepare the figures and tables.

Preliminary research II - Measuring the climate of educational institutions

In the preliminary research II our aim was to examine the organizational climate of the 2 schools participating in the research (Eger 1. Primary School and Eger 2. Primary School).

During the investigation, we found out about the attitude of the faculty of the two schools participating in the research to innovations, whether the institutional (school) atmosphere is suitable for the introduction of a modern tool, the application under investigation.

The testing method related to this goal is the test, and the testing tool is Éva Tímár's Pedagogus Klíma Perception climate test tool, which has a reliability coefficient. The test is a 70-question tool designed for faculty.

Whether there is a difference between the two faculties in terms of the improvement of the institutional climate and the possibility of improvement was investigated using the ANOVA test. In the case of the overall climate index, the difference between the two faculties was determined based on the difference in averages, using an interval estimate (95% interval - 5% significance level).

Information about interval estimation can be found in part of the preliminary research II. , it was described in detail when analyzing the climate data of the education board.

The data of the preliminary research (preliminary research I and preliminary research II) can be found in no. 2 table contains:

test phase	**Preparatory stage**	
name of study	Using LearningApps - preliminary research I.	Measuring the climate of educational institutions preliminary research II.
test method	interview	test
test tool	individual unstructured interview	Examination of Dr. Éva Tímár Pedagogue Climate Perception
date of examination	September 2017	November 2017
study participants and number	teachers N=12	teachers N=78
data analysis method	descriptive statistics	descriptive statistics, mathematical statistics
relevant hypothesis (H)	there is none	there is none

No. 2 table Preliminary research I and preliminary research II (self made)

After completing the preliminary research, we performed measurements *in four test stages* (Tables 3-4).

Goals, methods, tools, target group, activities related to the test stages

In the **the examination phase I, the ability test of the students of** the two groups participating in the research *(1st group - Tankocka group*, 2nd group - non-Tankocka group) was performed, as well as the related measurements. (Measurement 1 and Measurement 2 - Table No. 3)

The purpose of the aptitude test: the students, or getting to know and diagnosing the learning ability of the participating student groups (3 times), comparing the learning abilities of the two student groups. These tests were justified by the following: from the point of view of the experiment planned for September 2020, it is important to learn about the learning ability of the two groups, and thus to form two identical - homogeneous groups.

The testing method suitable for carrying out the aptitude test is the test, the test tool is the dr. Éva Tímár's „Measurement of learning abilities", which is a measuring tool with a calibrated reliability coefficient.

The ability measurement was carried out 3 times: in the 1st year at the beginning of the year (input measurement), the 1st grade at the end of the year (output measurement) and in the 4th grade at the end of the year (follow-up or output measurement).

The analysis of the data of the ability test was carried out using the method of descriptive statistics. We used the Microsoft Excel spreadsheet program and its functions (Statement manager, solver) to perform the calculations and prepare the figures and tables.

Using the data from the ability test, our goal was to carry out further tests. These are the following:

Measurement 1 - Examining the students' self-reported progress

We used the methods of descriptive and mathematical statistics to show the students' self-reported progress. Calculations, figures and tables were made using the Microsoft Excel spreadsheet program on the one hand, and the ANOVA test on the other.

Measurement 2 - Examining the difference in students' learning ability

For this study, the data was analyzed using the descriptive statistics method. We also used the Microsoft Excel spreadsheet program to perform the calculations and prepare the figures and tables.

In the II. examination phase, the processing of two topics within the subject of mathematics - *unit of measure and fractions with tankocka and traditional tools - was carried out*. During the processing of the two topics, we used the *crossover method among the multivariate analysis methods*, in which both groups were included as both control and experimental groups. The tools were used alternately by the groups. We also tried to eliminate the differences resulting from the different composition and level of knowledge of the groups with the help of the *crossover procedure*. In the course of our work, we also paid special attention to pre- and post-tests.

In the *crossover procedure,* the groups that took part in the study: *1st group Eger 1. Primary School and 2nd group Eger 2. Primary School.*

We have planned 3 measurements for processing units and fractions with tankocka and traditional teaching aids.

These measurements were:

Measurement 1 - Conducting a pre- and post-test on the subject of units of measure, fractions - measuring the student's level of knowledge

The purpose of the pre-test is to measure the initial level, diagnose the prior knowledge of the two groups, and compare their results.

The purpose of the follow-up examination is to measure the results achieved and to determine how the two groups acquired and applied the new knowledge - measuring the level of knowledge and comparing the results.

Our testing tool for this purpose was the knowledge level measuring worksheet prepared based on the analysis of the teaching material and curriculum requirements.

The groups participating in the pre - and post-tests:

Group 1 (Tankocka group) and Group 2 (non-Tankocka group)

The quantitative analysis and evaluation of the data obtained during the pre- and post-tests, as well as the comparison of the results, were carried out using descriptive and multivariate mathematical statistics. The calculations, figures, and tables were prepared using the Microsoft Excel spreadsheet program and the SPSS program.

Measurement 2- Examining the end-of-year marks of the 3rd - 4th grade mathematics of the students of the two groups

Our goal was to investigate whether there is a difference in results between the two groups, that is, in the effectiveness of learning. With the help of document analysis, we performed the examination of the year-end marks of the 3rd and 4th grade mathematics of the two groups participating in the study.

The following two groups participated in the examination of the tickets: Group 1 (Tankocka group) and Group 2 (non-Tankocka group)

The data was analyzed using descriptive and mathematical statistics. Calculations, figures and tables were made using the spreadsheet program Microsoft Excel on the one hand, and the SPSS program on the other.

Measurement 3- Using the results obtained during the follow-up examination, the examination of the difference in the students' knowledge of mathematics

Our goal was to use the results of the post-test to examine whether the traditional or modern teaching material processing is more effective. Our aim was also to examine whether or not the use of the LearningApps application helped in learning the course material more effectively.

After learning the knowledge - two chapters (one chapter - units of measure and one chapter - fractions), we carried out post-tests. The students' knowledge level was measured using self-made worksheets. With the help of these results, we carried out the examination of the difference in students' knowledge of mathematics.

The data was analyzed using descriptive and mathematical statistics methods, the calculations, figures and tables were prepared using the Microsoft Excel spreadsheet program and the SPSS program.

In the **III. test phase,** we conducted two measurements. The first measurement, in the case of using the tankocka, was aimed *at the interest in the subjects*, the second measurement was aimed at the examination *of the attitude towards the mathematics subject*.

During these studies, we looked for the answer to how students' interest in subjects and their attitude towards the subject of mathematics changes when using LearningApps.

Our goal was to investigate whether there is a difference between the two groups of students included in the measurements in terms of interest and attitude.

Measurement 1 – Measurement of interest in subjects

Measurement 2 – Measurement of attitude towards the subject of mathematics

Groups that participated in the study:

Group 1 (Tankocka group) and Group 2 (non-Tankocka group).

The research method assigned to this purpose was the questionnaire, and the research tool was Vera Kósáné Ormai's „Interest in Subjects" and „Attitude toward Mathematics Subject" questionnaires.

The analysis of the quantitative data was carried out using the descriptive statistics method. The difference between the two groups (Tankocka and non-Tankocka) was determined using interval estimation based on the deviation of the averages. (95% interval - 5% significance level).

We used the Microsoft Excel spreadsheet program to perform the calculations and prepare the figures and tables.

No. 3 table I.-II. and III. presents a test phase.

test phase	**I. test phase** Ability measurement		**II. test phase** units and fractions topics			**III. test phase** Interest and attitude test
name of study	examination of students' self-reported progress **1. measurement**	examination of the difference in learning ability **2. meas.**	Student knowledge level measurement **1. measurement**	examination of end-of-year mathematics grades (p. 3-4) **2. meas.**	mathematics difference in knowledge examination **3. meas.**	measuring interest in subjects **1. measurement** measurement of attitude towards the subject of mathematics **2. measurement**
test method	test		experiment (pre- and post-test)	document analysis	trial (cross procedure)	questionnaire
test tool	Dr. Éva Tímár's learning ability test		mathematics test	mathematics 3rd-4th year end-of-year tickets	math worksheet	Vera Kósáné Ormai's interest and attitude survey questionnaire
date of examination	1. September 2017- 1.o input measurement 2. May 1, 2018 output measurement 3.2021. output measurement on May 4		2020 Sept. beginning Oct. beginning	June 2021	2020 Sept. it's over Oct. _ it's over	Sep 2020 it's over Oct. it's over
study participants and number	students N=44		students N=49	students p. 3 N = 48 p. 4 N = 50	students N=49	I'm learning N = 47
data analysis method	descriptive and mathematical statistics	descriptive statistics	mathematics statistics descriptive statistics			descriptive statistics
relevant hypothesis (H)	H1	H2	H2	H2	H3	H4

No. 3 table I - II. and III. planned measurements of the test phase (self preparation)

The last **IV. test phase** consisted of two parts. The first part **is among teachers in digital education,** three measurements are carried out (*measurements 1, 2 and 3 - table no. 4*), while the second part **among students** it included 2 measurements (*measurements 4 and 5 - table no. 4*) **carried out in attendance education.**

Among teachers, in digital education, *is an online survey where we aim to measure the use of the application in classrooms, the extent of use, age, the role of the platform (LearningApps), the number of tankocka created by teachers, the increase in users experienced during digital education, and the teachers' was the collection of data on the frequency of use of tankocka and their level of education.*

The first three measurements of this section are:

Measurement 1 *- Examination of the relationship between frequency of use and age*

Measurement 2 *- Examination of data on the role of the platform (Learningapps.org), the number of tankocka used by teachers, the number of tankocka used in digital education and user growth*

Measurement 3 *– Examining the correlation between teacher education and user frequency.*

The analysis of the data in this study phase was carried out using the methods of descriptive statistics (interval estimation) and mathematical statistics (correlation analysis). Calculations, figures and tables were made using the spreadsheet program Microsoft Excel on the one hand, and the SPSS program on the other.

In the **IV. of** the last two measurements **of the test phase were carried out *in attendance education, among*** **junior, senior and high school *students*** *(* measurements 4 and 5, table 4).

Our goal during the questionnaire survey was to collect data on the popularity and incentive effect of the tankocka.

The data collection focused on the following: how different age groups relate to the application, what is their attitude, does the application help them to like a particular subject, does it encourage independent learning, independent knowledge acquisition, when and how often do students use the application, and what are their preferred types of tankocka. We also asked students for their opinions on the advantages and disadvantages of the application.

In the last 2 measurements of the IV section are as follows:

Measurement 4 - Attitude towards the subject - the popularity of the tankocka among students

Measurement 5 - The stimulating effect of the tankocka on independent knowledge acquisition and independent learning

The analysis of the quantitative data on the popularity and incentive effect of the tankocka was carried out using the descriptive statistics method. The study of the stimulating effect of the tankocka on learning was carried out using confidence interval estimation. (95% interval - 5% significance level).

We used the Microsoft Excel spreadsheet program to perform the calculations and prepare the figures and tables. The IV. test section’s 4th no. table contains the data of the 4th and 5th measurements.

The datas of the 1-5. of the IV. examination stage measurement were the follows:

test phase	IV. examination phase - Online questionnaire				
	Digital education		**Attendance education**		
name of study	Frequency of use-age test **1. measurement**	Platform (LearningApps) role, Tankocka number and user growth investigation **2. measurement**	Examination of the frequency of use of teacher qualifications **3. meas.**	Examining the attitude towards the subject **4. meas.**	Examination of independent knowledge acquisition and independent learning **5. meas.**
test method	questionnaire	questionnaire	questionnaire	questionnaire	questionnaire
test tool	online questionnaire	online questionnaire - data provided by LearningApps Team	online questionnaire	online questionnaire	online questionnaire
date of examination	March 2020	March 2020	March 2020	June 2021	June 2021
study participants and number	teachers N=951	teachers N=951	teachers N=951	I'm learning (lower school, upper school, high school) N=608	I'm learning (lower school, upper school, high school) N=608
data analysis method	descriptive statistics mathematics statistics	descriptive statistics	descriptive statistics mathematics statistics	descriptive statistics	descriptive statistics
relevant hypothesis (H)	H5	H6	H7	H8	H9

No. 4 table IV. test phase – Planned online questionnaire tests among teachers and students (self preparation)

Scientific results of the thesis - Theses

I structured my research presented in my dissertation around a total of 9 theses.

T1. Students' self-reported progress shows a higher value for students who regularly use LearningApps.

According to the results obtained with the help of descriptive statistics, the students of the 1st group (Tankocka) continuously used LearningApps in the teaching-learning process, in this group the majority of the students, i.e. 71.4%, showed self-improvement based on the figures of the descriptive statistics can be detected. The 2nd group (not Tankocka) used LearningApps, /tankocka, during the processing of two topics in the 4th grade. In this group, 18.7% of students showed improvement. The difference between the two groups was confirmed by the results of the ANOVA test , in several cases we showed a significant difference between the two groups, in favor of the Tankocka group.

Examining the results of the end-of-year measurements of the 1st grade, we found a significant difference between the two groups, in favor of the Tankocka 1st group. $F(43) = 9.52$ $p < 0.005$. There was also a significant difference between the two groups in the input measurements of the 1st grade at the beginning of the year and the output measurements of the 1st grade at the end of the year, here again in favor of the Tankocka 1st group. $F(42) = 36.374$ $p < 0.001$.

Looking at the first-class measurements, we were able to show a significant difference between the two groups during the 1st-class input and output and the 1st-class output measurements in favor of the Tankocka 1st group. In addition to the development of the learning ability in the first grade, we also looked at the development of the two groups between the 1st and 4th grades (1st grade input at the beginning of the year and 4th grade end of the year output).

In connection with the comparison of the results of the input measurement at the beginning of the 1st grade and the output measurement of the 4th grade at the end of the year, we came to the conclusion that there is a significant difference between the two groups in favor of the Tankocka group. $F(31) = 11.15$ $p<0.05$. Our tests proved that the students' self-reported progress shows a higher value for those students who used tankocka regularly.
During the measurements so far, we were able to show a significant difference between the two groups, in favor of the Tankocka 1st group. In only one case did it happen differently. We could not show any significant differences between the groups at the beginning of the year at the entrance to the first grade.

According to the results obtained during the Anova measurement, there is no significant difference between the two groups in the 1st grade entrance - beginning of the year measurement $F(43) = ,877$, $p=0.355$. The above data confirm our previous calculations, according to which the ability of the two groups was identical at the first measurement, i.e. first class at the beginning of the year. This data was considered important from the point of view of carrying out the subsequent crossing procedure.

T2. Among the members of the group that uses LearningApps continuously (10 tasks twice a week), the difference in learning ability and the difference in math knowledge decrease.

The change in the differences between the student results was carried out by examining the standard deviation of the student results. The standard deviation shows the difference between the student results and the change in the difference between the results. Based on the standard

deviation, you can see how much the quantitative values differ from the average. Based on the researches carried out, it can be concluded that the difference between student results has decreased. The children in group 1 already encountered the use of LearningApps in the first grade, the difference between the student results decreased by 2% points, and the difference between the student results of group 2 decreased by 4% points.

Measurement of prior knowledge - pre-test

The standard deviation of the student results of prior knowledge in the subject area of the unit of measure is the same in both groups. In the topic of fractions, the difference between the knowledge of the students of the 2nd (non-Tankocka) group is smaller than the knowledge of the students of the 1st (Tankocka) group. The result of the worksheets, for both topics, is better than the 1st (Tankocka) group.

Follow-up examination - Measurement of knowledge level

The difference between the students' knowledge level was evaluated based on the standard deviation of the results of the knowledge level measurement worksheet. The topic of fractions was processed in the 2nd group with the help of LearningApps/tankocka. The standard deviation of the results shows that the result measured on the worksheet of the curriculum processed using the traditional method shows a smaller standard deviation. The topic of the unit of measure was processed in group 1 using LearningApps/tankocka. The standard deviation of the results, here too, shows that the result measured on the worksheet of the curriculum processed using the traditional method shows a smaller standard deviation. In both cases, when the traditional method is used, the difference in knowledge between the student results of the groups is smaller.

Based on the examination of the end-of-year grades in mathematics, we found the following. Correlation study between math grades and the two groups (Tankocka and non-Tankocka):

In the third grade, the Pearson correlation r=-0.007, Kendall: r=-0,031, Spearman: r=-0,033. In the fourth grade, the Pearson correlation shows r=-0,097, the Kendall: r=-0,084, and the Spearman: r=-0,090.

It is clear from the figures of the correlation test (we obtained a value of around 0) that no correlation can be detected between the mathematics grades and the group in either the third or fourth grade so the two groups can be considered the same.

In addition to the correlation test, we also performed a difference test between the mathematics average and the groups using the Mann-Whitney test. (Between Tankocka and non-Tankocka groups)

The average of the math marks of the 2nd group apparently decreased over the course of one year, according to the Mann-Whitney test, this is not significant and can be considered unchanged.

According to the difference test, the significance value is $p = 0,824$ in the 3rd grade, and $p = 0,529$ in the fourth grade. In both cases, $p<0.05$. So it is clear from the figures that there is no difference between the math averages of the two groups in either the 3rd or 4th grade. The ability test, the measurement of the knowledge level, and the examination of the grades show that among the members of the group that continuously uses LearningApps/tankocka (10 tasks

twice a week), neither the difference in learning ability nor in mathematical knowledge has decreased.

T3. Continuous use of LearningApps significantly improves student performance

Using SPSS, we performed correlation and difference analysis. The results obtained during the correlation test (Pearson, Kendall, Spearman), which was performed between the groups (Tankocka and non-Tankocka groups) and performance.

The values obtained for the unit tasks have a negative sign: Pearson r= -0, 274, Kendall r= - 0, 212, Spearman r=-0, 255. The values obtained for the fraction tasks have a positive sign: Pearson r=0, 220, Kendall's r=0,267, Spearman's r=0,321.

There is a tendency-like correlation between the group and performance. Because of the negative values, the first group is better, so the modern method is more efficient here.

The results of the Mann Whitney difference test in the units of measurement topic: The Mann-Whitney test shows that there is a strong trend-like difference between the two group averages p=0.078. The 1st group (the Tankocka), which used the modern method - LearningApps, when processing the unit of measurement topic, was more successful.

The results of the Mann Whitney dissimilarity test in the area of fractions: Here, too, the group taught with the modern method, i.e. LearningApps /tankocka, i.e. group 2, shows significantly better results. The Mann-Whitney test shows that there is a significant difference between the mean (median) of the two groups p = 0,026. According to the results obtained, the result of the 2nd group taught with the modern method - LearningApps is better.

According to the figures presented above, both groups' processing of course material was more effective with the modern method, i.e. the tank cube, so in the case of topics taught with the LearningApps application / tankocka, student performance improved significantly .

T4. Students who use LearningApps are more interested in the content of the mathematics subject than their peers who do not use the application.

The difference between the two groups (group 1 Tankocka and group 2 non-Tankocka) was determined based on the deviation of the averages using interval estimation (95% interval - 5% significance level). We determined the 95% confidence intervals of the two groups. We marked where there is a significant difference between the two groups.

According to the obtained figures, there is a significant difference between the two groups in terms of both attitude and interest. In other words, the 1st group that constantly uses tankocka likes math better and finds it easier. Students who constantly use LearningApps are more interested and have a stronger attitude towards the content of the mathematics subject than their peers who do not use the application.

T5. A significant difference can be detected between the individual age groups in the frequency of use and content of LearningApps .

In all three cases (Pearson, Kendall, Spearmann), the relevant correlation test showed a weak significant correlation. The Pearson correlation coefficient is r = - 0,137, the significance value is p=0,01. Kendall's r= - 0,73 is the significance value p= 0,021. Spearman's r= - 0,91 and the significance value is p= 0,021, which is also below 0,05.

Based on the obtained values, there is a weak significant relationship between age and time spent risking fuel. Considering the negative sign, the older someone is, the less time they spend taking risks. Based on the above figures, the hypothesis was confirmed.

T6. In the course of digital education, the role of the platform, the number of teachers using the application, and the number of tips created by users have increased.

According to the official data provided by the LearningApps Team: The number of tankocka has increased by 6.7 times and the number of users by 5 times. Based on the data received, it can be seen that the role of the platform, the number of teachers using the application, and the number of tankocka prepared by users have increased during digital education.

The frequency of tankocka use was determined by the two functions that can be used to create tankocka: "Create similar tankocka" and "Create tankocka based on template". The obtained data clearly show that both during the epidemic and more recently after the Pandemic, almost half of the teachers (N=414 and N= 443) use the "Make a similar tankocka" and "Make a Tankocka based on a template" function more. All of this did not decrease in terms of values even with the end of digital education .

When asked how often they use LearningApps during digital education, the majority of respondents (N=951) answered that they use the application often. 41,85% several times a week, and 32,81% on a daily basis.

T7. A clear correlation can be shown between the professional qualification and education of the teachers who use it and the frequency of use of the tankocka.

After the qualifications were coded with a ranking assignment, it was examined whether there was a correlation between the qualification and the degree of use. The Pearson correlation coefficient is r = 0,006, the significance value is p = 0,881. Kendall's r = - 0, 12 the significance value is p = 0,747. Spearman r = - 0,013 and significance value is p= 0,749 which is above 0,05.

Based on the multivariate statistical analysis of the results, there was no correlation between the degree of use and education and professional qualification.

We attempted to determine the frequency of use (N=951) using the method of descriptive statistics.

The obtained results clearly show (weekly + daily total = 0,800210305) that most and most often teachers use the tankocka for practice. It is used for practice by 497 people several times a week, and by 264 people every day. It is used weekly for the purpose of differentiation and tuning. For reflection, 259 people use it occasionally, 396 people never use the application for this purpose.

T8. By using the application, the teacher is able to achieve a positive attitude among students who are less fond of the given subject.

According to 74% of the lower school students (N=92), the use of tankocka helps them to like a subject. According to 62% of high school and high school students (N=516), using the application helps them to like a specific subject. The difference between the age groups was determined using an interval estimate based on the difference in the averages. (95% interval – 5% significance level).

On the obtained results, it can be concluded that there is no significant difference between the age groups in terms of the popularity of the subject. Examining the number and frequency, it is clear that tankocka are preferred in both the lower and upper grades. The liking of the tankocka is high in both the lower and upper grades, only the reason for liking showed a difference.

T 9. LearningApps encourages a significant part of the 9-18-year-old age group in independent knowledge acquisition and self-study.

According to 73% of the 9-10-year-old students, i.e. the significant majority, the use of tankocka has a stimulating effect on learning (N=92). According to another sample (N=516), 74,4% of the respondents, i.e. the significant majority (384 people) think that the use of tankocka has an encouraging effect on learning. Of this (out of 516 people), the 11-14 age group makes up 74%, and the 15-18 age group makes up 26%. Based on the confidence interval calculations, it can be stated that the tankocka has a significant stimulating effect on learning in the 9-18 age group. Based on the answers, the respondents believe that the tankocka has an encouraging effect on learning. This stimulating effect decreases slightly but noticeably with age.

Summary - Conclusions - Future outlook

The obtained test results did not support my assumptions in all cases. Within the framework of the research, I had the opportunity to try several methods. With the help of a total of 10 cross-sectional studies, I explored the raised research problem.

Based on all of this, by measuring the interest in the subject and the attitude towards the subject, it was numerically proven that the students who use LearningApps are more interested in the content of the mathematics subject than their peers who do not use the application. During the long series of years, I examined with follow-up measurements the students' or the development of the learning ability of the two groups. Here I had the opportunity to make several (e.g. individuals, groups, input-output) comparisons. The level of learning abilities and the rate of development were influential factors in the effectiveness of the application of LearningApps. In Hungary, no research has yet been conducted regarding LearningApps, it feels good to be the first to do this. The first thing to do is to face the result and write the sentence that the use of the tankocka significantly improves student performance.

In the case of students, looking at the age groups, it can be concluded that there is no significant difference between the age groups in terms of the stimulating effect. In terms of popularity, one of the biggest factors is the "suitable for independent learning" factor, but it is important to remember that all factors are the same, they reinforce each other.

During the examination of the tankocka application in different grades, it was found that the use of the tankocka shows a decreasing trend with increasing age. The tests also clearly pointed out that the use of tankocka does not depend at all on the teacher's education, professional qualifications and age.

In conclusion, my research has shown that the use of LearningApps in the classroom and at home has a positive effect on student performance. It is hoped that the obtained results will also influence the application to become even more widespread. By getting to know and using LearningApps, education is expanded with an internet-based tool that develops abilities and skills with an excellent motivational effect. With a digital tool that greatly contributes to increasing the efficiency of learning by conveying useful theoretical and practical knowledge.

I consider the importance of research to be the collection of information and data related to the use of the application. I consider this particularly important because we have not yet had data of such a scale and type regarding the application.

It can also be said, based on my experiences and investigations, that colleagues can use the application to make lessons colorful and atmospheric, and that using the application at home can help the development of independent learning. When using LearningApps, we can create a joyful atmosphere and effective knowledge acquisition, as our students acquire knowledge in a playful, interactive way.

I trust that the actors of the teaching-learning process will make sufficient use of the potential of LearningApps in education, so that research results already support its positive effect.

Significance of research results

The obtained research results and the conclusions that can be drawn from them, a tool with an excellent development effect can enrich the repertoire of online teaching aids, and the methodological culture of teachers can also expand.

The tool can contribute to increasing the efficiency of learning, and can also convey useful theoretical and practical knowledge. User information related to the application can help to collect data useful for educational science.

If the results of domestic research also support the positive effect of the tankocka, then it will become even more usable in education, in addition to national expansion, even international expansion can be realized.

Through its integrated application in the future, a new, innovative methodological culture can continue to be formed, which is very impressive for the younger generations, and extremely useful and user-friendly for teachers.

The candidate's publications and presentations related to the topic

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