

DIGITAL STORYTELLING IN ECONOMICS SUBJECTS AND ITS EFFECTIVENESS ON STUDENT LEARNING OUTCOMES BY GENDER AND DIFFERENT ECONOMIC KNOWLEDGE

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ABSTRACT

Digital storytelling (DST) is one of the alternative teaching methods and previous research shows its positive impact on students' motivation and learning outcomes, especially in humanities subjects. In vocational subjects such as economics, the effectiveness of this method is questionable. 856 respondents aged 15 to 19 from six business academies in the Czech Republic took part in the testing, which focused on the effectiveness of digital storytelling in economics. This paper presents other possible factors that may have influenced students' performance in the post-test. A comparison of the results from the pre-tests and post-tests of the experimental and control groups showed that the students from the experimental group reached higher mean values in the post-test than the students from the control group. It was also found that in the group that used digital storytelling, the year of study and the initial knowledge of the students assessed in the pre-test influenced the mean post-test scores. On the other hand, the factor of students' gender was not demonstrated. At the end of the testing, a questionnaire survey was conducted to investigate students' views on digital storytelling and their preferences for teaching methods.

KEYWORDS

Business academy, digital storytelling, economics, education, standard teaching, student achievement

HOW TO CITE

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Highlights

- The use of the alternative teaching method DST does not differentially affect learning outcomes by gender.
- The use of the alternative teaching method DST differentially affects learning outcomes by year of study in high school.
- The use DST method and standard teaching in economics does not have a differential effect on the learning outcomes of students with lower pre-test scores.
- The use of DST method and standard teaching in economics has a differential effect on the learning outcomes of students with higher pre-test scores.
- DST method has a higher effect on students' learning outcomes with higher pre-test scores than standard teaching.

INTRODUCTION

Digital storytelling, abbreviated as DST, is one of the tools that can be used to draw the attention of the audience and convey information and knowledge. In earlier times, storytelling was one of the few ways people passed on their experiences, advice, and traditions. With the proliferation of printing, computers, databases, and electronic communication, information has become freely available in endless quantities and people are

now overwhelmed by information. It is becoming increasingly difficult to engage the viewer and the story is once again proving to be a powerful tool in business communication (Dolan, 2017), marketing (Mengu et al., 2017; Phillips, 2012), personal life (Ramsden and Hollingsworth, 2013) and education (Miller, 2014). As Frazel (2010) wrote in his book, digital storytelling is a modern expression of old art. Digital stories are created using audiovisual technology and with the development of

information technology and other tools, there are new ways to use this 'old art'. People share their experiences through social networks (YouTube, Instagram, tik-tok, etc.) and present them as personal stories (Sanchez-Lopez et al., 2020). Storytelling creators use photos, videos, text, music, the narrator's voice, and sound effects to create multimedia presentations on a given topic. Stories can connect theoretical knowledge with real life and attract, inspire and evoke positive and negative emotions. Linking listening and visual perception with the experience of certain emotions can help to better understand and remember the information presented. For example, better memorization through the elicitation of emotions was confirmed by a survey conducted in 2014 in Greece (Papadopoulou and Vlachos, 2014). The main aim of the research was to find out whether the repetition of already known concepts using the DST method and inducing emotions would help in better memorization. The research results show an improvement in language skills, higher motivation, and engagement of students in the learning process. All the mentioned attributes of this tool predispose digital storytelling to be used in the process of education.

Ongoing research around the world verifies the benefits of multimedia and digital storytelling in education. In their article, the authors (Wu and Chen, 2020) reviewed research on the use of digital storytelling conducted between 1993 and December 2018. The studies cited in the article and many others show the overwhelmingly positive impact of this alternative teaching method on student motivation, critical thinking, and academic achievement. Pupils in primary schools (Hung et al., 2012; Liu, Huang and Xu, 2018; Tsou et al., 2006; Yang and Wu, 2012), secondary schools (Lestari et al., 2019; Lin et al., 2013) and universities (Goldingay et al., 2018; Hafner and Miller, 2011) perceive digital stories in teaching as diversification of teaching and linking theoretical knowledge with real life. The results of studies show that especially in foreign language teaching (Afrilyasanti and Basthomy, 2011; Anderson and Macleroy, 2016; Heathfield, 2014; Yang and Wu, 2012), literature (Balaman, 2018; Yuksel, Robin and McNeil, 2021), psychology (Belland, 2017) and other humanities and social sciences, digital storytelling has positive results on students' learning outcomes and motivation. This teaching method has also been tested in mathematics (Niemi et al., 2018), technology, and natural sciences (Belland, 2017), and also here a positive effect was confirmed mainly on the cognitive results of the students. In contrast, Stocchetti (2016) together with other authors of the articles, points out that the role of digital storytelling is often overestimated and highlights the benefits and risks of using information technology in education. Some research shows contradictory results. Research conducted in a junior elementary school in Taiwan in 2014 during English language and literature classes evaluated the DST method as unsatisfactory. Students were not shown to have a better understanding of the selected concepts, nor was there evidence of a positive effect on students' motivation (Liu et al., 2014). The authors reached similar results in a survey that was also conducted in a primary school in Taiwan in 2017. Some students were more motivated after using the method, while others were demotivated (Belland, 2017; Huang et al., 2017). Belland (2017) investigated the effectiveness of digital stories

in STEM subjects, i.e., science, technology, engineering, and mathematics, and points out that the high effectiveness of this method may not be true in all subjects.

In economics subjects, according to available sources, a survey was conducted in 2001 at a university in Bratislava (Andrasik, 2023). Using digital stories, students were introduced to several possible causes of economic behaviour that affect the business cycle and then explained the mathematical methods that solved the given problem. However, this study did not investigate the impact of using different teaching methods. Another survey focused on the use of digital storytelling in economics courses was conducted by the authors (Lestari et al., 2019). The authors focused on the influence of alternative teaching methods on students' motivation and the atmosphere during the teaching. The results, which were obtained by means of a questionnaire survey, show that students rated the effectiveness of the media used and digital storytelling very positively. However, this research also did not investigate the impact of digital storytelling on student learning outcomes in an economics subject.

Many factors influence the effectiveness of the digital storytelling teaching method, such as the subject taught, the topic, the chosen story, and its processing. Each person is an individual, perceives the world around him/her differently, and is focused on different stimuli. As Minhova (2012) states, a large number of images can increase the cognitive load of students and can be distracting. Interpretation can become confusing and complex. It is important to include lesson-specific visual material and to select it with the age and mental level of the learners in mind. In the author's opinion, the verbal presentation should remain the basic teaching method and pictorial material should serve as a supplement to facilitate understanding of the material (Minhova, 2012). As Pratten (2015) states, the key to the success of digital storytelling in education is to create a story that appeals to as many audiences as possible. An important prerequisite is the author's understanding of the audience. The author must be able to put himself/herself in the shoes of the listener and create a story based on age, gender, education, or social status (Pratten, 2015). In schools, students are usually divided into classes according to age, which is optimal for creating a digital story for a given class. However, there may be differences in knowledge of the subject. Another variable that can affect the effectiveness of the story being told is the gender of the student. Teaching in schools is done together in most subjects, and digital stories may affect males and females differently.

The aim of this research is to discover whether the effect of digital storytelling on students' learning outcomes in an economics subject is related to the year of study of the students, their prior knowledge of the economics, and the gender of the student. First, the methodology of the pedagogical experiment and the method of data collection are described. The results are presented in four subsections. The first subchapter focuses on differences in post-test scores by year of study. The second subchapter reports whether there are significant differences in post-test score based on the student's gender, and the third subchapter examines the effect of DST as a function of pre-test performance. The questionnaire

survey focusing on students' motivation and critical thinking is evaluated in the fourth subsection. The results obtained are summarized in the discussion chapter, the limitations of this pedagogical experiment and suggestions for further research are given in the conclusion.

MATERIALS AND METHODS

Based on the given objective, mixed research was carried out, where quantitative research is predominant, complemented by qualitative research. First, pilot research was conducted with a small number of respondents in which the test instruments were validated on a different economic topic. A total of 82 business academy students in the Czech Republic were randomly divided into two groups and taught using two different methods on the topic "Total and Marginal Utility". The students in the experimental group ($n = 41$) watched the digital storytelling and the students in the control group ($n = 41$) listened to the teacher's explanation with the support of the presentation. Several changes in methodology were made after the pilot phase. The total number of six questions in the pre-test and post-test was increased to 16 due to the higher reliability of testing, and the total number of six questions in the questionnaire survey was increased to 10. Unlike the pedagogical experiment, the pilot phase was conducted in person (Nunvarova et al., 2023). A total of six business academies from the Czech Republic participated in the pedagogical experiment, which was conducted during online learning from February to June 2021 via MS Teams. A total of 856 respondents from all four grades of business-oriented secondary schools, i.e., aged 15 to 19, were tested. Students were randomly divided into two independent groups in each grade. There was a total of 430 students in the experimental group and 426 students in the control group. The economic topic "Demand, Supply and Price Elasticity" was selected for testing based on the Framework Curriculum, which is mandatory for all business academies, and the School Curriculum of all participating schools. Testing was carried out only in those classes in which this topic had not yet been covered. Jana Nunvarova, one of the authors of this

article, who is also an economics teacher at the business academy, created a digital storytelling (DST) called "How Vojta sold shoes". DST has been validated by experts and was used in the teaching of an experimental group. The video lasts a total of 7 minutes and tells the story of a boy who has just graduated from a business academy and has been offered to take over his family's shoe shop. Through his mistakes, the young inexperienced salesman gradually tests his knowledge from the business academy, the basic principles of the market mechanism and the theoretical knowledge of price elasticity of demand. In the control group, the concepts of demand, supply and price elasticity were explained using the standard method, i.e., teacher explanation supported by a presentation. The effectiveness of both methods on students' learning outcomes was verified by the same tests for both groups. The pre-test and post-test contained a total of 16 identical closed questions on the given economic topic. The reliability of the test was verified using the Kuder-Richardson formulas²⁰ (Mares et al., 2015). The observed value of 0.714 satisfies the lower limit for a test with good reliability. Students in the experimental and control groups were tested separately for one class period, i.e., for 45 minutes. As shown in the flowchart in Figure 1, both groups were first introduced to the testing procedure via MS Teams and completed the pre-tests using MS Forms. Then, the experimental group students watched the digital storytelling and the control group students listened to the teacher's explanation with the support of the presentation. After introducing the given economic topic using different teaching methods, students of both groups completed the post-tests. In order to evaluate which method suited them better for the topic, a second teaching method was applied to both groups after completing the post-tests. The students in the experimental group listened to the teacher's explanation supported by the presentation and the control group watched DST. At the end of the lesson, both groups completed a questionnaire focusing on students' motivation and critical thinking. In it, students could give their opinions on both teaching methods and answer the questions using a Likert scale.

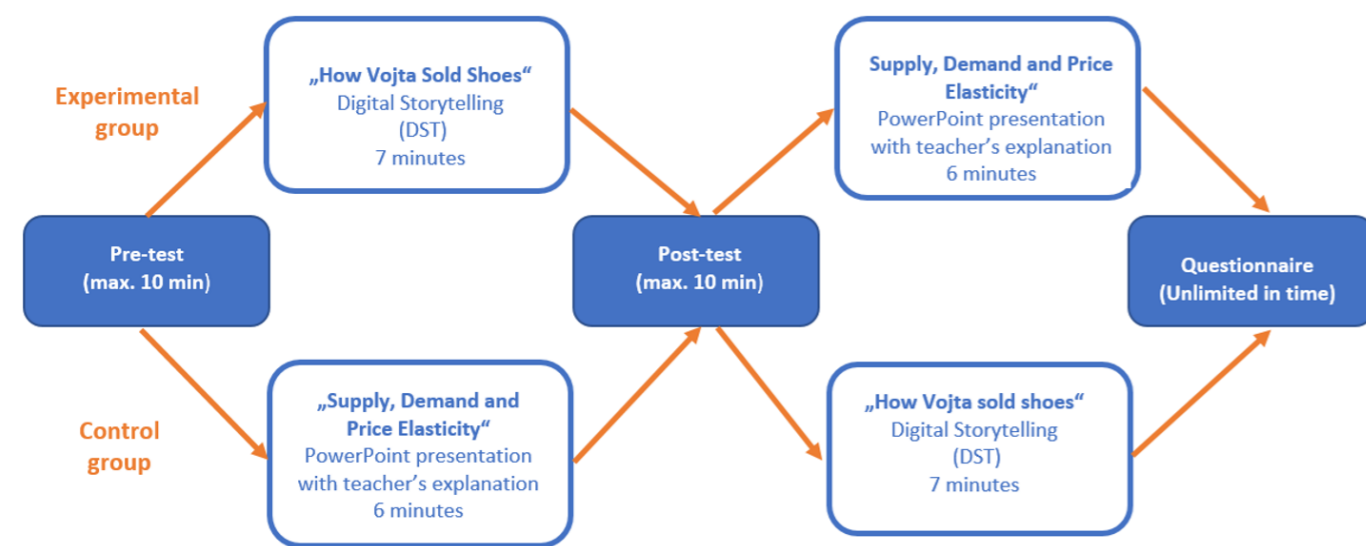


Figure 1: Diagram of testing schedule, (source: own processing)

The data obtained from the pre-tests, post-tests, and questionnaire survey were processed using MS Excel and the calculations were performed using IBM SPSS Statistics 26 software. A significance level of 5% was considered when performing the tests. The students' academic performance was compared not only between the experimental and control groups, but also depending on the duration of study, gender of the students or their initial knowledge. The gender of the students was determined by the binary categorization of male and female, as usually indicated at birth. The length of study was determined by the year the student attended at the time of testing. It was not considered if a student repeated a year for any reason. For example, although he/she would have studied one year longer, he/she would have lacked the knowledge of the next year. Initial knowledge of a given economic topic was assessed through a pre-test which students complete before using the standard or alternative teaching method. Specifically, students' performance was compared according to their group affiliation, determining the pre-test's 1st and 4th quartiles. Students were divided into a group of those who performed worse in the pre-test and a group of those who performed well in the pre-test. For these two groups, it was assessed whether storytelling was a better way of teaching for them.

In this paper, we would like to deal with the following hypotheses:

H1: In the group that used the DST method, gender has an impact on the mean score of the post-test.

H2: In the group that used the DST method, the year of study has an impact on the mean score of the post-test.

H3: The use of DST methods in economics has a different effect on the post-test scores of students who are in the first quartile (Q1) according to the pre-test results.

H4: The use of DST methods in economics has a different effect on the post-test scores of students who fall into the fourth quartile (Q4) according to the pre-test results.

RESULTS

The students' initial knowledge of supply, demand and price elasticity was tested using a pre-test containing 16 closed questions. After using the DST method in the experimental group and the teacher's explanation supported by the presentation in the control group, a post-test was used to determine the differences in the students' results. The results of the paper (Nunvarova, Poulouva, Prazak & Klimova, 2023) were that students in the experimental group had slightly worse results in the pre-test than students in the control group and that students in the experimental group achieved the same results in the post-test as students in the control group. This means that the DST method is not worse than standard teaching methods. Furthermore, repeated measures ANOVA showed that students in the experimental group had a higher individual mean success rate in the post-test than students in the control group. The similar result can be verified by the *t*-test performed on the difference between the individual score of the post-test and the pre-test. The mean difference score of the experimental group ($n_1 = 430$) is 1.754 (*s.d.* 2.677) and the mean difference score of the control group ($n_2 = 426$) is 1.228 (*s.d.* 2.667). Using the *t*-test for two independent samples with equal

variances (Levene's test, $F(1, 854) = 0.108$, p -value = .743), we can see that the difference score of the experimental group is significantly higher than the difference score of the control group ($t(854) = 2.879$, p -value = 0.002). This means that the students in the experimental group who were taught with the help of storytelling achieved higher scores in the post-test individually.

Here we present other possible factors that were recorded and that might influence the students' results in the post-test. In particular, we consider the following factors: *group* (experimental/control, 430/426), *gender* (male/female, 304/552) and *class* (4 classes of high schools - the class 1 includes students in their first year of study etc., 140/301/258/157).

Data were analyzed using ANOVA with three factors given. The results showed that the factor *group* ($F(1, 850) = 0.225$, p -value 0.636) and the factor *gender* ($F(1, 850) = 0.378$, p -value 0.539) were not significant in the post-test. On the other hand, the factor *class* was found to be significant ($F(3, 850) = 3.309$, p -value 0.020) and, therefore, a more detailed analysis was conducted focusing on this factor. None of the interactions between the factors are significant. Based on these results, we do not have sufficient evidence for hypothesis H1 that gender has an impact on the mean score of the post-test. We have also found evidence for hypothesis H2 that the year of study influences the mean score of the post-test, but we will discuss this issue in more detail in the next section.

Differences in post-test scores based on the year of study

The analysis focusing on the factor *class*, which turned out to be significant in the previous test, is divided into two steps, one for the experimental group and one for the control group, see Figure 2 and Table 1.

First, the one-way ANOVA test was conducted for the experimental group with the factor *class*, which proved to be significant ($F(3, 426) = 3.723$, p -value 0.012, $\eta^2 = 0.026$), which means that the factor *class* influences the mean score of the post-test in the experimental group, although the effect size is relatively small. The Tukey's post-hoc test for multiple comparisons shows significant differences between class 1 and class 4 (p -value 0.038, 95% CI of the difference [-2.45, -0.05]) and between class 2 and class 4 (p -value 0.011, 95% CI of the difference [-2.24, -0.23]). On the other hand, the results of the one-way ANOVA test for the control group with factor *class* indicate that there were no significant differences among them ($F(3, 422) = 0.565$, p -value 0.638). This means that we do not have enough evidence that the factor *class* influences the mean score of the post-test in the control group. Based on the given results, we have sufficient evidence for hypothesis H2 that the year of study has an impact on the mean score of the post-test in the experimental group.

Assessment of the effectiveness of alternative learning (digital storytelling) and depending on the results in the pre-test

Further data analysis focused on assessing the post-test results of the experimental and control groups in relation to their placement in the pre-test. Specifically, students'

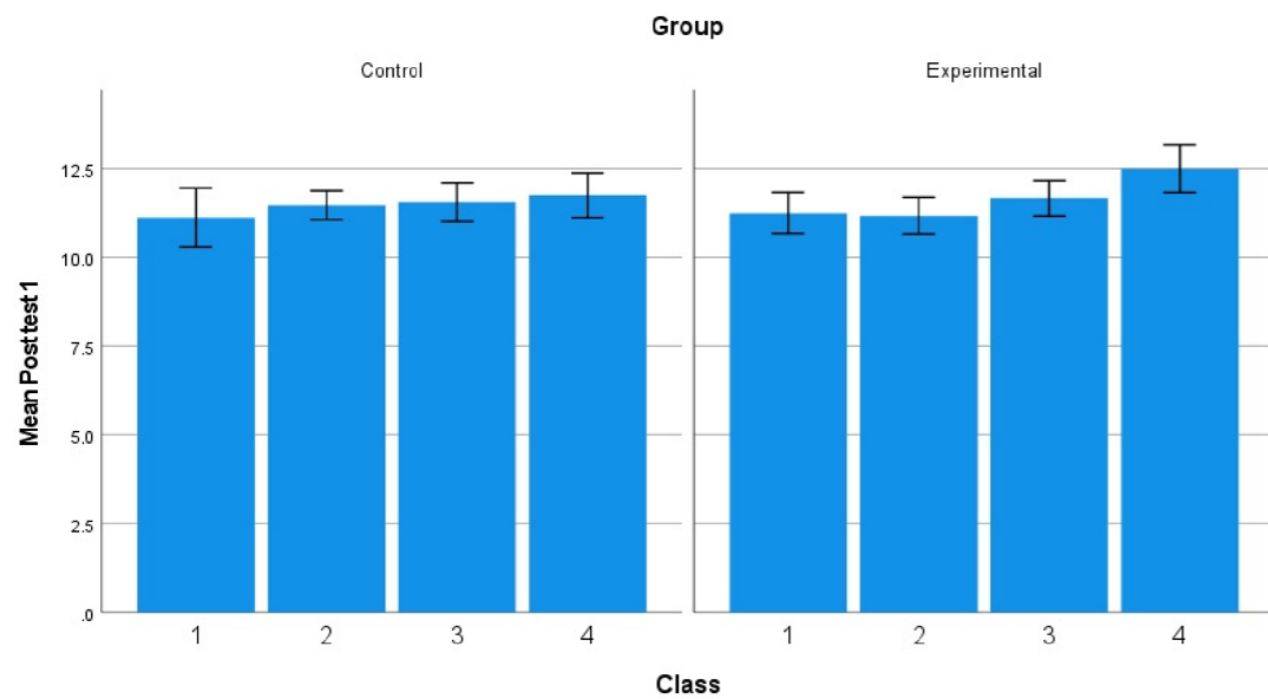


Figure 2: Mean post-test scores in the experimental and control groups. Error bars means 95% CI (source: own arrangements in IBM SPSS Statistics)

Group	Class	N	Mean	Std. Deviation	Grouped Median	Maximum	Minimum
Experimental	1	79	11.25	2.569	11.42	16	5
	2	118	11.18	2.821	11.28	16	5
	3	153	11.67	3.122	12.00	16	2
	4	80	12.50	3.052	13.39	16	3
	Total	430	11.61	2.960	12.02	16	2
Control	1	61	11.13	3.227	11.50	16	3
	2	183	11.48	2.757	11.66	16	3
	3	105	11.56	2.835	11.90	16	2
	4	77	11.75	2.754	12.00	16	6
	Total	426	11.50	2.843	11.78	16	2

Table 1: Descriptive statistics of the post-test in the experimental and control groups (source: own computations in IBM SPSS Statistics)

performance was compared according to their group membership, determining the pre-test's 1st and 4th quartiles. That is, students were divided into a group of those who performed worse in the pre-test and a group of those who performed well in the pre-test. For these two groups, it was

assessed whether storytelling was a better way of teaching for them or not. The descriptive statistics of the pre-test is presented in Table 2 and the corresponding quartiles of the pre-test scores are presented in Table 3.

	N	mean	standard deviation	95% confidence interval		minimum	maximum
				lower limit	upper limit		
Pre-test	856	10.06	2.356	9.91	10.22	2	16
Pre-test, experimental group	430	9.86	2.303	9.64	10.08	3	16
Pre-test, control group	426	10.27	2.393	10.04	10.50	2	16

Table 2: Descriptive statistics of the pre-test (source: source: own calculations in SPSS Statistics)

Based on these scores, the respondents (students) were divided into 2 groups. The first group, which we will label S, included all students who received a pre-test score less than the first quartile of Q1, i.e., 9 points. This group contains 212 students, of which 118 are in the experimental group and 94 are in the control group. The second group, which we mark

by D, includes those students who received scores greater than or equal to the third quartile of Q3, i.e., 12 points, in the pre-test. This group contains 230 students, of which 98 are in the experimental group and 132 in the control group. The results of the post-test in groups S are summarized in Table 4.

	Q1	Q2	Q3
Pre-test	9	10	12

Table 3: Quartiles of the pre-test, (source: own calculations in SPSS Statistics)

	N	mean	standard deviation	95% confidence interval		minimum	maximum
				lower limit	upper limit		
Post-test for students S	212	9.83	3.049	9.42	10.25	2	16
Post-test, experimental group S	118	9.94	3.081	9.38	10.50	2	16
Post-test, control group S	94	9.70	3.019	9.08	10.32	2	16

Table 4: Descriptive statistics of the post-test for students with low scores in the pre-test (source: own calculations in SPSS Statistics)

Based on a *t*-test for the means of two independent samples with identical variances (Levene's test, $F(1, 210) = 0.028$, p -value = 0.866) it cannot be shown at the 0.05 level of significance that students with low scores on the pre-test (Q1) from the experimental group perform differently than students with low scores on the pre-test (Q1) from the control group ($t(210) = 0.565$, p -value = 0.573). The difference between teaching methods is statistically insignificant and, therefore, we reject hypothesis H3, that the use of DST methods in

economics has a different effect on the post-test scores of students who are in the first quartile (Q1) according to the pre-test results. This means that the observations made for the group of students labelled S who were in the first quartile of Q1 show no difference in teaching style, and teaching using storytelling does not result in different outcomes for this group of students than standard teaching. The results of the post-test in group D are summarized in Table 5.

	N	mean	standard deviation	95% confidence interval		minimum	maximum
				lower limit	upper limit		
Post-test for students D	230	13.44	2.037	13.17	13.70	7	16
Post-test, experimental group D	98	13.53	1.914	13.53	14.30	8	16
Post-test, control group D	132	12.73	2.060	12.73	13.44	7	16

Table 5: Descriptive statistics of the post-test for students with high scores in the pre-test (source: source: own calculations in SPSS Statistics)

Table 5 shows the values obtained in group D. The students of the experimental group, i.e., those who were taught using the digital storytelling method, achieved an average score of 13.53, while the students of the control group achieved an average score of 12.73. Based on a *t*-test for the means of two samples with equal variance (Levene's test, $F(1, 228) = 1.854$, p -value = 0.175), it can be shown at the 0.05 significance level that students in the experimental group, perform significantly better than students in the control group ($t(228) = 3.132$, p -value < 0.001). Based on these obtained results, we fail to reject the hypothesis H4 that the use of DST methods in economics has a different effect on the post-test scores of students who fall into the fourth quartile (Q4) according to the pre-test results. This means that the observations made for the group of students (D) demonstrate a difference in teaching style and teaching using digital storytelling shows better results for this group of students than standard teaching.

Evaluation of a questionnaire survey focused on student motivation and critical thinking

At the end of the testing, students in both the experimental and control groups completed a questionnaire survey. The questionnaire consisted of 10 closed-ended questions, which were answered using a 4-point Likert scale (definitely no - rather no - probably yes - definitely yes) or by selecting from the teaching methods. Students were also given the opportunity to write additional comments on the methods used in teaching

economics. The graphical representation of the answers to the selected questions shows the students' attitude towards the alternative method of digital storytelling. Figure 3 shows the intensity of students' agreement with the statement that they remembered the selected economic concepts better after watching digital storytelling than after standard teaching, i.e., teacher explanation supported by a presentation. As the graph shows, 62.8% of the students in the experimental group and 69.2% of the students in the control group agree or strongly agree with this statement. The next question focused on students' preferences when choosing between two teaching methods. Again, students answered using a Likert scale whether they preferred digital storytelling to standard teaching (teacher explanation supported by a presentation) in teaching economics. As shown in the Figure 4, 55.5% of students in the control group preferred the alternative teaching method - digital storytelling. In the experimental group, 45.41% of students answered "rather yes" or "definitely yes" to this statement. In question 9, students already directly select the teaching method from four options. The options offered were the alternative method of digital storytelling, standard teaching (teacher interpretation supported by a presentation), a combination of both options and self-study. The self-study option was offered because the students may have already encountered the concepts being explained, even though this economic topic had not been discussed in the year's

economics course so far. As shown in Figure 5, the majority of the students chose a combination of both options, regardless of their inclusion in the experimental group (61.35%) or control group (63.33%).

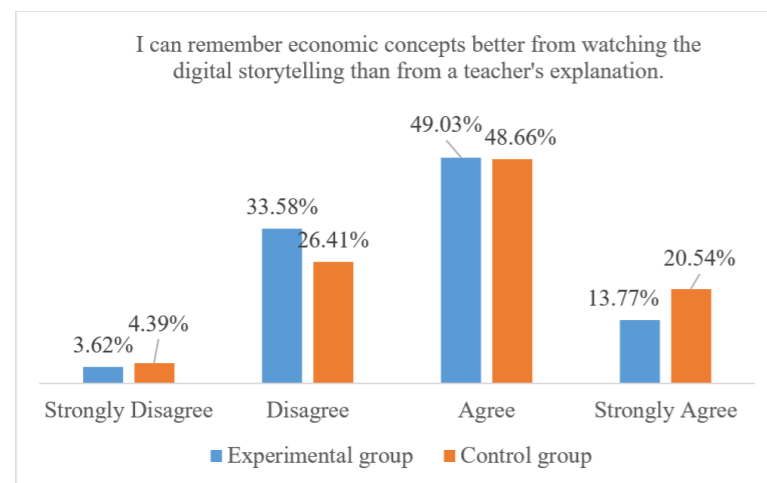


Figure 3: Graphical processing of question 4 from the questionnaire survey (source: own processing)

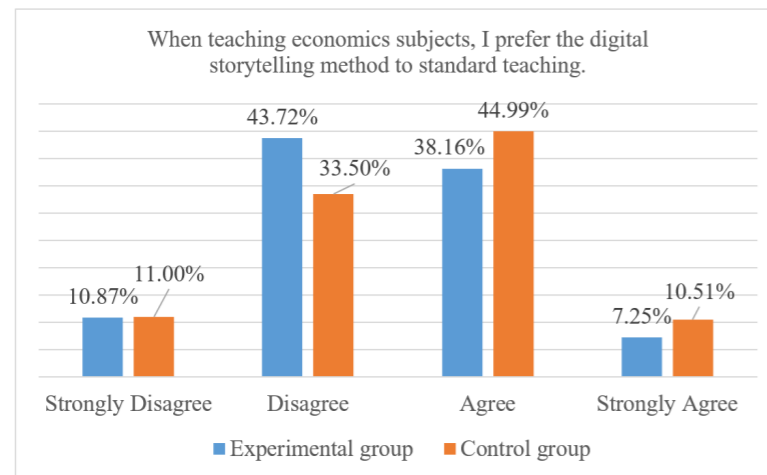


Figure 4: Graphical processing of question 8 from the questionnaire survey (source: own processing)

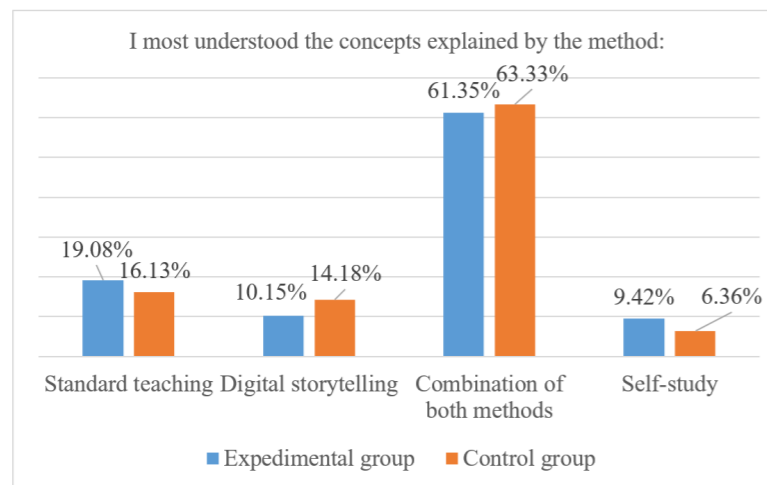


Figure 5: Graphical processing of question 9 from the questionnaire survey (source: own processing)

This result is also confirmed by the students' opinions written in the questionnaire survey. For example, a student (17 years old) of the third year of business academy from the control group wrote: "I think the teacher's explanation is necessary. At the same time, thanks to DST, I can better visualize the information and connect it with the theory from the explanation. That's why I find the combination the best." The opinion of another fourth-year student (19 years old) from

the experimental group was, "Definitely, the combination of interpretation and storytelling is good. But it depends on the topic being discussed and also the fact that something different suits everyone." Another opinion was written by a student (19 years old) studying year 4: "I liked storytelling and I think it is a good way to learn. I remembered the story more. Anyway, concepts are better remembered when you see them in front of you with the definition - as it was in the presentation. The combination of both seems perfect to me. But first the interpretation and then the storytelling. One learns something about the theory and then sees it in practice." The students (19.08% of the experimental group and 16.03% of the control group) who chose the standard teaching option in question 9 explained their choice with greater clarity and the possibility to read or note the information. As one of

the students (18 years old) of the fourth year stated, "I often get lost in storytelling, unlike in presentations where everything is clear." The opposite view was shared by a student (17 years) from the third-year control group. "Storytelling is much more interesting and grabs a lot more attention than a teacher's explanation. It's more memorable in an entertaining way than just an explanation." As shown in Figure 5, 10.15% of the students in the experimental group and 14.18% of the students in the control group agreed with her opinion. One of the questions in the questionnaire survey focused on the order of teaching methods when they are combined. In Figure 6, we can see that a higher percentage of students from both the experimental (50.97%) and the control group (57.95%) preferred to first listen to the teacher's explanation with the support of a presentation and then watch the digital storytelling when combining the two options.

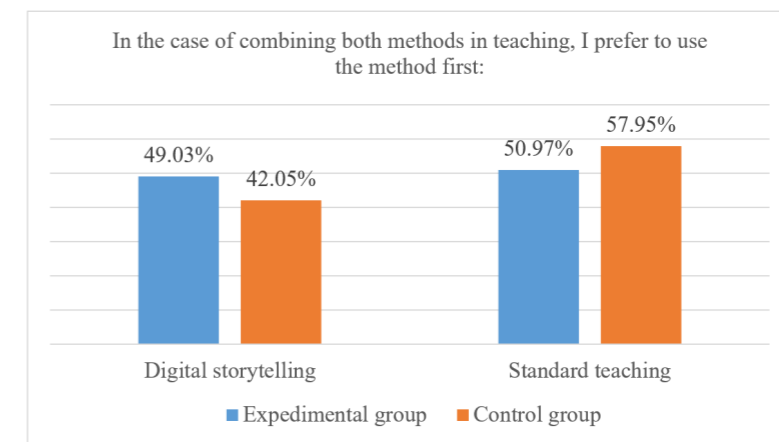


Figure 6: Graphical processing of question 10 from the questionnaire survey (source: own processing)

A 17-year-old student in Year 3 from the experimental group wrote: "Definitely the teacher's explanation first with the support of the presentation and then storytelling, I personally find it better this way. Although it is true that after the storytelling, I already understood some of the concepts in the presentation better." However, the percentage difference in the number of students who would prefer the opposite order is not very large. For example, a student aged 16 from the second year of the experimental group stated, "I would prefer the DST first and then the classical interpretation. The story was able to keep my attention more, but I understood some things better from the presentation. That's why the combination of both methods suits me probably the most."

As can be seen from the results, the students' opinions on the order of teaching methods differ, but the majority of students prefer a combination of both methods. They perceive digital storytelling as a pleasant diversification of teaching, stories keep their attention. Students appreciate the DST method for linking theoretical concepts with practice and for better memorization of selected economic concepts. A fourth-year pupil from the experimental group wrote "Digital storytelling is a great method to really understand the material. It doesn't provide the students with meaningless concepts but puts them into practice and therefore forces them to de facto construct the definitions of the concepts and derive them from the information in the story. Although some of the definitions need to be said independently afterwards, storytelling is a great

method not only to teach students the concepts but also to show them how they work in real life. I enjoyed it tremendously, and the difference between the attention I personally gave to the DST and the presentation was also a difference - without meaning to, I caught myself distracted, not paying attention, at the beginning of the presentation. That didn't happen to me with DST."

DISCUSSION

This research aimed to discover whether the effect of digital storytelling on students' learning outcomes in an economics subject is related to the year of study of the students, their prior knowledge of economics, and the gender of the student. At the same time, a questionnaire survey was conducted to find out students' opinions about the digital storytelling method in teaching economics subjects. The research was conducted from February to June 2021 as part of online distance learning and involved a total of 856 students aged 15 to 19 at six business academies in the Czech Republic. The students were randomly divided into two independent groups. The 430 respondents in the experimental group viewed digital storytelling on the topic of supply, demand and price elasticity, while 426 respondents in the control group were taught by standard teaching method (teacher's explanation supported by a PowerPoint presentation). The students' initial knowledge was tested using a pre-test containing a total of 16 closed questions, and after the application of the DST method and standard teaching, a post-test with

the same questions was used to determine differences in the student's results. The data were analysed according to three factors that may have influenced the students' performance on the post-test. These include factor *group* (experimental/control), *gender* (male/female) and *class* (4 high school classes - class 1 includes first-year students etc.). A multi-way ANOVA test was conducted with three given factors, in which the factor *group* and the factor *gender* were found to be not significant. Based on these results, we do not have sufficient evidence for hypothesis H1 that gender has an impact on the mean score of the post-test. This result is supported by previous research (Gerstner and Bogner, 2009; Oludipe, 2012) that tested the effect of different teaching methods by gender and found no significant difference in student achievement.

The factor *class*, on the other hand, was evaluated as statistically significant, and therefore a more detailed analysis was performed.

First, a one-way ANOVA test was performed for the experimental group, which was again found to be statistically significant. However, the one-way ANOVA test for the control group with the factor *class* showed the opposite results, i.e. that the different years of study did not show significant differences in the mean post-test scores after using both methods. This means that we do not have enough evidence that the factor *class* influences the mean score of the post-test in the control group. Based on the given results, we have sufficient evidence for hypothesis H2 that the year of study has an impact on the mean score of the post-test in the experimental group. No other research was found in the available sources that focused on the effect of DST on learning outcomes as a function of students' age. According to previous research, the DST method is suitable for all levels of education and yields positive learning outcomes in elementary schools (Liu, Yang and Chao, 2019), middle schools (Lin et al., 2013), and universities (Sheafer, 2017). Usually, respondents of the same age are tested together.

Another factor that could affect digital storytelling's effectiveness in teaching economics is initial knowledge of the topic. Therefore, the results of the students of the experimental group and control group in the post-test were assessed in relation to their ranking in the pre-test. Students were ranked according to their pre-test scores and divided into four groups, according to quartiles. Based on these results, two groups were formed. The first group (S) included all students who received a pre-test score less than the first quartile of Q1, i.e., 9 points. This group contained 212 students (118 in the experimental group and 94 in the control group). These students scored lower than the others in the pre-test and, therefore, less initial knowledge of the economic topic can be assumed. Students with low pre-test scores in the experimental group were not shown to perform differently on the post-test than students with low pre-test scores in the control group. The difference between teaching methods is statistically insignificant, and therefore we reject hypothesis H3 that the use of DST methods in economics has a different effect on post-test results for students who are in the first quartile (Q1) according to the pre-test results.

The second group (D) included students who scored greater than or equal to the third quartile of Q3, i.e., 12 points, on the pre-test. Thus, the initial knowledge of these students

was better than that of the other respondents in this area. This group contained 230 students (98 in the experimental group and 132 in the control group). For this group (D), at the 0.05 level of significance, it was shown that students in the experimental group, performed significantly better than students in the control group. Based on these obtained results we fail to reject the hypothesis H4 that the use of DST methods in economics has a different effect on the post-test scores of students who fall into the fourth quartile (Q4) according to the pre-test results. This means that the observations made for the group of students (D), demonstrate a difference in teaching style and teaching using digital storytelling shows better results for this group of students than standard teaching. For students with an average better result in the pre-test, digital storytelling helped them understand the subject better by linking theory with practice. The alternative method was more effective in teaching the economic topic. In the case of students with a lower average score on the pre-tests, their learning outcomes on the post-test were not affected by the teaching method. Thus, it can be said that for students with worse results, it does not matter which teaching method is chosen. On the contrary, for students with better learning outcomes, the choice of teaching method will significantly affect students' future knowledge. The results can be compared with a study (Nwagbo, 2006) that investigated the relative efficacy of the guided inquiry and the expository teaching methods on the achievement in and attitude to biology of students of different levels of scientific literacy in four secondary schools in Nsukka, Enugu State, Nigeria. The study found no statistically significant difference between teaching methods and the level of scientific literacy on achievement in biology. The study's conclusions are inconsistent with the results of the pedagogical experiment in terms of the effectiveness of different teaching methods depending on the results in the pre-test. In the pedagogical experiment, the DST method had different effects on the post-test scores of students with higher initial knowledge and students with lower initial knowledge. The reason may be the difference in the subjects and teaching methods used in testing, and the requirements for initial knowledge (basic economic concepts and the level of science literacy). In economics, a similar study was conducted in four different high schools in Northern California (Mergendoller et al., 2006). This study compared the effectiveness of problem-based learning (PBL) and traditional instructional approaches in teaching macroeconomics while also examining whether PBL method had the same effect on students who demonstrated different levels of four skills: verbal ability, interest in economics, preference for group work, and problem-solving efficacy. Overall, PBL was found to be a more effective approach to teaching macroeconomics than traditional lecture. Thus, there was no confirmed difference in effectiveness of the teaching methods used with respect to the level of the four chosen skills, which again represents different results with the pedagogical experiment. In the pedagogical experiment, the greater effectiveness of the DST method in economics was demonstrated only for students with higher initial knowledge, not for students with lower initial knowledge. This may again be due to differences in teaching methods and the way students are divided into groups. The effectiveness of teaching methods

in economics has also been investigated in studies (Kirchherr and Piscicelli, 2019; Wetzal et al., 1982), but none of the mentioned studies investigated the effect of DST method. Another issue is the motivation and interest of students in their studies. The questionnaire survey confirmed the results of previous research both in different subjects (Belland, 2017; Chan et al., 2017; Jonassen, 2003; Lin et al., 2013; Miller, 2014; Schiro, 2004; Wu and Chen, 2020) and in the field of economics (Andrasik, 2023; Lestari et al., 2019) evolutionary animation and programmed learning. System dynamics approach using storytelling helps understanding a multitude of complex behaviours arisen in contemporary economy. Method is advantageous first of all in situations where explanation of complex phenomena is required too sophisticated mathematical tools. Using those simulation (numerical. Students perceive the DST method as more enjoyable than standard teaching, in which they maintain more attention and remember more from watching a digital story. As shown in Figure 3, more than half of the students in the experimental and control groups agree with the statement that they remember selected economic concepts better after watching digital storytelling than after standard teaching. In the next question, given a choice of two applied teaching methods, 55.5% of the students from the control group who first listened to the teacher's explanation with the support of a presentation and then watched the DST preferred digital storytelling.

On the contrary, more than half of the students from the experimental group (54.59%), who first applied the DST method and then listened to the teacher's explanation with the support of the presentation, prefer standard teaching. "Rather yes" or "definitely yes" to use digital storytelling to teach economic concepts was answered by 45.41% of the students from the experimental group; see Figure 4. The results show that students in the control group, who already had some knowledge of the topic from the teacher's explanation, perceived the digital story as a more beneficial method for understanding the selected economic concepts. More than half of the students in the experimental group who heard new economic concepts for the first time in a digital story would have preferred standard teaching. In the next question, when students could choose not only the teaching methods used but also the combination of both methods and self-study, the option of combining both methods received the highest percentage. According to the pupils' opinions, the methods complement each other, link economic concepts and definitions with real life, and together they help to understand and better remember the learning material. The results obtained are consistent with the results of Robin's (2009) research. The DST shows the interconnections within the wider curriculum and facilitates discussion of the themes presented in the story. However, the teacher's interpretation is irreplaceable in some subjects and topics. These views support the theory in the book focusing on interpersonal communication as a means of personal and social development (Minhova, 2012). If the two methods were combined in teaching economics, more than half of the pupils would first integrate the teacher's explanation with the support of a presentation, and then complement it with a digital story on the topic.

The advantage of this pedagogical experiment is the large number of respondents and the maintenance of a level playing field for all respondents during testing due to online distance learning. Students completed the same pre-tests and post-tests using MS Forms. Through MS Teams, they were provided with the same educational digital storytelling and explanation by the same teacher with the support of the presentation. All research participants attended a business academy at the time of the research. The selected topic was not taught before the pedagogical experiment. Thus, it can be assumed that the students had an initial knowledge of the topic at the same level. However, their knowledge of basic concepts and general overview may have varied due to individual interest in economics.

This study has some limitations. Although the sample consisted of 856 students, the conclusions of the pedagogical experiment relate only to the selected sample, and the results cannot be generalized. The educational digital storytelling took approximately 7 minutes so that the entire test could be carried out within the duration of one class. Therefore, it would be advisable to verify the results by further investigation, for example, implementing a longer DST or with different economic topics. The choice of the economic topic, the design of the DST and presentation, the teacher's interpretation and the classroom atmosphere are other factors that could have influenced the results of the study. Another limitation is that the students in the experimental group performed slightly worse in the pre-test than the students in the control group, although the assignment of respondents to the groups was random and the topic was not discussed in school (Nunvarova et al., 2023). The entire testing was conducted online as part of a distance education for Covid-19, which brought with it a number of advantages and disadvantages. The advantage of online instruction was the maintenance of the same testing conditions for all 856 respondents, the disadvantage was the lack of direct communication between teacher and student. Some authors confirmed the importance of face-to-face instruction and the possibility of direct communication with the teacher (Belland, 2017; Goldingay et al., 2018). Further research could focus on establishing the effectiveness of DST in economics, for example, supplemented by discussion with students in face-to-face teaching. The data obtained were further analysed in terms of the year of study, student's gender, and the results in the pre-test. Other factors that could be analysed from the data collected are the field of study or the location of the business academy. Comparing the success rates of different test questions could also provide interesting results, as some questions were based on definitions and others focused on practical examples and understanding of theory.

CONCLUSION

Digital storytelling is one of the alternative teaching methods that has been shown to have a positive impact on student motivation (Lestari et al., 2019), critical thinking (Yang and Wu, 2012) and the atmosphere in teaching (Wu and Chen, 2020). The results of the pedagogical experiment conducted in the teaching of economics in business academies support this claim. The use of the DST method led to a higher mean

success rate in the post-test for students in the experimental group than for students in the control group (Nunvarova et al., 2023). However, this improvement was very small, in contrast to the results published in, for example, foreign language research (Anderson and Macleroy, 2016; Heathfield, 2014) or literature (Balaman, 2018; Yuksel et al., 2021). The data were analysed using multi-way ANOVA test with three factors that might influence the students' results in the post-test. The results showed that in the group that used the DST method, the gender of the students did not affect the average post-test score. On the contrary, the factor *class* was shown to be statistically significant and in the group that used the DST method, the year of study influenced the average post-test score. The third factor was the results from the pre-test, i.e., the students' initial knowledge. The differential effect of the DST method and standard teaching in economics on learning outcomes was not proven for students who had lower pre-test score. On the other hand, the differential effect of the DST method and standard teaching in economics on learning outcomes was demonstrated

for students who had higher pre-test scores. For this group of students, it was found that the effect of the DST method is greater than that of standard teaching methods. In the final questionnaire, students appreciated the linking of theory and practical examples and better memorization of economic concepts when using the DST method. Nevertheless, most of them consider the teacher's explanation in the economics subject as irreplaceable. They perceive the digital storytelling as a motivational tool and a method to support their learning. This article was supported by the SPEV project 2105, Faculty of Informatics and Management, University of Hradec Kralove. The authors report there are no competing interests to declare.

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