Analysis of the Increase in Learning Success Through the Use of Digital Tools in Repetitive Teaching Entry in Economics Lessons

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Vocational schools face the challenge of preparing learners for the digitalised world of work within the framework of media and digital education, which also includes advanced digital working methods. The focus of the present study is on the one hand on possible positive effects in relation to the learning success of the learners and on the other hand to differentiate between the male and female gender in this respect. The students come from business classes at the vocational college. In order to be able to record and illustrate the results of this study in a measurable way, a learning assessment was carried out at the end of the teaching sequence. The results show that the tool *Kahoot!* has a measurable and beneficial effect on the learners' performance. In addition, it could be measured that the positive effect mentioned has a stronger impact on the male students than on the female students.

Keywords: vocational education didactics, digital tools, learning success, teaching

University of Maribor Press

DOI https://doi.org/10.18690/um.fov.3.2024.52
ISBN 978-961-286-842-0

1 Research question, state of research and research gap

Lesson starters are of central importance for successful teaching. In the first few minutes of the lesson, it is particularly important to arouse the students' attention and to transform this into a sustained interest in the subject matter (cf. Brühne, Sauerborn 2011:11). For the long-term activation of students as well as the safeguarding of the subject matter, an in-depth examination of the repetitive lesson introduction[1] can be informative. Greving and Paradies, for example, make the following demands on the repetitive introduction to lessons:

> [...] the thematic introduction at the beginning of a lesson should tie in with the material of the previous lesson in as short and concentrated a form as possible and remind the pupils of the work results of the previous lesson, the problems that remained open, the proposed solution strategies or the opinions of individuals". (Greving, Paradies 2011:19, own translation)

In prior literature, on the other hand, it is often described as a homework check, an oral repetition of the last lesson by the students or a summary of the central learning content by the teacher (cf. Brühne, Sauerborn 2011:59; Greving, Paradies 2011:19; Meyer, Junghans 2021:252; Sutter 2015:28). Greving and Paradies (2011:19), however, criticise such a "ritualised control entry", as it can lead to increased tension and anxiety on the part of the students. The intention of the repetitive lesson introduction is not to discipline but to activate and motivate students (cf. Sutter 2015:28). Greving and Paradies (2011:19) as well as Meyer and Junghans (2021:252) therefore plead for new forms of repetitive entry, but they do not give practical examples. One way to comply with this could be the use of digital tools, more specifically digital audience response systems (ARS). ARS are electronic voting systems that can be used to make teaching more interactive and flexible. They make it possible to open up teaching structures towards user-determined teaching and learning (cf. Canto, Olesch 2015). Examples include the platforms *Mentimeter, slido* or *Kahoot!*

[1] In the literature, the repetitive teaching entry is also referred to as practising or thematic entry. In the course of this work, the term repetitive teaching entry or repetitive entry will be used.

The integration of such platforms into everyday school life could be useful because the use of digital tools is an elementary part of the current and future reality of pupils' lives (cf. Roß 2020:10). The situation at school should not contrast with this reality of life. Rather, it must help shape the development processes of a digitally shaped society. This is all the more true in the context of vocational schools, as they are supposed to prepare students for the labour market. In addition, digital media enable the design of new learning paths and experiences (cf. Heusinger 2020:11-12). Studies on student motivation and the efficiency of teaching processes have shown that students learn faster and better the more active the learning processes are designed (cf. Yildirim, Sadik 2021:12, 18; Syafitri, Pami Putri, Reflinda 2020:2). Digital ARS can enable the teacher to involve all students in the learning processes and make them more fun and active. Klinsmann et al. (2016:2, 6) attest to the possibility of ARS to activate learning potentials in students through their active problem solving. They state that the ARS eKaRuS has a positive effect on the interaction between students and lecturers and on students' test results. Fotaris et al. (2016:106) and Martínez-Jiménez et al. (2021:11) conclude in similar studies that a game-like learning environment can increase students' enjoyment and cooperation. In a practical approach, teachers attest that ARS provide teachers with a picture of students' individual performance, so that comprehension problems can often be addressed immediately (cf. Schmidt, Hinderer 2017:24). An exemplary study for the use of *Kahoot!* shows a high level of acceptance of the tool among students of engineering subjects at bachelor level. Participants were more motivated and came to their seminars better prepared because they knew that everyone had to participate in *Kahoots!* (cf. Chernov, Klas, Furman Shaharabani 2021:491). The study also proves that students who worked with *Kahoot!* had greater learning success on tests (cf. Chernov, Klas, Furman Shaharabani 2021:494-495). Other studies show similar positive influences on participants' learning outcomes (cf. Toma, Diaconu, Popescu 2021:13; Elkhamisy, Wassef 2021:218-219). Goshevski, Veljanoska and Hatziapostolou (2017:6) have identified the following *game mechanics* for the modes of action of such ARS: Challenges, Chance, Competition, Cooperation, Feedback, Resource Acquisition, Rewards, Transactions, Turns and Win States. These modes of action are mainly based on behaviourist approaches.

The studies listed here show that digital tools and their positive impact are receiving a lot of attention in research. There are studies from various countries and for different learning levels, from schools to universities. However, there is only little

evidence for positive effects on the learning level of students in business classes at vocational colleges. Moreover, the studies did not investigate in which teaching phases ARS can be used particularly effectively. However, due to its function, the repetitive lesson entry seems to offer good conditions. In order to counteract this research gap, this study analyses the effectiveness of a digital, repetitive lesson introduction on the learning success of students in business lessons at vocational colleges.

2 Generation of hypotheses

The repetitive practice and reactivation of learning content is a central element for the long-term anchoring of knowledge. Research from neuroscience confirms a causal connection between activation through repetition of knowledge and linkage in long-term memory (cf. Brühne, Sauerborn 2011:58-59). Even though research in learning psychology from the field of the "cognitive theory of learning" recommends continuous repetition of learning content, "practice and repetition phases", especially in the form of the repetitive start of lessons, are rarely used in practice. The main reasons given for this are the tightly knit educational plans and the associated time pressure (cf. Brühne, Sauerborn 2011:59). In the psychology of learning, however, even 5 to 10 minutes of continuous repetition of learning content is considered sufficient for the long-term retention of knowledge. Therefore, the repetitive lesson introduction is particularly suitable due to its simple implementation in the lesson sequence (cf. Brühne, Sauerborn 2011:59). In addition, the repetitive lesson entry combines various features for the sustainable safeguarding of learning content. Characteristics are the structuring and reconstruction of learning content, feedback as learning status control and self-reflection for teachers and learners, problem solving as well as the individualisation of learning (cf. Brühne, Sauerborn 2011:59; Greving, Paradies 2011:19-22).

The extent to which the repetitive entry into lessons could have an influence on the learning success of pupils can be guessed at by looking at the meta-study "Visible Learning" by Hattie (2009). Regarding Cohen's d effect size, a comparison of the characteristics shows that, according to Hattie, especially the self-assessment of one's own level of performance (d= 1.44), feedback (d=0.73), solving of problems (d=0.61), the learning techniques (d=0.59), motivation (d=0.48) and questioning (d=0.46) have a beneficial effect on learning success. The effect of homework

(d=0.29) in contrast, Hattie attributes only a minor influence on learning success (cf. Lipowsky, Lotz 2015:103, 106). According to Lipowsky and Lotz (2015:104, 106), these characteristics are particularly important for the cognitive activation of students. Cognitive activation is one of the three basic dimensions for teaching quality and good teaching.

> "The cognitive activation of students is described by Lipowsky (2015) as the stimulation of "deeper reflection and elaborate engagement with the subject matter" (p. 89 f.). Here, then, it is required that "all learners are encouraged to actively engage with the subject matter at a level appropriate to them" (Leuders & Holzäpfel 2011, p. 213), whereby the term activity refers to the thinking and not the behaviour of the learners." (Lipowsky, Lotz 2015:106)

At this point of cognitive activation, the digital tools come into play. They offer teachers varied and new access to the students in combination with the repetitive lesson entry. Digital ARS allow students to test their learning level anonymously. Due to the playful and ungraded character, the "fear of failure" (cf. Bernshausen 2010:54) and the shame of speaking in front of the class may also be taken away, as well as active participation in the repetition of the learning content of the previous lesson. The performance and social pressure that arises from showing and answering in class is probably often perceived negatively by the pupils and could lead to refusal and fear (cf. Bäuerle, Kury 1980:71; Bernshausen 2010:54-56, 58). The students are freed from this pressure to perform by the anonymous evaluation possibilities in the digital tools. The teacher can receive realistic feedback on the performance of the entire class, as all students are actively involved and can thus reveal their understanding of the topic.

The following hypothesis can therefore be derived from the preceding presentation:

Hypothesis 1: *A repetitive teaching approach in combination with digital tools has a positive effect on the learning success of the students.*

The use of digital media by pupils in Germany has been intensively studied for about 20 years, especially through the JIM studies. In the studies, young people between 12 and 19 years of age from all over Germany are surveyed. Based on the studies of the last few years, it can be stated that the differences between the genders in media use are small and have decreased in recent years. The JIM-Study 2021 (cf. mpfs

2021:8) shows that there are hardly any noticeable differences in device ownership between girls and boys. In terms of daily or several times a week use of the available media, girls and boys differ only minimally (96% to 94%[2]). A clear advantage of boys only exists in gaming (59% to 84%) (cf. mpfs 2021:15), which already stood out in the 2010 JIM study (cf. mpfs 2010:8). A recent study by Forsa on behalf of the DAK- Gesundheit (2020:6) also showed that the daily use of social media is at a high level (205 minutes to 182 minutes) for both girls and boys (same age group as JIM study). This means that young people, regardless of gender, are now very familiar with digital offerings.

The JIM Study 2021 also examined online learning in the context of the corona pandemic. In this study, 35% of girls and 34% of boys said that online learning worked very well to well, 50% of girls and 44% of boys rated it on average, while 11% of girls and 18% of boys rated online learning as poor to very poor (cf. mpfs 2021:18). Lampert and Thiel (2021:20, 21) provide diverse background and explanations for this finding in their study on 'Media use and school at the time of the first lockdown during the 2020 Covid 19 pandemic'. Boys were more likely to report being nervous (29% to 32%) and to feel anxious about their learning success in online classes (27% to 32%). Furthermore, they rated their motivation in online teaching lower (52 % to 44 %) and also rated their own performance less well than girls (50 % to 48 %). Finally, boys also asked the teacher questions or sought help more often than girls.
From these data, it is clear that there are only small but crucial differences between girls and boys specifically in online teaching. This suggests that the effects of repetitive teaching using digital tools are similar and that differences between girls and boys are measurable. For this reason, the second hypothesis can be derived as follows:

Hypothesis 2: The *successful use of digital tools at the beginning of a lesson depends on the gender of the students. Girls take up the offer better than boys and therefore achieve greater learning success.*

[2] For all percentages in this chapter, the data of the female respondents follow first, then the data of the male respondents.

3 Research design

The hypotheses that have been put forward will be tested through an empirical study with quantitative data collection. The aim is to transfer the assumptions derived from theory into practice at the vocational college and the business lessons there. For this research, data collection takes place at four vocational colleges in the Aachen city region. For this purpose, the effects of a repetitive introduction to lessons using digital tools on the learning success of students in business lessons at vocational colleges as well as the effect of gender[3] on this will be examined. The sample consists of students from a DQR- level four course[4] . For each vocational college, two classes of the same educational level and year are considered. One of the classes in the sample acts as the experimental group and one as the control group. The classes are selected so that they are as homogeneous as possible in terms of learning level, age structure and gender distribution.

The repetitive lesson introduction with digital tools takes place in the classes of the experimental group, whereas a conventional repetitive introduction is used in the classes of the control group. In the experimental and control group, a comparison takes place per vocational college in the same learning situation (teaching sequence) to the extent of six teaching hours in the form of three double lessons. The digital repetitive lesson introduction for the experimental group consists of about five concise questions on the topic of the last lesson, each lasting between 5 and 10 minutes. These are asked in the form of a short digital question or quiz. Closed questions are used as the question type; semi-open and open questions are not asked for better comparability of the results. The learning and feedback platform *Kahoot!* is used in all classes for the implementation of the digital repetitive lesson introduction. *Kahoot!* was chosen as an example for ARS because it is known by the students. They do not have to register, it is free of charge and does not require any downloads (cf. Goshevski, Veljanoska, Hetziapostolou 2017:4). The questions are varied in order to achieve a high degree of student activation. The automatic evaluation functions of *Kahoot!,* which can be used especially well with closed questions, can also reveal

[3] The survey of gender is based on the Doing Gender approach of West and Zimmerman (1987:131-135), where a categorisation into sex, sex categories and gender takes place. In the study, gender is determined on the basis of the category sex (biological sex), which is why it is limited to the sexes male and female. This is also done against the background of comparability with other studies.

[4] DQR stands for German Qualifications Framework. An overview can be found at the Federal Ministry of Education and Research (2023).

difficulties in understanding on the part of the students. These are directly addressed during the implementation in order to actively prevent major comprehension problems from arising or remaining. The focus here is explicitly on constructive feedback, which should point out learning difficulties to the students and support them in self-reflection.

In order to test the hypotheses, the same learning assessment will be carried out at the end of the teaching series in the experimental and control groups of the respective vocational college. In the quantitative data collection, the gender of the students is recorded in addition to the percentage results achieved in the learning assessment and the form of the repeated lesson entry. The recording of the percentage result enables comparability among each other.

4 Results

4.1 Evaluation procedure

To test the hypotheses, the collected data is subjected to an inductive data analysis using statistical methods. Inductive statistics allows the results found for the sample to be assumed for the population as well. In this respect, the collected data are subjected to a one-sided significance test in order to verify the hypotheses that have been formulated. Here, the procedure is based on that of Schnell, Hill and Esser (2018:403-432) and Rasch et al. (2021). The analysis and processing of the data is carried out with the statistics program SPSS in version 29. Furthermore, a significance level of $\alpha=0.05$ was used for the study.

The variables are results of learning level control (dependent variable), lesson entry (independent variable) and gender (independent variable). The entry level has the characteristics experimental and control group (coding: experimental group=1, control group=2). Gender is divided into male and female (coding: male=1, female=2).

For the analysis of the data, they are first visualised in a marginal count and then subjected to a subgroup analysis. For this purpose, an exploratory data analysis is carried out in SPSS and the data is compared with each other with regard to the frequency distribution, outliers and other elements of descriptive statistics.

Furthermore, the samples are checked for their normal distribution during the explorative data analysis. This is done using visualised histograms and the Shapiro-Wilk test. The Shapiro-Wilk test is chosen here because, in contrast to the Kolmogorov-Smirnov test, which only indicates the lower limit for a true normal distribution, it has a statistically more precise significance with regard to normal distribution. Subsequently, the data are subjected to a significance test to verify the hypotheses.

In order to test the first hypothesis, the variables results learning level control in dependence on the start of teaching are examined for significance by means of an independent two-sample t-test. The parametric test procedures, such as the t-test, require normally distributed data and variance homogeneity. The variance homogeneity is checked with the Levene test; if this is not present, the Welch test is used as an alternative to the t-test. However, the certification of a significant result does not provide any conclusion about the significance, existence or strength of the effect (cf. Schnell, Hill, Esser 2018:413-414). In order to be able to make a statement about the effect size, Cohen's d is analysed. The effect size is classified as $d=0.2$ as a small effect, $d=0.5$ as a medium effect and $d=0.8$ as a strong effect (cf. Rasch et al. 2021:54).

The second hypothesis examines the variables results learning level control in dependence on gender and lesson entry. For this purpose, two independent two-sample t-tests are conducted. The t-test procedure is equivalent to the first hypothesis. The effect size of the start of the lesson on the results of the learning assessment of male subjects and the effect size of the start of the lesson on the results of the learning assessment of female subjects are examined. The effect sizes are then compared with each other if they are significant. Finally, a two-factor analysis of variance (ANOVA, 2x2 design) is used to check whether there are interaction effects between the two independent variables (Eid, Gollwitzer, Schmitt 2017:432-440). Significance is demonstrated by means of ANOVA for values $p< \alpha=0.05$ values.

Finally, the results of the first and second hypothesis are subjected to a post-hoc test strength analysis with regard to possible limitations of statistical significance.

4.2 Results for hypothesis 1

The data basis for the first hypothesis consists of a sample N=114 divided into the experimental group n=58 and the control group n=56. No cases are excluded. A descriptive evaluation of the data as well as the observation of the box plots allow a visualisation of the data distribution and the results in the learning level control.

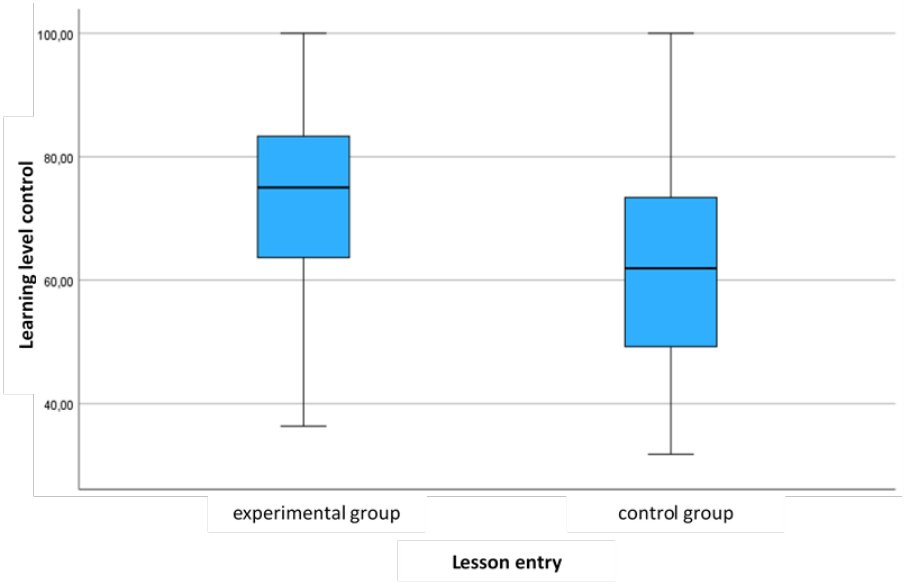

Figure 1: Box plot results of learning level control in the experimental and control group
Source: Own

The descriptive evaluation shows that the experimental group, which has undergone a repetitive introduction to teaching with *Kahoot!,* performs better than the control group, especially when looking at the interquartile range and median. Due to the smaller interquartile range in the experimental group, there is also greater homogeneity in the distribution of results compared to the control group. There are no outliers in the experimental and control groups.

The normal distribution of the experimental and control groups is tested by the Shapiro-Wilk test. Basically, in the case of significance, it can be $p > \alpha = 0.05$ it can be assumed that the null hypothesis for the normal distribution can be confirmed and the alternative hypothesis rejected. In the case of a value $p < \alpha = 0.05$ the alternative hypothesis for the normal distribution is confirmed and the null hypothesis rejected. In the Shapiro-Wilk test, the experimental group has a significance value of $p = 0.128 > \alpha = 0.05$ and the control group a value of $p = 0.477 > \alpha = 0.05$ for the control group. Through these results, the null hypothesis can be considered confirmed, resulting in a normal distribution according to the Shapiro-Wilk test.

In order to carry out the independent two-sample t-test, variance homogeneity is checked in advance. This is the case if the null hypothesis can be confirmed. $p > \alpha = 0.05$ can be confirmed. The alternative hypothesis is present if $p < \alpha = 0.05$. Variance homogeneity is then not present. This can be checked with the Levene test. Since this value has a magnitude of $p = 0.814 > \alpha = 0.05$ the null hypothesis can be confirmed. Variance homogeneity is therefore present and the t-test can be used.

Table 1: Independent two-sample t-test for hypothesis 1

		Levene-test of the equality of variance		t-Test for the equality of means							
						Significance				95% confidence interval of the difference	
		F	Sig.	T	df	one-sided P	Two-sided p	Mean difference	Differences for standard errors	Lower value	Upper value
Learning level control	variances are equal	.055	.814	3.471	112	<.001	<.001	10.49344	3.02300	4.50375	16.48313
	variances are not equal			3.469	111.442	<.001	<.001	10.49344	3.02490	4.49967	16.48721

For the evaluation of the two-sample t-test, the p-value of significance is necessary. Since there is a directed hypothesis and a positive effect can be expected from the theory, the one-sided p-value is used to test the hypothesis for significance. Since the one-sided significance $p < 0.001 < \alpha = 0.05$ the null hypothesis for hypothesis 1 can be rejected and thus hypothesis 1 can be accepted as an alternative hypothesis. Thus, a statistical significance of more than 95% is demonstrated for the two means compared. Consequently, the students in the experimental group achieved a

significantly better result than the students in the control group due to the repetitive introduction to teaching with digital tools.

For the significance of the observed significance for hypothesis 1, a consideration of the effect size is indispensable. According to Cohen's d, hypothesis 1 with a significance of $p<0.001<\alpha=0.05$ an effect size of $d=0.650$. According to Hattie, this results in a positive effect of medium strength on the learning success of students through digital tools. Furthermore, the statistical significance in the form of the test strength of the sample is relevant. With a test strength of 0.964 *and a sample size of* $\alpha=0.05$ with a sample size of $n=58$ for the experimental group and $n=56$ for the control group, it has sufficient statistical significance to be able to apply it to the population. In sum, our results support Hypothesis 1.

4.3 Results for hypothesis 2

To examine the second hypothesis, the data of the experimental and control groups of both genders are compared with each other. The experimental groups consisted of 29 students each in both the female and male groups. The male control group consisted of 32 participants, the female control group of 24 participants. Exclusions or errors do not have to be taken into account at any point.

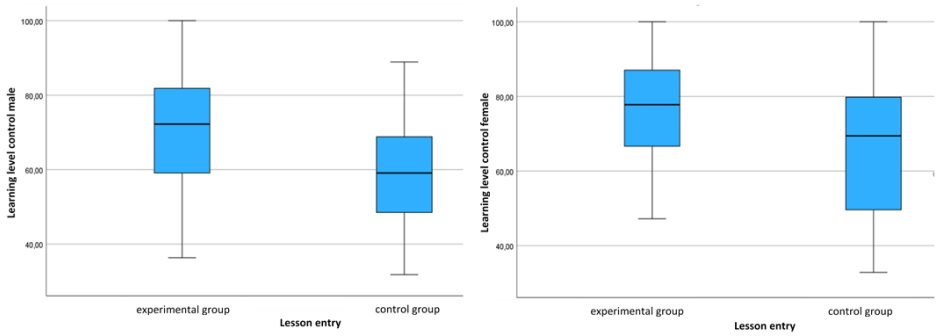

Figure 2: Box plot results learning level control by gender in the experimental and control group

Source: Own

When looking at the boxplots, it is noticeable that the medians of the results of the learning level checks of the female control and experimental groups are higher than those of the male groups. Furthermore, it can be seen that the interquartile range of the female control group is significantly larger compared to the male group. This indicates a more heterogeneous distribution of learning levels within the female control group. The interquartile range for the female experimental group is significantly smaller compared to the control group, which could indicate a homogenisation of learning levels. If, on the other hand, the boxplots of the male experimental and control groups are compared, it is noticeable that the position of the box for the control group shifts upwards, but both boxes show very similar ratios.

In the following, the data are analysed using inductive statistics. In order to apply the t-test, it must first be checked to what extent the data are normally distributed. In principle, the normal distribution of the sample is equal to the normal distribution of the overall distribution. The test according to Shapiro and Wilk is intended to prove the normal distribution of the samples. Its results show normal distribution for the experimental and control groups. As described above, $p > \alpha=0.05$ for the null hypothesis and $p < \alpha=0.05$ for the alternative hypothesis. In the present test, the results of the experimental groups of male participants are at $p=0.557>\alpha=0.05$ and those of the female participants at $p=0.350>=0.05$. The control groups, in turn, show a value of $p=0.950> \alpha=0.05$ and for the female participants a value of $p=0.545> \alpha=0.05$ for the female subjects. With these results, the null hypothesis can be considered confirmed, which means that a normal distribution exists according to the Shapiro-Wilk test.

An additional prerequisite for conducting the t-test is variance homogeneity. This is present if the null hypothesis can be $p > \alpha=0.05$ can be confirmed. As already mentioned above, if this is not the case, the Welch ($p<\alpha=0.05$) the Welch test would be used as an alternative. As explained above, the Levene test is used for testing. For the male experimental and control groups, this is $p=0.182> \alpha=0.05$ and for the female groups $p=0.131> \alpha=0.05$. Thus, the null hypothesis is confirmed and variance homogeneity is given. The t-test can be applied.

Table 2: Independent two-sample t-test for hypothesis 2 (male)

		Levene-test of the equality of variance		t-Test for the equality of means							
						Significance				95% confidence interval of the difference	
		F	Sig.	T	df	one-sided P	Two-sided p	Mean difference	Differences for standard errors	Lower value	Upper value
Learning level control (male)	variances are equal	1.826	.182	2.629	59	.005	.011	10.34139	3.93373	2.47001	18.21277
	variances are not equal			2.602	54.055	.006	.012	10.34139	3.97419	2.37380	18.30898

Table 3: Independent two-sample t-test for hypothesis 2 (female)

		Levene-test of the equality of variance		t-Test for the equality of means							
						Significance				95% confidence interval of the difference	
		F	Sig.	T	df	one-sided P	Two-sided p	Mean difference	Differences for standard errors	Lower value	Upper value
Learning level control (female)	variances are equal	2.356	.131	2.106	51	.020	.040	9.57658	4.54748	.44714	18.70603
	variances are not equal			2.050	42.008	.023	.047	9.57658	4.67060	.15098	19.00218

After the prerequisites for applying a t-test have been confirmed, the results of the male and female experimental groups are compared with the control groups. Since there is a directed hypothesis and a positive effect is assumed, the one-sided p-value is used to test the significance of the hypothesis. With equal variances, the one-sided significances are as follows in the case of the pupils $p=0.005< \alpha=0.05$ and in the case of the female students $p=0.02<\alpha=0.05$. It can be deduced from this that hypothesis 1 is not only true for both genders together, but also for the isolated consideration of female and male pupils and that one group does not equalise or reverse the result of the other.

Finally, the decisive test of hypothesis 2 is carried out by comparing the effect sizes using Cohen's d. The assumption that girls generate greater learning gains than boys through repetitive lesson introductions with *Kahoot!* Should be reflected in a higher d. However, for hypothesis 2, the male experimental group results in an d=0.674 and for the female group a d=0.581. Thus, both are in the range of a medium,

positive effect size (0.4<d<0.8), but the effect size is higher for the boys. Hypothesis 2 is therefore refuted, as boys benefit more than girls from the use of digital tools when starting lessons.

Finally, two checks were made to exclude errors regarding the refutation of hypothesis 2. Firstly, the test strength resulting from the sample size is relevant with regard to the statistical significance and effect strength of the sample. With the given sample sizes, the test strength for the pupils is d=0.674 and for the female students for d=0.581 respectively 0.830 and 0.667. The significance level in both cases is, as before, at α=0.05.

Table 4: Two-factor ANOVA

dependent variable: results of learning level control					
Source	type III: sum of squares	df	Mean of the squares	F	sig.
corrected model	4559.373[a]	3	1519.791	6.027	<.001
constant term	525967.424	1	525967.424	2085.734	<.001
lesson entry	2796.162	1	2796.162	11.088	.001
gender	1421.176	1	1421.176	5.636	.019
lesson entry gender	4.123	1	4.123	.016	.898
error	27739.113	110	252.174		
total	561280.259	114			
corrected total variation	32298.486	113			

R-square =.141 (corrected R-square =.118)

The check for evaluation errors using ANOVA revealed that there was a significant difference (independent of gender) between the results of the learning level check ($p<0.001<\alpha=0.05$), depending on the type of instructional introduction that was carried out in the classes in the instructional sequence. It thus confirms the results of hypothesis 1. The ANOVA also showed a significant result ($p=0.019<\alpha=0.05$) for gender (independent of the type of lesson introduction). It thus confirms that there is a gender difference in the results of the learning level control (hypothesis 2). However, there are no significant interaction effects of gender and type of lesson entry ($p=0.898>\alpha=0.05$). Both final checks do not speak against the interpretation of the data. The test strength is discussed in more detail in the limitation in chapter

5. Thus, hypothesis 2 is considered refuted, the data suggesting instead the opposite of the original assumption.

5 Conclusion, limitations and need for research

In summary, two central findings can be noted on the basis of this analysis. Firstly, the data analysis showed that the use of digital tools in the repetitive introduction to lessons has a positive effect on the learning success of students in business lessons at vocational colleges. The use of digital, repetitive entry into lessons was shown to have an effect strength in the medium range (d=0.650) was demonstrated. There are demonstrable gender differences. Contrary to the hypothesis, pupils (d=0.674) benefit more than female pupils (d=0.581). Possible reasons for this positive effect could be the variety and the playful element of the quizzes. It also plays a major role that all students have to repeatedly deal with the lesson material of the previous lesson. With the classic repetitive lesson introduction, on the other hand, it can easily happen that only high-performing students participate and thus the weaker students in particular are already left behind at the beginning of a lesson. These assumptions are based on the literature mentioned in chapter 1 and the teachers' subjective impressions. However, a survey among the students of the control group was not conducted.

On the other hand, the data analysis showed that - contrary to the hypothesis stated at the beginning - pupils can increase their learning success more than female pupils if the teacher uses digital lesson introductions. In the sample considered, the slightly higher effect size for pupils could even lead to a homogeneity of performance between the sexes in the long term, since the female pupils also achieved better learning successes than the male pupils within the control group, which can also be assumed for the population (cf. Voyer, Voyer 2014:1189). However, both effect sizes lie in the middle range (female d=0.581; male d=0.674), so that no preferential treatment of the pupils is to be expected, especially if one takes into account the short period of time spent in educational programmes at the vocational college. The descriptive data analysis also suggests an improvement in the homogeneity of learning outcomes through the use of digital tools. Here it is noticeable that for the samples from hypothesis 1, the interquartile range of the control group is significantly greater than for the experimental group. However, a generalisation to the population was not tested for this effect in this study using inductive methods.

This could therefore be an approach for further hypotheses to be tested in potentially subsequent studies. In combination, these findings suggest that the learning success of a class can not only be increased through the use of digital tools, but that performance differences can also be reduced.

This study is subject to some limitations. For example, due to the short time span considered, no statements can be made about the long-term effect of the use of digital, repetitive lesson starters. It is not possible to predict from the data collected what the effect size will be when a class is confronted with digital entrances in several consecutive teaching sequences. In this context, a further study could examine whether the effect of variety is a one-off effect and whether the inclusion of all students in the repetition of lesson content using digital tools shows long-term learning success. Whether random influences had an impact on the better learning success of the experimental groups cannot be completely ruled out. However, since the lessons were conducted with the same materials and methods except for the introduction, it can be assumed that random influences had only minimal effects. Furthermore, the experimental groups worked exclusively with *Kahoot!* so that the experiment could be repeated with other ARS to confirm the study results. Another limitation is the influence of the teacher, which would be difficult to measure but could also have a significant impact on learning outcomes. At the same time, teachers are forced to further develop their digital competence and can thus also benefit from the use of digital tools to start teaching (cf. Wohlfart, Trumler, Wagner 2021:7360). There is also a limitation to the validity of hypothesis 2 with regard to sample sizes. Due to the smaller sample sizes, the strengths of the tests are 0.830 for men and 0.667 for women. A larger number of participants could thus significantly increase the test strength of the experiment and is therefore recommended.

However, since hypothesis 1 has a test strength of 0.964 with the present sample size, it can be concluded that repetitive digital lesson starters offer added value for teaching in the form of measurably increased learning success. In addition, they bring variety into the lesson introduction and can be easily integrated into the lesson.

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