EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

Analysis of The Influence Of Digital Quiz Formats On The Learning Success Of Learners In Vocational Education And Training Using The Example Of The Subjects Economics And Accounting

doi: 10.52987/edc.2025.001

Christoph Maus
RWTH Aachen University, Didactics of Economics
Templergraben 64, 52062 Aachen
maus@wiwi.rwth-aachen.de

Björn Paape
RWTH Aachen University, Didactics of Economics
Templergraben 64, 52062 Aachen
paape@wiwi.rwth-aachen.de

Iwona Kiereta
RWTH Aachen University, Didactics of Economics
Templergraben 64, 52062 Aachen
kiereta@wiwi.rwth-aachen.de

ABSTRACT

In the context of vocational schools, a key didactic challenge is preparing learners for a digitalized professional world through media and digital education. This includes integrating new teaching approaches. Accordingly, this practical school research project investigates the relevance of the digital quiz platform "Kahoot!" in the learning process. The individualized, stimulus-rich, and interactive nature of such quizzes holds significant didactic potential and offers valuable feedback functions. The study focuses on the positive effects of Kahoot! on learning outcomes, with a differentiated analysis across various commercial subjects. Performance tests were conducted across different groups of learners at the end of a series of lessons to statistically measure the impact of the digital quiz. Results indicate that Kahoot! generally had a positive effect on learner performance, showing statistically significant differences. Moreover, learners in business studies with accounting tended to benefit more from Kahoot! than those in economics, though no statistically significant differences were found between these subjects.

KEYWORDS: digital quiz, learning success, vocational education, didactics of economics, Kahoot

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

1 INTRODUCTION

In the context of vocational schools, digital education is emerging as a particular didactic challenge. In line with the didactic principles of action orientation and practical relevance, it should be emphasized that vocational schools are particularly affected by the technological and economic changes of digitalization due to their proximity to the world of work. The increasing demands of the world of work are also reflected in practical teaching [1].
The interaction between teachers and learners as a typification of teaching, in which the learning activities of the learners are stimulated and supported by specific teaching activities, provides the didactic conclusion that digital media can function as learning material and at the same time as a learning tool in addition to traditional forms of teaching [2]. This results in formal and content-related restructuring of learning processes that promote both independence and the development of individual potential [1].
In general, study results on the use of media in connection with laptop or tablet projects show that the use of digital media strengthens interdisciplinary skills. These interdisciplinary competences include motivational effects, increased media skills, greater self-control and an improvement in cognitive complexity [2].
The potential of digital media in relation to the entire educational process arises in connection with sensory modalities and process structures. The combination of auditory, visual and haptic modalities in connection with the use of digital media enables learners to develop their full potential. In addition, the sequence structures enable a high degree of individualization and process-based learning progress. The type, number and difficulty of tasks in the digital space can be adapted to the level of performance and prior knowledge of the users [3]. This last feature in particular emphasizes the adaptability and feedback function of digital learning opportunities. The media are directly linked to the learning and performance requirements of the learners and can provide information about the learning progress for the learners themselves through direct feedback on the current level of knowledge [3]. Hattie [22] show that greater effectiveness can be achieved if there is a high level of control over the learning process by the learners, if peer relationships are activated and if feedback opportunities are created for the learners. It should also be noted that the effects increase when the learners' autonomy increases [2]. In order to meet the needs and lifeworld of learners, digital media are gradually being introduced into the classroom. "Digital natives" favour experiential learning over passive learning [4]. The game-based learning approach pursues the goal of activating learners by combining playful (learning) elements with knowledge acquisition. Digital quiz platforms such as Kahoot are a prime example of the increasing popularity of game-based learning.
The use of quizzes in teaching is a modern field of research that has been gaining more and more attention in empirical discourse in recent years due to the increasing digitalization of education. Most literature focuses on the effects of quizzes on learning success, classroom dynamics and the attitudes and perceptions of learners and teachers. The majority of empirical research can be assigned to the university context. In their studies, Nevid/Mahoon [5], Osman [6], Bawa [7] and Brink [8] demonstrate a positive effect on students' learning success through the use of quizzes in a university setting. In a school context, Gholami/Moghaddam [9] and Haigh [10] have shown a positive correlation between analog quiz formats and learning performance in their experiments. Current studies are investigating the effects of the increasingly popular online quiz format Kahoot on the learning performance of students and learners at mainstream schools. Ares et al. [11], Bawa [7], Esteves et al. [12], Göksün/Gürsoy [13], Toth/Logo/Logo [14] and Tsihouridis/Vavougios/Ioannidis [15]

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

demonstrate an increase in performance among students/learners at mainstream schools in experimental groups in which Kahoot was used as a didactic tool. In addition, studies come to the conclusion that a quiz promotes the participation of students/learners at mainstream schools, increases their motivation and boosts the knowledge they can recall (cf. [16], [17], [18], [19]). Gamified multiple-choice tests have the potential to improve the quality of learning by better involving learners in learning activities, increasing engagement and satisfaction and thus increasing learning effectiveness [20]. Regularly conducted quizzes can lead to better and more intensive preparation on the part of students/learners at mainstream schools [21], [8]. Digital quizzes have an immediate feedback function for the participants [8], can promote retention if repeated regularly [9] and lead to greater engagement on the part of the participants [7].

The study-based findings on laptop and tablet classes and the meta-studies by Hattie [22] as well as the wide-ranging international research on quiz formats outline the current state of research and the expected effectiveness for learning success. However, there is a research gap in terms of transferability to the target group-specific structure at vocational schools. International comparative studies such as the ICIL study [23] on the topic of digital media in the classroom are aimed at learners at lower secondary level of general education schools and often only emphasize the media skills to be acquired, but not the possibilities of a learning success-promoting component of the use of digital media [25].

Furthermore, the majority of studies carried out on quiz formats took place in a university setting, in which the effect of the quiz on students' learning performance was researched. These results are a good indicator of the effectiveness of a quiz in the school context, but cannot be explicitly transferred and must be examined in the corresponding context of vocational schools. A high degree of self-regulation and independence as well as the willingness to prepare for the respective content on their own responsibility are expected of students and are the prerequisite for the successful implementation of the quiz. The extent to which this knowledge can be transferred to learners at mainstream schools has not yet been researched in the context of quiz implementation. The effect of game-based learning on the learning success of students at vocational colleges is a research gap, as is the suitability of commercial subjects such as business studies and economics for a quiz.

Generation of Hypothesis

As already shown in the above-mentioned Hattie study [22], the use of media in lessons is particularly effective when learners are given the opportunity to receive feedback and peer relationships are activated. The quiz serves various feedback levels of the Hattie model [26]. On the one hand, it fulfills the function of providing immediate feedback on the task, in this case the quiz question, by declaring the answer as correct or incorrect. However, it is not only the correctness of the task solution that is reflected to the learner in the context of a quiz, but also the learner's own positioning in the learning process in the sense of self-regulation and self-assessment. This enables learners to draw conclusions about their learning needs, i.e. which content has been well internalized and which needs to be further deepened [26]. In addition to the emphasized feedback opportunities in knowledge building for learners, the quiz also offers didactic assistance for teachers in planning the teaching-learning process. Furthermore, Herzig [2] states that media with a short time intensity and a direct stimulus prove to be particularly effective for learning success. This requirement can be considered a given due to the time-limited use in class.

A quiz can also fulfil the function of securing knowledge by consolidating acquired knowledge through repetition and practice as a kind of "drill & practice" program [27]. As

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

part of the "drill & practice" principle, the learner receives the corresponding solution immediately after answering the question. It has been shown that learning games, which include quizzes, promote learning success significantly better than regular learning opportunities [28].
In a repetitive lesson introduction that picks up on the topics of the previous lesson unit, the quiz offers a promising approach as a reproductive element. This can also be deduced from the study by Haigh [10].
Previous studies have shown a positive correlation between the use of Kahoot as a tool in the teaching/learning context and an increase in the learning success of participating learners (cf. [11], [7], [12], [13], [14], [15]. In the studies listed, improved learner performance was diagnosed as a result of taking the Kahoot quiz format. In addition, other positive effects on learning success such as improved class dynamics [29], increased motivation [30], [31], participation and engagement [32], [33], [34] as well as increased attention [34] through the use of kahoots in the didactic setting.
Wang/Tahir [35] apply Malone's [36] findings regarding intrinsic motivation to the characteristics of kahoots. Kahoot combines the three elements of challenge, fantasy and curiosity. The fantasy character is generated by the temporary transformation of the classroom into a quiz show. The challenge effect is created by the uncertain outcome of the quiz and the variable level of difficulty. Curiosity is created by animated graphics, the audio setting and the general graphic design of Kahoot. In addition, the anonymity of the participants prevents a stressful situation and the fear of losing [35].
Based on the aforementioned features that are achieved through the use of a quiz and on the findings of the studies already conducted, it can be anticipated that a digital quiz has a positive effect on the learning success of learners at vocational schools. On this basis, the following unidirectional hypothesis should be tested.

Hypothesis 1:
Learners in the area of commercial education for whom a kahoot was carried out at the beginning of a lesson within a series of lessons will perform better in learning assessments than learners for whom this was not the case.

Furthermore, in connection with the use of quiz formats in lessons, a distinction can and should be made between the effects on different subjects. The two commercial subjects on which the study is based, "business administration with accounting" and "economics", show fundamental differences due to the objectives formulated in the curriculum. The subject "Economics" builds on the findings and procedures of business administration and also requires learners to reflect critically [37]. Based on Bloom's six-level taxonomy of learning objectives, the operators taken up in the objectives of the fields of action and tasks can be considered in a differentiated manner [38]. The subject "Business Administration with Accounting" has a fundamentally different pattern of requirements, as on the one hand mathematical operators such as document-oriented recording, carrying out bookings, determining and on the other hand operators such as describing, creating, presenting are often used. The latter operators indicate a requirement level in levels 1-3 of Bloom's taxonomy and primarily relate to the understanding and application of knowledge [39]. In contrast, the subject "Economics" often mentions operators such as analyze, evaluate, compare, critically analyze, which are located in the higher levels 4-6 according to Bloom's taxonomy [37]. These requirements in the areas of analysis, synthesis and evaluation correspond to a reflective, controversial and productive development of individual skills in the subject

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

"Economics". In comparison to "Business Administration with Accounting", the mathematical and reproductive operators take a back seat. In addition, the competencies of knowledge and skills are primarily addressed in various fields of activity in the subject "Business Administration with Accounting" and the competencies of independence and social competence are less affected [39]. In summary, it can be deduced from this that an imaginary division into reproductive and productive skills development can be made between the two subjects.
In the context of the operators, the concept of a quiz format to ensure learning progress can be classified as a task primarily in the lower taxonomy levels 1-3, as the assurance of learning progress or feedback on the learning process primarily addresses the area of knowledge acquisition and understanding. Furthermore, the quiz is limited in terms of open and discursive answer options and only allows for "right-or-wrong" tendencies. In this sense, it can be assumed that a quiz achieves greater learning success in subjects with reproducing and mathematical structures than in subjects with a high critical reflection and action orientation.

Hypothesis 2:
The use of digital quiz formats to ensure learning progress achieves greater success among learners in the subject "Business Administration with Accounting" than in the subject "Economics".

2 RESULTS

2.1 Results for Hypothesis 1

The entire sample (n=243) is to be tested for homogeneity of variance using a type of pre-test based on the learners' previous exam results in percent in order to ensure the validity of a t-test in advance. The two-sample F-test is generally based on the null hypothesis that there is no difference in variance between the samples under consideration. If the test variable F exceeds the critical F value in a one-sided test, the null hypothesis must be rejected [40].

Table 1: Two-sample F-test to check the homogeneity of variance in the pre-test

	Control groups	*Experimental groups*
Mean	61,904	64,3559
Variance	469,5875	428,7098
Degrees of freedem (df)	124	117
Test statistic (F)	1,0954	
P(F<=f) one-sided	0,3098	
Critical F value for one-sided test	1,3522	

However, the aforementioned null hypothesis for the two-sample F-test cannot be rejected on the basis of the data shown in Table 1, as F=1.0954 < Fcrit.=1.3522. Thus, there is no difference in the variances in the samples considered and variance homogeneity can be assumed in the pre-test.
The situation is similar for the variance comparison for hypothesis 1, in which the results of the entire experimental group with Kahoot are to be compared with those of the entire control group without Kahoot.

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

Table 2: Two-sample F-test to test the homogeneity of variance for hypothesis 1

	Total experimental group with kahoot	*Total experimental group without kahoot*
Mean	66,3475	59,6640
Variance	616,8611	607,4023
Degrees of freedom (df)	117	124
Test statistic (F)	1,0156	
P(F<=f) ine-sided	0,4656	
Critical F value for one-sided test	1,3502	

As can be seen in Table 2, the selected samples based on the results of the learning status survey at the end of the study period fulfill the required criterion of variance homogeneity, since F=1.0156 < Fcrit.=1.3502.

It is now necessary to analyze the learner results from the learning status survey in a mean value comparison with regard to hypothesis 1 as part of a two-sample t-test. The aim is to reject the null hypothesis, according to which there is no difference between learners with Kahoot and without Kahoot. Taking variance homogeneity and a given normal distribution into account, a two-sample t-test can be carried out assuming equal variances. Since the formulation of hypothesis 1 assumes a directional increase in learning success, the results of the t-test are only considered with regard to one-sided effects.

Table 3: Two-sample t-test assuming equal variances to test hypothesis 1

	Total experimental group with kahoot	*Total experimental group without kahoot*
Mean	66,3475	59,6640
Variance	616,8611	607,4023
Hypothetical difference in mean values	0	
Degrees of freedom (df)	241	
t-statistics	2,1048	
P(T<=t) one-sided	0,0182	
Critical t-value for one-sided t-test	1,6512	

When evaluating the two-sample t-test, it is essential to consider the p-value. The specified significance level $\alpha=0.05$ is the decisive point of reference here. If there is a p-value of less than 0.05, there is a statistically significant effect, as this indicates statistical significance with a confidence level of more than 95% for the compared mean values [41]. The assumption of $p < 0.05$ means that the null hypothesis, according to which there are no differences, can be rejected. Table 3 shows that the null hypothesis for hypothesis 1 can be rejected and hypothesis 1 can be accepted, as $p=0.0182 < \alpha=0.05$. As a result, the learners in the experimental group who completed a kahoot at the start of the lesson performed significantly better in the learning status survey than the learners without a kahoot.

2.2 Results for Hypothesis 2

To test the second hypothesis that the positive effect of Kahoots for learners is stronger in business administration with accounting than in economics, four two-sample t-tests will be

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

set up below. Only the learning groups of the commercial vocational colleges form the data basis.

Table 4: Two-sample F-test to test the homogeneity of variance between the results of the control groups and experimental groups at commercial vocational colleges

	Total experimental group without kahoot	*Total experimental group with kahoot*
Mean	60,7647	68,6311
Variance	604,6768	584,8429
Degrees of freedom (df)	101	102
Test statistic (F)	1,0339	
P(F<=f) one-sided	0,4333	
Critical F-value for one-sided test	1,3881	

Analogous to the testing of hypothesis 1, the experimental and control groups must first be compared in Table 4, but at this point adjusted for the learning groups from the technical vocational college. Since F=1.0339 < Fcrit.=1.3881, variance homogeneity can be assumed for the samples, so that a two-sample t-test is possible assuming equal variances.

Table 5: Two-sample t-test assuming equal variances to test for significant differences between the experimental groups and control groups at commercial vocational colleges

	Total experimental group with kahoot	*Total experimental group without kahoot*
Mean	68,6311	60,7647
Variance	584,8429	604,6768
Hypothetical difference in mean values	0	
Degrees of freedom (df)	203	
t-statistics	2,3092	
P(T<=t) one-sided	0,0110	
Critical t-value for one-sided t-test	1,6524	

Similar to the results for hypothesis 1, Table 5 shows that learners in the experimental group achieved significantly better results than those in the control group, as $p=0.0110 < \alpha=0.05$. This further confirms that quizzes generally have a positive influence on learners' success in the learning assessment. A general comparison of the learners' results in the subjects of business studies and economics is also carried out.

Table 6: Two-sample F-test to check the homogeneity of variance between the results in business studies and economics

	Economics	*Business administration*
Mean	60,7216	68,3056
Variance	694,2655	507,5600
Degrees of freedom (df)	96	107
Test statistic (F)	1,3678	
P(F<=f) one-sided	0,0575	
Critical F-value for one-sided test	1,3866	

Since F=1.3678 < Fcrit.=1.3866 applies in Table 6, a two-sample t-test can be carried out under the assumption of equal variances.

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

Table 7: Two-sample t-test assuming equal variances to test for significant differences between the subjects of business administration and economics

	Business administration	*Economics*
Mean	68,3056	60,7216
Variance	507,5600	694,2655
Hypothetical difference in mean values	0	
Degrees of freedom (df)	203	
t-statistic	2,2210	
P(T<=t) one-sided	0,0137	
Critical t-value for one-sided t-test	1,6524	

Table 7 shows that $p=0.0137 < \alpha=0.05$ and thus a significant difference can be assumed between the subjects of business studies and economics. This initially means that the results of the learning status surveys were significantly better in business studies than in economics. In order to be able to explain and verify the statistically significant difference between the subjects in the learning level surveys and thus hypothesis 2 with the help of the assumption that learners achieve significantly better results with Kahoot, the control and experimental groups of the two subjects will be considered separately below.

Table 8: Two-sample F-test to test the homogeneity of variance between the control groups in business studies and economics

	Control groups economics	*Control groups business administration*
Mean	56,7347	64,4906
Variance	672,4490	524,2932
Degrees of freedom (df)	48	52
Test statistic (F)	1,2826	
P(F<=f) one-sided	0,1897	
Critical F-value for one-sided test	1,5960	

Since $F=1.2826 < Fcrit.=1.5960$ (Table 8), a two-sample t-test can again be carried out assuming equal variances for the control groups.

Table 9: Two-sample t-test assuming equal variances to test for significant differences between the control groups of the two subjects business administration and economics

	Control groups business administration	*Control groups economics*
Mean	64,4906	56,7347
Variance	524,2932	672,4490
Hypothetical difference in mean values	0	
Degrees of freedom (df)	100	
t-statistic	1,6038	
P(T<=t) one-sided	0,0560	
Critical t-value for one-sided t-test	1,6602	

A statistically significant result of this t-test would mean that the control groups in business studies with accounting achieve significantly better results than the control groups in economics, even without kahoots. However, since $p=0.0560 > \alpha=0.05$, this assumption

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

cannot be confirmed with the help of Table 9, so that the learners in business studies do not show significantly better results. Despite the high difference in the mean values (mean=64.4906 and mean=56.7647), the assumption therefore remains that the above general statistical significance between the two subjects is due to the use of the kahoots. To finally accept hypothesis 2, the experimental groups of the two subjects should be compared.

Table 10: Two-sample F-test to test the homogeneity of variance between the experimental groups of the two subjects business administration and economics

	Experimental groups economics	*Experimental groups business administration*
Mean	64,7917	71,9818
Variance	697,8280	472,7960
Degrees of freedom (df)	47	54
Test statistic (F)	1,4760	
P(F<=f) one-sided	0,0836	
Critical F-value for one-sided test	1,5905	

As can be seen in Table 10 by F=1.4760 < Fcrit.=1.5905, a two-sample t-test can finally be carried out assuming equal variances for the experimental groups.

Table 11: Two-sample t-test assuming equal variances to test for significant differences between the experimental groups of the two subjects business administration and economics

	Experimental groups business administration	*Experimental groups economics*
Mean	71,9818	64,7917
Variance	472,7960	697,8280
Hypothetical difference in mean values	0	
Degrees of freedom (df)	101	
t-statistic	1,5147	
P(T<=t) one-sided	0,0665	
Critical t-value for one-sided t-test	1,6601	

Similar to the control groups, the experimental groups in the subject comparison differ significantly in the difference between the mean values (mean=71.9818 and mean=64.7917). However, even in this t-test shown in Table 11, the mean values do not differ statistically significantly from each other, as $p=0.0665 > \alpha=0.05$, so that the conclusion can be drawn that the experimental groups in business administration perform better, but not significantly better, than the experimental groups in economics. In the context of the four two-sample t-tests carried out, the null hypothesis H0 of hypothesis 2 can therefore not be rejected. Conversely, hypothesis 2 must therefore generally be rejected, as the statistically significant differences of the t-tests initially carried out in the subject comparison cannot ultimately be confirmed by statistical significance between the experimental groups.

3 DISCUSSION

The aim of the research project was to transfer the positive effects of quiz formats in the classroom derived from other studies to vocational schools using the example of Kahoot and

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

to examine possible subject-related differences. In general, based on the results of the inductive statistics for hypothesis 1, it can be concluded that the use of Kahoots as a reproducible element at the start of the lesson has a positive effect on the performance of learners in the learning success measurement. The experimental groups that completed a kahoot in three consecutive teaching units achieved significantly better results, thus supporting the assumptions formulated in Chapters 1 and 2. The study results of Ares et al. [11], Bawa [7], Esteves et al. [12], Göksün/Gürsoy [13], Toth/Logo/Logo [14] and Tsihouridis/Vavougios/Ioannidis [15], among others, can therefore also be transferred to the vocational school context. However, the second hypothesis that a quiz achieves higher learning success in subjects with reproducible and mathematical structures (business studies) than in subjects with a high critical reflection and action orientation (economics) could not be proven with statistically significant differences. Although the differences in the mean values of the experimental groups suggest such a tendency, they are not statistically significant. Rather, the high mean differences between the two subjects in Tables 7, 9 and 11 for hypothesis 2 allow the assumption that generally better results were achieved in business administration with accounting than in economics and that these differences cannot be explained solely by the use of the kahoots. Limitatively, it must therefore be noted that the learners in the samples always tend to achieve better results in business studies with accounting, regardless of the kahoots. This should possibly have been analyzed in a two-sample test as part of the pre-test on the basis of the previous exam results in order to anticipate and control such subject-related performance differences at an early stage. However, the rejection of hypothesis 2 on the basis of the data collected may also be due to possible uncontrollable confounding factors. The data collection in the form of the learning status survey took place in the temporal context of the Covid-19 pandemic, so that the influences of distance and alternating teaching at the vocational colleges on the learners' performance should not be underestimated. Furthermore, the differences between the two subjects, some of which are significant, may be attributable to the fields of activity, meaning that differences in performance in this measurement may be distorted by the requirements or levels of difficulty of the teaching topics. The same applies to the quality criterion of objectivity during implementation. Although the attempt to carry out the same teaching units by different teachers at different vocational colleges fulfills the requirement of objectivity, even the smallest communicative differences in teaching behavior could cause deviations at the learner level. It must therefore also be stated that uncontrollable distortions can arise from the teaching behavior and study design.

4 METHODOLOGY

In order to make the positive effects on learning success and retention performance outlined at the beginning of the studies measurable, the data collection planned for this empirical project takes the form of outcome diagnostics, as this can provide information about the learning success of the teaching unit [42].
The initial situation consists of five different vocational colleges. Four of these vocational colleges are commercial vocational colleges and one is a vocational college for technology. In the following, the inductive test procedure considers the population of all participating learners from the five vocational schools in the Aachen city region and the surrounding area. In order to be able to make a reliable representative statement and adequately compare the given statistical units, a deliberate sample selection is generated [43].

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

The measurement is carried out in six comparable classes of the two-year vocational college in the field of business and administration, which are taught in the subjects of business administration with accounting and economics in the same fields of activity. At the technical vocational college, two classes of the two-year vocational school in the subject area of technology are also considered in the subject of economics. The selection of the classes is based on the didactic analysis of the supervising teachers, as their experience and expertise provide them with the appropriate diagnostic skills to select classes of approximately equal performance. By including the learners' previous exam results as a percentage and in anonymized form, this approach of approximate homogeneity can be supported and offers an approach for the following variance comparisons. An attempt is made to carry out the same series of lessons in the control and experimental groups, which differ only in that quizzes on the content of the previous lesson are carried out at the beginning of the lesson in the experimental group, which is not done in the control group. This modification of the lesson takes place in three thematically consecutive teaching units. At the end of the teaching units, both learning groups (control/experimental group) are given an identical written learning assessment, which is thematically based on the Kahoots question items. The results in the form of the percentage of correct answers in the learning level survey allow conclusions to be drawn about the influence of the quiz on learning success when comparing the control and experimental groups.

Inductive statistics offers the possibility of drawing conclusions from the results of individual or several samples regarding the validity of the population. It is of particular interest to test the previously established hypotheses in the course of a hypothesis test. This is to be applied methodically in the form of t-tests in order to determine whether there is a statistically significant difference between two samples. The sample size in the present study design is n=243 for hypothesis 1 and n=205 for hypothesis 2. The application of various two-sample t-tests is shown below, as in the course of the previous hypothesis formulations, two samples are to be compared in terms of their mean values and considered with regard to significant differences [43].

The samples to be compared are to be regarded as independent samples in nature, as the values of two groups of learners are compared in each case. Since the t-test for independent samples requires variance homogeneity, the comparability of the two selected samples should firstly be ensured by the fact that all learning groups come from courses of study that aim to acquire a level 4-degree of the German Qualifications Framework [44]. In the course of this, an approximately equal variance can be assumed, which, however, should secondly be statistically tested and confirmed by a two-sample F-test. This variance test is initially carried out on the basis of previous exam results of the learning groups examined as a kind of pre-test. In order to be able to guarantee the criterion of variance homogeneity in the following t-tests as well, a test of variance homogeneity is carried out for each additional t-test in order to guarantee empirically meaningful data. The other conditions for carrying out a t-test for independent samples are normal distribution and interval scaling. Furthermore, a significance level of $\alpha=0.05$ is selected [43].

Central to the use of the t-test is the null hypothesis, according to which the differences in the mean values are due to chance and there are no real differences between the groups. The aim is to reject this null hypothesis and accept the alternative hypothesis [43]. With regard to the tests to be compared, the null hypothesis H0 for the first hypothesis states that there are no statistically significant differences between the learning groups that use a kahoot in class and those that do not use a kahoot in class. In contrast, the alternative hypothesis H1 corresponds to the previously established hypothesis 1 and expects a statistically significant difference. In

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

the following, the mean values of the learning groups (n=243) that carried out a quiz in the classroom for interim learning assurance (experimental group) and those that did not carry out a quiz (control group) are compared and interpreted using a t-test.
With regard to the second hypothesis at hand, the null hypothesis H0 can be formulated that there is no statistically significant difference in the influence of a quiz on the two contrasting commercial subjects "Business Administration with Accounting" and "Economics". Here, too, the alternative hypothesis H1 corresponds to hypothesis 2 set out in a previous chapter. In the following, the mean values of the learning groups (n=205) that used a quiz in class are compared in relation to the subjects taught, "business administration with accounting" and "economics", in a total of four t-tests.

5 CONCLUSION

Despite possible limitations, the significant results for hypothesis 1 allow the conclusion that the use of Kahoots as a supplement to the analog teaching process is definitely advisable, as the initial considerations on the findings of Herzig [2] already suggested. At this point, it should only be noted that the integration of Kahoots should be didactically well thought out and justified with regard to both teaching topics and teaching phases. There is a risk that the activating and learning-promoting effect could be undermined if repeated too frequently in successive teaching units, leading to the conclusion that the motivating and self-regulatory effect of Kahoot is primarily dependent on a short, temporal intensity, as already assumed in Chapter 1.
In order to further strengthen the results of the first hypothesis in particular, a future, renewed survey would be conceivable both in terms of reliability and to validate the statements about the target population [41]. Furthermore, the question arises as to which direction further research on digital quiz formats in the classroom can take. In the context of this research project, the Kahoot quiz format was a useful addition to the classroom activities, which was demonstrated by the better results in the learning success survey. Nevertheless, the follow-up question arises as to how these performance gains came about from the learners' perspective: Were they motivational effects due to the inclusion of a digital, game-based format or did the gains result from the repetitive lesson introduction in the form of a quiz? Now that this project has attempted to analyze the effect of Kahoots with regard to a possible subject reference, further conceivable approaches could be found in studies on the effect in different educational courses or in a comparison of the effect on low-performing or high-performing learners. Finally, the focus should be shifted from the learning status surveys at the end of the study period to the individual kahoots. It is possible that both motivational and learning success-specific effects would change if individual quizzes were linked to extrinsic stimuli (e.g. grade bonuses for the three best learners in the quiz) and the focus were thus on the quizzes in a competitive form and not on the learning success assessment.

FUNDING: This research received no external funding.

CONFLICT OF INTEREST: Authors declare no conflict of interest.

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

REFERENCES

[1] Kultusministerkonferenz (KMK) (2017): Bildung in der digitalen Welt. Strategie der Kultusministerkonferenz, online im Internet: https://www.kmk.org/fileadmin/Dateien/veroeffentlichungen_beschluesse/2016/2016_12_08-Bildung-in-der-digitalen-Welt.pdf, 07.12.2017.

[2] Herzig, B. (2014): Wie wirksam sind digitale Medien im Unterricht?, online im Internet: https://www.researchgate.net/profile/Bardo-Herzig-2/publication/269669941_Wie_wirksam_sind_digitale_Medien_im_Unterricht/links/549146110cf2d1800d87d673/Wie-wirksam-sind-digitale-Medien-im-Unterricht.pdf, Januar 2014.

[3] Herzig, B. (2017): Medien im Unterricht, in: Schweer, M. K. W. (Hrsg.): Lehrer-Schüler-Interaktion. Inhaltsfelder, Forschungsperspektiven und methodische Zugänge, 3. Aufl., Wiesbaden 2017, S. 503-522.

[4] Sarkar, N.; Ford, W.; Manzo, C. (2017): Engaging Digital Natives Through Social Learning, in: Journal of Systemics, Cybernetics and Informatics, Vol. 15, No. 2, pp. 1-4

[5] Nevid, J. S.; Mahon, K. (2009): Methods And Techniques. Mastery Quizzing as a Signaling Device to Cue Attention to Lecture Material, in Teaching of Psychology, Vol. 36, No. 1, S. 29-32.

[6] Osman, C-C. (2019): The Impact of Pre-Lecture Quizzes on Student's Performance in Blended Learning, in: Journal of Applied Computer Science & Mathematics, Issue 2/2019, Vol. 13, No. 28, S. 25-31.

[7] Bawa, P. (2018): Using Kahoot to Inspire, in: Journal of Educational Technology Systems, 0(0), S. 1-18.

[8] Brink, A. G. (2013): The Impact of Pre- and Post-Lecture Quizzes on Performance in Intermediate Accounting II, in: Issues in Accounting Education, Vol. 28, No. 3, S. 461-485.

[9] Gholami, V.; Moghaddam, M. M. (2013): The Effect of Weekly Quizzes on Student's Final Achievment Score, in: International Journal of Modern Education and Computer Science, 5(1), S. 36-41.

[10] Haigh, M. (2007): Sustaining learning through assessment: an evaluation of the value of a weekly class quiz, in: Assessment & Evaluation in Higher Education, Vol. 32, No. 4, August 2007, S. 457-474.

[11] Ares, A. M.; Bernal, J.; Nozal, M. J.; Sanchez, F. J.; Bernal, J. (2018): Results of the use of Kahoot! gamification tool in a course of Chemistry, in: 4th International Conference on Higher Education Advances (HEAd' 18), S. 1215-1222.

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

[12] Esteves, M.; Pereira, A.; Veiga, N.; Vasco, R.; Veiga, A. (2018): The Use of New Learning Technologies in Higher Education Classroom: A Case Study, in: International Journal of Engineering Pedagogy, Vol. 8, No. 2 (2018), S. 115-127.

[13] Göksün, D. O.; Gürsoy, G. (2019): Comparing success and engagement in gamified learning experiences via Kahoot and Quizizz, in: Computers & Education, 135 (2019), S. 15-29.

[14] Toth, A.; Logo, P.; Logo, E. (2019): The Effect of the Kahoot Quiz on the Student's Results in the Exam, in: Periodica Polytechnica Social and Management Sciences, 27(2), S. 173-179.

[15] Tsihouridis, C.; Vavougios, D.; Ioannidis, G. S. (2018): Assessing the Learning Process Playing with Kahoot - A study with Upper Secondary School Pupils Learning Electrical Circuits, in: 20th International Conference on Interactive Collaborative Learning (ICL2017), S. 1108-1118.

[16] Novo-Corti, I.; Varela-Cadamio, L.; Ramil-Diaz, M. (2013): E-learning and face to face mixed methodology: Evaluating effectiveness of e-learning and perceived satisfaction for a microeconomic course using the Moodle platform, in: Computers in Human Behavior, 29.2 (2013), S. 410-415.

[17] Tan, P. M.; Saucerman, J. J. (2018): Enhancing Learning and Engagement through Gamification of Student Response Systems, in: ASSE annual conference & exposition.

[18] Bawa, P. (2017): Hey, want to play? 'Kahooting' to win the learning game, in: The annual convention of the association for educational communications and technology, S. 57-66.

[19] Lee, C.-C.; Hao, Y.; Lee, K. S.; Sim, S. C.; Huang, C.-C. (2018): Investigation of the Effects of an Online Instant Response System on Students in a Middle School of a Rural Area, in: Computers in Human Behavior, 95, S. 217-223.

[20] Cheong, C.; Cheong, F.; Filippou, J.; (2013): Quick Quiz: A Gamified Approach for Enhancing Learning, in: PACIS 2013 Proceedings.

[21] Olson, R. T. (2005): Comparison of the Impact of Pre- and Post-Lecture Quizzes on Student Learning in an Engineering Economics Course, in: 2005 Annual Conference, S. 1-9.

[22] Hattie, J. A. C. (2009): Visible Learning. A synthesis of over 800 meta-analyses relating to achievement, New York 200

[23] Fraillon, J.; Ainley, J.; Schulz, W.; Friedman, T.; Duckworth, D. (2018): Preparing for Life in a Digital World. IEA International Computer and Information Literacy Study. DOI: 10.1007/978-3-030-38781-5.

[24] Medienpädagogischer Forschungsverbund Südwest (2022): KIM-Study

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

[25] Albrecht, S.; Revermann, C. (2016): Digitale Medien in der Bildung. Endbericht zum TA-Projekt, online im Internet: https://edocs.tib.eu/files/e01fn19/1676381937.pdf, Juni 2016.

[26] Hattie, J.; Timperley, H. (2007): The Power of Feedback, in: Review of Educational Research, Vol. 77, No. 1, online im Internet: http://www.jstor.org/stable/4624888, März 2007, S. 81-112.

[27] Hillmayr, D.; Reinhold, F.; Ziernwald, L.; Reiss, K. (2017): Digitale Medien im mathematisch-naturwissenschaftlichen Unterricht der Sekundarstufe. Einsatzmöglichkeiten, Umsetzung und Wirksamkeit, Münster 2017.

[28] Wouters, P.; van Nimwegen, C.; van Oostendorp, H; van der Spek, E. D. (2013): A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games, in: Journal of Educational Psychology 2013, Vol. 105, No. 2, S. 249-265.

[29] Fotaris, P.; Mastoras, T.; Leinfellner, R.; Rosunally, Y. (2016): Climbing Up the Leaderboard: An Empirical Study of Applying Gamification Techniques to a Computer Programming Class, in: The Electronic Journal of e-Learning, Vol. 14, Issue 2, S. 94-110.

[30] Wichadee, S.; Pattanapichet, F. (2018): Enhancement of performance and motivation through application of digital games in an English language class, in: Teaching English with Technology, 18(1), S. 77-92.

[31] Aleksic-Maslac, K.; Rasic, M.; Vranesic, P. (2018): Influence on gamification on student motivation in the educational process in courses of different fields, in: 2018 41st international convention on information and communication technology, electronics and microelectronics MIPRO), S. 859-863.

[32] Licorish, S. A.; Owen, H. E.; Daniel, B.; George, J. L. (2018): Students' perception of Kahoot!'s influence on teaching and learning, in: Research and Practice in Technology Enhanced Learning, 13 Jg., S. 1-23.

[33] Asa'd, R.; Gunn, C. (2018): Improving problem solving skills in introductory physics using Kahoot!, in: Physics Education, Vol. 53, No. 5, S. 1-4.

[34] Chaiyo, Y.; Nokham, R. (2017): The Effect of Kahoot, Quizizz and Google forms on the Student's Perception in the Classrooms Response System, in: 2017 International Conference on Digital Arts, Media and Technology (ICDAMT), S. 178-182.

[35] Wang, A. I.; Tahir, R. (2020): The effect of using Kahoot! for learning - A literature review, in: Computers & Education 149, S. 1-22.

[36] Malone, T. W. (1980): What makes things fun to learn? Heuristics for designing instructional computer games, in: The 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems, S. 162-169.

[37] Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (2018): Bildungsplan für die zweijährigen Bildungsgänge der Berufsfachschule, die berufliche

EDC Proceedings 2025 ISBN-978-86-87043-96-1 DOI: doi: 10.52987/edc.2025

Kenntnisse, Fähigkeiten und Fertigkeiten sowie den schulischen Teil der Fachhochschulreife vermitteln (Bildungsgänge der Anlage C APO-BK). Fachbereich: Wirtschaft und Verwaltung. Volkswirtschaftslehre, online im Internet: https://www.berufsbildung.nrw.de/cms/upload/_lehrplaene/c/wirtschaft_und_verwaltung/bfsc_wuv_vwl.pdf, 01.08.2018.

[38] Bloom, B. S. (1976): Taxonomie von Lernzielen im kognitiven Bereich, 5. Aufl., Weinheim/ Basel 1976.

[39] Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (2018): Bildungsplan für die zweijährigen Bildungsgänge der Berufsfachschule, die berufliche Kenntnisse, Fähigkeiten und Fertigkeiten sowie den schulischen Teil der Fachhochschulreife vermitteln (Bildungsgänge der Anlage C APO-BK). Fachbereich: Wirtschaft und Verwaltung. Betriebswirtschaftslehre mit Rechnungswesen, online im Internet: https://www.berufsbildung.nrw.de/cms/upload/_lehrplaene/c/wirtschaft_und_verwaltung/bfsc_wuv_bwl.pdf, 01.08.2018.

[40] Cramer, E.; Kamps, U. (2020): Grundlagen der Wahrscheinlichkeitsrechnung und Statistik. Eine Einführung für Studierende der Informatik, der Ingenieur- und Wirtschaftswissenschaften, 5. Aufl., Berlin 2020.

[41] Schnell, R.; Hill, P. B.; Esser, E. (2013): Methoden der empirischen Sozialforschung, 10. Aufl., München 2013.

[42] Wilhelm, O.; Kunina-Habenicht, O. (2015): Pädagogisch-psychologische Diagnostik, in: Wild, E.; Möller, J. (Hrsg.): Pädagogische Psychologie, 2. Aufl., Berlin/Heidelberg 2015, S. 305-328.

[43] Rasch, B; Friese, M.; Hofmann, W.; Naumann, E. (2014): Quantitative Methoden 1. Einführung in die Statistik für Psychologen und Sozialwissenschaftler, 4. Aufl., Berlin/Heidelberg 2014.

[44] Federal Ministry of Education and Research (2021): Liste der zugeordneten Qualifikationen. Deutscher Qualifikationsrahmen für lebenslanges Lernen, online im Internet: https://www.dqr.de/dqr/shareddocs/downloads/media/content/2021_dqr_liste_der_zugeordneten_qualifikationen_01082021.pdf;jsessionid=9D8EA436BCA513E649F1647E5A3DE2A1.live381?__blob=publicationFile&v=1, 01.08.2021.