SERIOUS GAMES IN VOCATIONAL WHITE-COLLAR LESSONS – A METHODOLOGICAL END IN ITSELF OR A COMPETENCY-PROMOTING LEARNING METHOD?

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Abstract It is indisputable that games are suitable for lessons, and in this context "serious games" have a special role. The goal of the current study is to establish whether serious games are efficient in the area of vocational white collar education, whereby the following research question is asked: To what degree do serious games lead to superior learning results in comparison to traditional group work? In order to answer this question, four groups were formed, two of which took part in a serious game on the topic of "stock market" and two took part in a group work approach to the same topic. Within these different formations, the respective approach was applied at two different DQR (German Qualifications Framework) levels. Subsequently, the learning results were measured by using a uniform learning test. By means of a two-factor variance analysis, both the impact of the method as well as the DQR level were measured. Although no generally increased effectiveness of serious games as a methodology could be found over the methodology of "group work", the analysis does show a significantly positive change in the learning effectiveness of serious games among the DQR levels, so that we can assume that serious games show increased effectiveness over group work at lower DQR levels. In line with this finding, we can speak of a "meaningful supplement" with regard to the use of serious games. However, this does not signify that this method is generally better than that of group work: a precise analysis of classes is needed in order to ascertain whether method competence has been trained sufficiently in order to make effective use of serious games.

1   Current state of research

In its handbook for elaborating curricular framework plans, the German *Kultusministerkonferenz* (Standing Conference of the Ministers of Education and Cultural Affairs (KMK)), emphasizes action-oriented teaching and learning, which should be applied as a specific pedagogy in order to achieve the goals set by the KMK (Sekretariat der Kultusministerkonferenz, 2013). Serious games belong to this action-oriented teaching methodology. They can be traced back to ancient times, where they were used for military purposes. In the 20th century, serious games were additionally used for economics and politics (Raiser & Warkalla, 2011). Digitalization during the last few years has opened up more possibilities for incorporating more complex serious games into lessons.

Due to the ever-increasing popularity of serious games, several large banks now offer stock exchange games[1]. The Sparkasse-Finanzgruppe has, for instance, developed a stock exchange game specifically for learners, where they can deal in stocks. However, the game does not train a conscious handling of financial investments but rather a willingness to take the risk of investing existing capital. The goal of the game is to make as high a profit as possible. In order to do so, players need to take big risks and they also need a certain amount of luck. Due to their "gambling" character and a lack of learning intention, such widely promoted stock exchange games are subject to frequent criticism.

This is just one of the reasons why the RWTH Aachen University project "LeBiAC" (teacher training program) developed a stock exchange game entitled "Mündiger Bürger an der Börse und den Kapitalmärkten" (Competent Citizens on the Stock and Capital Markets).

This particular game combines fun elements with didactically prepared learning content addressing the topic of the stock exchange. Against this background, the game may be assigned to the category of serious games (Blötz, 2015; De Gloria, Bellotti & Berta, 2014).

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[1] Stock exchange games are offered by, amongst others: Commerzbank, Sparkasse, ING-DiBa, Volksbank, Frankfurter Allgemeine.

A serious game (also known as a "learning game") may be developed via various methods. There is an opportunity to fill out learning content with playful aspects and thus to design a learning game. In the "Competent Citizens" game, however, the learning content was implemented within a stock exchange game (Schulz, Prinz & Isabwe, 2016).

Even though serious games are enjoying growing popularity, a great number of teachers are reticent about using them in their own lessons. The time and effort involved in adapting the learning games to the desired learning outcomes and then actually implementing the games is usually too extensive. However, the new media have considerably reduced the time and effort required (Jacobs & Schalück, 2011).

2   Research gap

For several years, various teaching and learning methods have been examined. Kerres, Bormann & Vervenne addressed in 2009 the topic of whether games are generally usable for educational purposes. They focused on the paradox in which learning and playing find themselves: between freedom of purpose and a specific purpose.

Kerres et al. (ibid.) differentiate between a learning mode and a playing mode, which occur during the game but not in equal measure. This has an influence on the players' learning behavior in the sense that players want to return to the playing mode as soon as possible after the learning mode kicks in.

In their meta-analysis, Wouters, van Nimwegen, van Oostendorp & van der Spek (2013) were able to show that serious games involve more effective learning conditions in comparison to other learning methods but that they do not have any significant motivational impact in contrast to other motivating measures. Over the last ten years, there have been numerous studies on serious games, but as yet no manual has been produced for developing such. This leads us to believe that every game has different effects on learners. In their study on the learning success of serious games in relation to traditional teaching with the teacher in front of the class, Eckhardt et al. (2017) show that serious games offer added value. They used the serious game "Lost in Antarctica", which was developed to

train information competency. The level of knowledge of both test groups—Serious Game and Frontal Teaching was identified prior to and after the lesson.

However, in that study, the social form also differs. In order to examine the effectiveness of serious games as a teaching method, the social form of group work is retained throughout our analysis. In didactics, this social form is frequently broken down further, but this is not relevant to the study at hand.

Most studies on the learning effectiveness of serious games demonstrate improved learning, but do not differentiate further. The test groups are regarded as a general entity and not changed to other weightings. In particular, the performance capabilities of the test groups are taken as given.

In games studies, often the only differentiation is between age groups (Lynch, 2015; Sánchez & Olivares, 2011; Backlund, & Hendrix, 2013; Boyle et al., 2016). If the effectiveness between the same age groups is observed and a difference in level of performance is determined as an independent variable, the number of studies declines. However, differentiation within one class is elementary to lesson planning nowadays. During one lesson, a teacher is confronted with different performance capabilities and levels of willingness to perform. Correspondingly, individual support of learners is necessary (Utech, 2009). The internal differentiation addresses learners within one class. If this way of thinking is applied at a higher level of a school hierarchy, it results in an adjustment of teaching methods to classes which bring different performance capabilities with them. In the work at hand, the German qualification framework is used as a basis in order to generalize and define a differentiation of the classes. Different degrees of competency are used to make a distinction between the different levels.

The study at hand examines the impact of serious games in vocational white-collar education, whereby the learning success is quantified and analyzed in the form of a test in order to draw conclusions on the effectiveness of the method and the optimization of class selection for playing serious games. Our research question comprises two hypotheses.

3   Derivation of the hypotheses

3.1   Comparison of learning effectiveness between serious games and group work

From a didactic perspective, educational games are a special method of teaching which, just like all other teaching methods, is intended to convey learning content to learners

(Herrmann, 2004). In educational games, reality is presented in a simplified form so that learners are able to forecast future developments and to make decisions. Usually, educational games are intended to have a certain entertainment effect. In order to differentiate, in 1970 Abt coined the term "serious games". With serious games, apart from the entertainment factor, clear learning goals are formulated which can be achieved through play. The terms "serious games" and "educational games" are often used synonymously but they need to be observed in a differentiated manner.

Many teachers are unaware of the great potential that educational games hold, which means that this potential cannot be unfolded. Obviously, motivation plays a key role in the use of learning games. Playing requires a high degree of classroom activity, which is documented as having a particularly positive effect on the motivation of learners (Cron & Langner, 2011; Klippert, 2002). However, this activity does not only have a positive impact on the motivation of learners; it also has a positive impact on the development of their competencies. Personal responsibility, which players need when playing, and the relevant self-organization foster their individual willingness to take on responsibility as well as their self-confidence (Cron & Langer, 2011).

As a rule, educational games are based on group work, so that learners have a lot of communication within their group, can argue and act interactively, in order to successfully finish the game. Here, particularly social skills of the individual actors are fostered, since the group must reach a joint decision about how to proceed (Klippert, 2002). This fostering of social skills does not only occur through the interaction of an individual with the rest of her group but also through interaction with the other groups. The peculiarity here is the competitiveness of the learners.

Each group wants to get the best result, but often this involves intensive negotiating, which requires compromises that are acceptable to all the groups. (Bundeszentrale für politische Bildung, 2018; Klippert, 2002). Whereas educational games play out in a fictive world and have no impact on real life, the necessary finding of compromises does transfer very well to real life. In a democracy, it is important to discuss various positions and to come to a consensus with which all parties are satisfied. In this way, education games do not only foster social competencies of learners but simultaneously their capacity for democracy (Klippert, 1984).

Furthermore, the relationship with reality speaks in favor of the use of educational games. One feature of educational games is that the game always takes place in a fictive world. The actions of the learners have no impact on reality (Bundeszentrale für politische Bildung, 2018), yet they allow the actors to make use of the heuristic "trial and error" method (Bruner, 1981). This method has the particular effect of simplifying the acquiring of knowledge, and learning content can be more strongly consolidated (Cron & Langer, 2011). This effect becomes even more efficient because an educational game always has a "model" character: it shows reality in a simplified form which is easier for learners to process.

If we observe all of the elucidated arguments as a whole, serious games—including the stock market game—hold great potential for conveying learning content more efficiently and for more intensively training learner competencies. As we mentioned earlier, however, serious games require a lot of time, because apart from the playing phase, a preparation phase and, most importantly, an evaluation phase are necessary. Also, serious games cannot be implemented in every class, as a "healthy" classroom climate is necessary in which learners have mutual respect for each other. Accordingly, the teacher must carefully consider when planning a lesson whether the time and effort required for implementing a serious game is justified in relation to the attainment of learning goals.

> Hypothesis (H1): Learners who play serious games as part of their white-collar vocational education achieve better results in tests in comparison to learners who carry out group work.

3.2   Learning effectiveness of serious games at different DQR levels

The German Qualifications Framework (DQR) is a tool for categorizing the qualifications of the German education system. On the one hand, it serves to facilitate orientation within the German system itself and on the other hand, it serves as an aid to comparing German qualifications throughout Europe ((Bundesministerium für Bildung und Forschung, 2019).

It was created as a support for lifelong learning and to provide employment support for the citizens of the country (Rein, 2010). Drivers behind the development of a German equivalent of the European qualification framework were socio-political aspects—such as facilitating access to education for educationally disadvantaged groups. Also, demographic developments and the increased demand for qualified employees played a key role. If we compare the European Qualifications Framework with the German Qualifications Framework, we see that in the former, knowledge, skills, and competencies are listed as a separate reference category, whereas in the German equivalent, "competencies" is a central, overarching category. The intention of the latter is to improve action competency as well as to improve the categorizing of high-level vocational and professional qualifications, because vocational knowledge is given more consideration. This means that vocationally and professionally qualified persons can reach the higher levels of the qualification framework which are only attainable for university graduates in some of the other European states (Nehls, 2014).

The DQR comprises 8 levels which serve to make the German educational system more transparent. It was introduced on 1 May, 2013 following the decision of the Standing Conference of the Ministers of Cultural Affairs (KMK), the Federal Ministry of Education and Research, the Federal Ministry for Economic Affairs and Energy as well as the Conference of German Ministers for Economic Affairs.

The DQR distinguishes between two different categories of competence: professional competence comprises knowledge and skills; personal competence comprises social competence and autonomy. The various levels differ in particular in the degree of autonomy with which graduates are in a position to

manage complexity and unforeseeable changes but also in the degree of autonomy with which they can act within a field of occupational activity or within an academic subject. The professional competence is characterized by the breadth and the depth of the acquired knowledge, while the social competence covers social aspects like teamwork and leadership skills, the ability to shape one's own learning and working environments, and communication skills.

For the observations of the study at hand, only levels two to five are relevant.

Level 2 describes the competences required for the professional fulfilment of basic requirements within a clearly structured area of learning or work. The fulfilment of tasks generally takes place under supervision.

Level 3 describes the competences required for the autonomous fulfilment of technical requirements in an area of learning or field of occupation which is still clearly structured and, in some parts, openly structured.

Level 4 describes the competences required for the autonomous planning and processing of technical tasks in a comprehensive field of study or field of occupation that is subject to change.

Level 5 describes the competences required for the autonomous planning and processing of comprehensive technical tasks in a complex and specialized field of study or field of occupation that is subject to change.

One frequent criticism is that there is not enough clear delimitation between the eight levels and that the levels are not clearly enough defined. However, a too-strong differentiation among the working population would lead to further segmentation and selection (Gebrande, 2011). This means that, for example, vocational training occupations such as a retail salesperson and a bank clerk are both described by the qualification level 4, although in teaching practice different cognitive levels are observed among learners. The described qualifications can, then, be regarded as minimum requirements for reaching a particular level (Federal Ministry for Education and Research, 2019). The differences between various vocational and training groups, which the DQR does not show in its

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levels, must however be heeded in the school/college and consequences must be drawn from them. Against this background, we formulate our second hypothesis:

Hypothesis 2 (H2): In white-collar vocational education, serious games lead to above average test results in classes which are aspiring to a lower qualification level within the German Qualification Framework than in classes which are aspiring to a higher qualification level.

4   Method of analysis

First, the hypotheses are empirically tested in a real-life classroom lesson. The stock exchange serious game is generated within the framework of two double lessons on economics at different vocational colleges.

In order to have a comprehensive sample, a total of four classes of about 20 learners are analyzed. These are comparable vocational college classes with analogous programs of study.

In our experimental setup, two test groups are compared with each other. The "Serious Game group" will be referred to in the rest of this research work as the group that takes part in the serious game.

In order to establish a negative or positive learning effectiveness, a reference group is needed in addition to the test group. This takes the form of a control group, which works though the same content focus in the same amount of time. However, the content for the control group is not conveyed and processed through a serious game but through normal group work.

Didactical or other dependencies do not exist between the test groups.

In order to quantitatively examine the learning growth of the learners, a learning goal control in the form of a written test is carried out after the serious game has been played. To this end, a ratio scale is used as an assessment measure. In order to obtain objective statements, percentages are used rather than grades. The raw data for the observations can be sent on request. In order to be able to compare

the acquired data, a statistical approach is needed. This will be elucidated in the following.

4.1   Set-up and implementation

In order to answer our hypotheses, we implement a purely descriptive data analysis in which fundamental findings are shown. As a first step, descriptive observation findings are provided and then first hypotheses are confirmed or rejected.

A descriptive data analysis does not, however, reveal any generalizations or associations. Within the framework of the research at hand, though, the intention is to examine whether the implementation of a serious game in a lesson has a positive impact on learning effectiveness. Thus, the field of explorative statistics is made use of in order to find unknown structures in the data and to confirm or reject the proffered hypotheses (Becker, Herrmann, Sandor, Schäfer & Hellish, 2016). Via a so-called two-factor variance analysis without repetition of measurement, the raw data are scientifically examined by means of quantitative evaluation.

As a special form of regression analysis, the goal of the two-factor variance analysis is to describe whether and to what degree the use of an economics-oriented serious game can impact the leaning effectiveness of learners.

In the second step, using the analysis as a basis, we examine whether an additional selection of vocational programs has a correct influence on learning effectiveness. In the framework of the two-factor variance analysis, dependent and independent variables are declared which represent a relationship, whereby the dependent variable Y is allocated to the overall performance of a learner.

In order to get a mathematically solid and comparable result and to eliminate potential errors of measurement in advance, two further nominally scaled variables are brought into the two-factor variance analysis without repetition of measurement. The choice of this test procedure is additionally fulfilled through the fulfilment of the conditions, namely the existence of two independent randomly chosen and normally distributed samples (Bortz, 2004).

Thus, both hypothesis conditions – the general learning effect and the analysis according to different levels of qualification, as well as the sample groups, are defined as factors in the following (Eid, Gollwitzer & Schmitt, 2017).

A mathematical evaluation for confirming or rejecting the proffered hypotheses takes place by means of the statistical software SPSS. Within the framework of the quantitative analysis, in addition to the mean value, several other measures of central tendency are used, e.g. median, mode and percentile, in order for us to make statistically meaningful statements. Further, the analysis results and the answering of the hypotheses are tested for their significance level by means of a t-test (von Detten, Faude & Meyer, 2008; Eid, Gollwitzer & Schmitt, 2017).

4.2   Group characterization

In this section, we characterize the individual learning groups in order to gain insight into the respective class structure. Additionally, we will take a brief look at the general willingness to perform and the respective experiences with the selected teaching method.

The first group, where learning content was conveyed via classic group work, comprised 2nd-year students on the 2-year program of the advanced vocational college (hereafter

HB_GA). Their ages ranged from 17 to 20. The topic of "stock market" was completely new for them although a few of them did have partial knowledge of it. This heterogeneity is reflected in the results for the group work, which showed a differentiated quality. The largest "outlier" in the group was a male student who also made a positive impact in the other subjects taught. With regard to the "group work" method, all of the learners were highly familiar with this method and this led to their swiftly taking up the work.

 In order to obtain comparable measurement results, the second test group, where the stock market serious game was to be implemented, was also in the two-year advanced vocational college program, whereby this test group was still in the first year (hereafter HB_SG). The learning group comprised equal shares

of learners aged between 17 and 21. The serious game was played within the framework of an optional course entitled "Financial Services", whereby the topic of "stock market" is usually addressed in the upper year. Accordingly, the learners had no knowledge of this topic. The learning group, although not achieving a particularly good performance during the lesson, displayed great interest for the topic of "stock market" and particularly for securities. The general theme of the serious game was totally unknown to the students before its implementation, but it subsequently met with a positive resonance.

In order to test the second hypothesis with regard to the effect at different levels of qualification, the third test group was an intermediate class in the vocational secondary school (hereafter BG_GA). The 12ᵗʰ grade class consisted of 22 learners aged between 17 and 19. Despite the business-orientation of their program, the learners had little knowledge of the topic of "stock market". It was noticeable in this class that business and economics interest was rather low and performance in class work was weak. Group work is for this learning group a regularly implemented method and thus familiar to them. The group work was implemented in the subject of business administration with accountancy.

Similarly to the test group BG_GA, the fourth test group which involved the serious game was also a class from the vocational secondary school (hereafter BG_SG). As this group was from the lower year, the age structure ranged between 16 and 18. Basically, 21 learners are part of this group, whereby an absenteeism rate of 50% and higher is no exception. The extremely high absenteeism rate reflects the general motivation and willingness to perform of these learners, which are also extremely low. Knowledge of the stock market did not exist in this learning group. The learners also had no experience of serious games and only displayed moderate interest in this type of learning.

5   Quantitative analysis

In order to address the research question of which learning effects serious games have in the classroom, we introduce in this section a quantitative analysis. First, we provide an overview of our observation results. Then we evaluate these individually and interpret them. More detailed results can be provided. The Serious Game (SG) group and the Group Work (GA) group are evaluated

together with the school types Vocational Secondary School (Berufliches Gymnasium – hereafter BG) and Advanced Vocational College (Höhere Berufsfachschule – hereafter HB)

5.1   Observation results

Within the framework of the first hypothesis, we examine whether a serious game leads to a general increase in learners' performance in comparison with a conventionally taught   class. Tables 1 and 2 provide detailed descriptive evaluations of both of the sample groups Serious Game and Group Work. These tables include the mean value (M), standard deviation (SD) and standard error (SE).

Table 1: Overview of the observation results for the Serious Game group

	M	SD	SE	Variance
Task 1	2.2931	.20238	1.08987	1.188
Task 2	2.1034	.26885	1.44778	2.096
Task 3	1.0000	.25427	1.36931	1.875
Task 4	.9310	.23109	1.24445	1.549
Total no. of points	6.3793	.74677	4.02149	16.172
Total percentage	31.9483	3.75163	20.20314	408.167

Note: n = 29

Table 2: Overview of the observation results for the Group Work group

	M	SD	SE	Variance
Task 1	2.0455	.18016	1.19504	1.428
Task 2	2.5682	.15727	1.04320	1.088
Task 3	1.2045	.25137	1.66737	2.780
Task 4	1.1477	.17249	1.14414	1.309
Total no. of points	8.1932	.54676	3.62680	13.154
Total percentage	41.4205	2.72919	18.10337	327.732

n = 44

If we compare both mean values with each other, we find that the Group Work group has 41.42% (see Table 2) and thus achieved a higher overall percentage than the Serious Game group, which has 31.95% (see Table 1).

The values differ by 9.47%, but in the Serious Game group there is a higher variance and thus standard deviation. Thus, owing to several statistical "outliers", it is meaningful to bring further parameters into the evaluation. For this reason, Tables 3 and 4 also show the median (Mdn), the mode and the percentile of the evaluation.

Table 3: (Mean value, median, percentile) for the Serious Game group

		Task 1	Task 2	Task 3	Task 4	Total no. of points	Total percentage
M		2.2931	2.1034	1.0000	.9310	6.3793	31.9483
Mdn		2.5000	2.0000	.0000	.0000	6.0000	30.0000
Mode		3.00	.00ª	.00	.00	2.50ª	12.50ª
Percentile	25	1.5000	.7500	.0000	.0000	2.5000	12.5000
	50	2.5000	2.0000	.0000	.0000	6.0000	30.0000
	75	3.0000	3.5000	2.0000	2.0000	9.0000	45.0000

Note: n = 29.
ª Several modes exist. The smallest is shown.

Table 4: (Mean value, median, percentile) for the Group Work group

		Task 1	Task 2	Task 3	Task 4	Total no. of points	Total percentage
M		2.0455	2.5682	2.3182	1.1477	8.1932	41.4205
Mdn		2.0000	3.0000	2.0000	1.0000	8.0000	42.5000
Mode		1.00ª	3.00	2.00	.00	10.00	50.00
Percentile	25	1.0000	2.0000	1.0000	.0000	6.0000	30.0000
	50	2.0000	3.0000	2.0000	1.0000	8.0000	42.5000
	75	3.0000	3.0000	3.0000	2.0000	10.0000	50.0000

Note: n = 44.
ª Several modes exist. The smallest is shown.

Via the median we can establish that approx. 50% of learners in classes with conventional group work achieved on average 42.5% of the points (see Table 5), whereas 50% of the learners engaging in serious games achieved only 30% of the points (see Table 3). Thus, the learners in the sample group "Serious Game" demonstrated a generally weaker overall performance in the test process. Therefore, Hypothesis 1 can be rejected.

The second hypothesis is concerned with the assumption that using a serious game at the qualification level of the advanced vocational college will lead to a better performance result than in the vocational secondary school. When both sample groups continue to be differentiated according to the different school forms "vocational secondary school" and "advanced vocational college", significant differences are observed (see Table 5).

Table 5: Cross table and comparison of variables SG/GA – BG/HB

Type of school	Serious game			Group work		
	n	M (SD)	SE	n	M (SD)	SE
Vocational secondary school	14	22.8751 (14.9954)	4.0076	22	40.6818 (16.6401)	3.5476
Advanced vocational college	15	40.4333 (21.1599)	5.4634	22	42.1591 (19.8250)	4.2267

If the medians are evaluated and compared with each other, we can see that the advanced vocational college has achieved a higher and thus better performance than the vocational secondary school. If the data are compared for the total percentage in the framework of the serious game, we see that in the advanced vocational college 50% of the learners have achieved a performance of at least 42.5% (see Table 6). In the vocational secondary school, 50% of learners have only achieved 16.25% (see Table 6). In sum, this is a significant increase in performance of 25.75%.

Table 6: (Mean value, median, percentile) for the Serious Game group in BG and HB

		Serious Game	
		Vocational Secondary School BG	Advanced Vocational College - HB
n		14	15
M		22.8751	40.4333
Mdn		16.2500	42.5000
Mode		12.50	22.50
Percentile	25	10.0000	22.5000
	50	16.2500	42.5000
	75	38.1250	62.5000

If we use a further comparative base—in this case, an advanced vocational college with group work—see Tables 6 and 7), we can establish by means of the percentiles that using serious games generally results in a higher share of learners who gained more points for the tasks.

Table 7: (Mean value, median, percentile) for the group "Group Work" in BG and HB

		Group work	
		Vocational Secondary School BG	Advanced Vocational College - HB
n		22	22
M		40.6818	42.1591
Mdn		42.5000	42.5000
Mode		50.00	50.00
Percentile	25	33.7500	26.2500
	50	42.5000	42.5000
	75	50.0000	53.1250

According to Table 6, 75% of the learners in the group have achieved a maximum score of 62.5%, whereas the reference group in Table 7 only achieved 53.125%. This means that for the same median total performance of 42.5%, a generally better performance was obtained in Tasks 1, 4 and 5. Thus, the learners at the DQR level of the advanced vocational college (HB) achieved a more efficient value than those of the vocational secondary school (BG) and even those of the reference group in the framework of "group work". Thus, we can confirm Hypothesis 2.

5.2   Interpretation

When the quantitative evaluation is assessed with regard to its methodological implementation, it becomes apparent that it is vulnerable to measurement errors:

1. The sample size of 73 learners is small (here: n). A small and uneven n poses a problem in the framework of a quantitative analysis when generally valid statements have to be made. In order to enable this, extensive analyses are required so that data can be collected and evaluated over a longer period of time,

2. Furthermore, our analysis is not exempt from uncertain influencing factors. For instance, there is the unavoidable influence of the teacher, what happened in the classroom before and after the period of time being examined, or the personalities of the learners themselves. Within the framework of the experimental setup, we tried to balance this out by considering a meaningfully structured lesson planning. However, in order to make thorough statements about significant correlations, further quantitative methods, e.g. regression analyses, are needed.

The findings of the quantitative analysis show that the implementation of a serious game does not lead to a universally regressive performance increase of the learners; however, a performance increase is noticeable in those classes with a low DQR standard.

But it is questionable whether the usage of a serious game was the cause of the good or poor learning success, so the analysis results of 5.1. were subjected to a significance test by means of SPSS, which in the framework of this analysis provides statements on general validity. In the framework of a two-factor variance analysis, we examine which significant impact the factors have here on the overall performance of the learners.

We refrain from applying a so-called post-hoc test on account of the clear group differentiation between SG-GA and BG-HB.

Table 8 shows the results of the Levene test, whereby the value, based on the median, of 0.49, shows a considerable insignificance of the respective groups, which confirms homogeneity of the error variances and a clear differentiation of the groups and thus fulfils the requirements for the subsequent use of two-factor variance analysis for our calculations.

Table 8: Levene's test of equality of error variances[a,b]

		Levene statistic	df1	df2	Sig.
Total_percentage	Based on mean value	.909	3	69	.442
	Based on median	.815	3	69	.490
	Based on median and with adjusted df	.815	3	67.892	.490
	Based on trimmed mean	.906	3	69	.443

Note: tests the null hypothesis that the error variance of the dependent variables is the same across groups.
a.   Dependent variable: Total_ percentage_
b.   Design: Constant term + SG_GA + BG_HB + SG_GA *BG_HB

The results from Table 9 show the concrete influencing factor of the variables and factors on the percentage of total performance of a learner.

It is noticeable here that both of the factors "Serious Game – Group Work" and "Vocational Secondary School – Advanced Vocational College" have a high variance (here: mean of squares) and a relatively low error variance (here: the F-value). Therefore, we can already generally state that both factors explain the overall performance of a learner.

Within the type of teaching – SG-GA with a significance variance of 0.029 – and the type of school – BG-HB with 0.034 – there is clear statistical significance (p

< 0.05). With a likelihood of 97.1% and 96.6%, a correlation between the factors and the overall performance of a learner can be made.

In the context of an interaction between both factors (here SG-GA*BG-HB), there is a significance of 0.071. Although this exceeds the corresponding likelihood of error of $p < 0.05$, in statistics it is said to be significant if $p > 0.1$ %. Thus, the variances are slightly inhomogeneous, yet both data sets display a noticeable number of significant values. Accordingly, 92.9% of the results of the second analysis did not occur randomly but can be observed as having a direct correlation with the overall performance.

Therefore, the correlation from Hypothesis 2 is statistically proven. There is a correlation between the performance of a learner and the implementation of the serious game in the advanced vocational college.

Table 9: Test of inter-subject effects

Source	Sum of squares Type III	df	Mean of squares	F	Sig.
Corrected model	3829.325ᵃ	3	1276.442	3.787	.014
Constant term	93248.813	1	93248.813	276.618	.000
SG_GA	1669.049	1	1669.049	4.951	.029
BG_HB	1585.273	1	1585.273	4.703	.034
SG_GA * BG_HB	1131.748	1	1131.748	3.357	.071
Error	23260.114	69	337.103		
Total	130610.000	73			
Corrected total variation	27089.438	72			

Note: Dependent variable = total percentage
ᵃR-square = .141 (corrected R-square = .104)

6   Relating the research findings to the research subject

Regardless of the findings of the work at hand, it should be noted that the stock market serious game focuses on a topic that is not foreseen in this form in the educational plans for the federal state of North Rhine-Westphalia. It is also not the intention of this research to debate about the composition of current educational plans. However, there is an opportunity to work through the topic of "stock market" as part of a selected additional course, e.g. as part of the subject "financial services". On account of the great interest of some learners and with regard to the "anticipatory didactics" of Zabeck, it would be a good idea to provide this offering in schools in order to prepare students for their future lifeworld (Paape, Kiereta & Maus, 2013). Particularly with regard to the fact that adequate retirement provision has no relevance in the learners' everyday life, getting them to interact with the topic of "stock market" serves to educate them towards becoming empowered members of society.

Further, the methods competence of the students must be observed as an impacting factor. The methods competence extends over all competence areas which are fostered in the action and learning fields-oriented teaching of economics (Achtenhagen & Pätzold, 2010). Being prepared to and having the ability to self-regulate knowledge acquisition with regard to tasks and problems is ascribed to methods competency. In lesson planning, a versatile mix of methods should be applied in order for students to experience the different facets of learning.

The method competence for group work was sufficiently present in the learning groups, since this is a frequently used method. In contrast, serious games had not been used before and thus constituted a new method for the students. It might be possible that the missing competence negatively impacted the performance of the learners, since their attention was not just focused on the content but especially on the hitherto unknown method. According to Meyer (2007), the methods competence describes the ability to handle the methodological parts of the learning process with awareness and economically and creatively. This competence is practiced in a lesson and step by step brought up to a higher level so that a method depth can emerge. The step by step practicing and thus the method depth were not ensured for the serious game implementation and this

might have led to the less positive results of the learners who played the serious game.

Owing to the playful components in the conveying of these thematic contents, the willingness to perform of the learners is increased. This is particularly obvious in the research findings on the lower DQR-level classes. Therefore, it is advisable to carry out group differentiations in order to train personal, social, and method competences.

7   Conclusions

Reflecting on all the findings of this study, we find that great potential is opened up if serious games are carefully and purposefully integrated into a lesson.

As the rejection of the first hypothesis shows, we cannot talk of a general performance increase between the different school classes; however, since the second hypothesis has been proven, it is clear that if a serious game is carefully and thoughtfully used, subject knowledge and competences of learners can be efficiently trained. Careful and thoughtful application is illustrated, for example, by a teacher classifying the group of learners beforehand. Further findings of our study demonstrate that learners from the advanced vocational college achieve better results than learners from the vocational secondary school.

The research question cannot be unequivocally answered. Predetermined conditions need to be fulfilled, such as a comprehensive method competency of the learners as well as a clear class differentiation by the teacher.

As the literature mainly differentiates according to the age of the learners, the claims made should be understood as being more generally applicable.

The teaching method of "serious games" should be seen as a more complex method which, similarly to other teaching methods, requires a differentiated approach.

It would, then, be meaningful to build on the new research gaps and to address them empirically. For example, the degree of motivation of serious games in comparison to that of regular classes could be examined. Furthermore, this empirical research only examined the educational programs of the vocational secondary school and the advanced vocational college for economics and administration. A practice-oriented analysis in training classes such as for "bank clerk" would be further connecting points. It would also be possible to not only differentiate according to the qualification framework in the training plan but to examine the application of serious games with regard to personal characteristics. Findings on the latter research gap could deliver insights into gender-dominated training occupations. Through this research work, a novel and target-oriented context is opened up, shifting the topic of "serious games" into a current scientific focus.

With regard to the performance and motivation potential of learners, which results from the topic of serious games, it makes sense to contemplate its implementation in the curriculum. Furthermore, particularly the link to the real-life world of the learners and the exploration of future-oriented topics, e.g. private old-age pensions, add support to this idea.

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