

THE INFLUENCE OF THE DESIGN AND PRIOR KNOWLEDGE ON THE INDIVIDUAL LEARNING SUCCESS OF STUDENTS

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In educational practice, various social forms and instructional methods are employed to organize classroom teaching. Research conducted in the context of general education schools has demonstrated that these forms and methods differ in their effectiveness regarding the development of specific competencies. However, the extent to which such findings can be transferred to commercial vocational colleges remains largely unexplored. The present study therefore compared the social forms of group work and teacher-centred instruction in commercial vocational colleges with respect to their effectiveness in fostering professional competence within the framework of a new teaching unit, while taking students' prior knowledge into account. The findings indicate that teacher-centred instruction leads to greater individual learning gains than group work when introducing new subject matter to students without prior knowledge. The second hypothesis, that group work promotes greater individual learning success among students with existing prior knowledge compared to teacher-centred instruction, could neither be supported.

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1 Introduction

Instructional social formats such as whole-class teaching and group work play a central role in shaping school learning processes. While both approaches offer distinct didactic potentials, their effectiveness with regard to students' individual learning outcomes remains a subject of academic debate. In this context, prior subject-specific knowledge is particularly relevant, as learners may benefit differently from instructional formats depending on their previous experience.

Previous studies provide conflicting evidence regarding which social format promotes greater learning success. Moreover, much of the existing research focuses on general education schools, whereas the context of commercial vocational colleges has so far received limited attention — despite the broad range of prior knowledge resulting from heterogeneous educational backgrounds.

Against this backdrop, the present study investigates the relationship between instructional design, prior subject knowledge, and individual learning outcomes in business education at vocational colleges. The aim is to empirically examine whether the effectiveness of whole-class teaching and group work varies depending on students' prior knowledge. The findings are intended to contribute evidence-based insights for more differentiated instructional design.

2 Research question, state of research and research gap

In school practice, various social forms and methods are used to diversify lessons. There are differing views on which methods and social forms are most promising for pupils' individual learning success and on the extent to which this success is related to pupils' prior knowledge. Social forms refer to the way in which communication is organized between teachers and students in the classroom (cf. Meyer 1994: 41f.; Wiater 1997: 229). These can generally be divided into two superordinate categories: self-directed and cooperative forms of learning. In self-directed forms of learning, learning processes are regulated by learners rather than by teachers, but are guided by external structures. Consequently, learning is not entirely self-directed, as it takes place within a sociocultural environment (cf. Breuer, 2000, p. 88). Cooperative learning refers to the collaboration of several group members who pursue learning as a shared goal (cf. Breuer, 2000, p. 92).

According to Meyer (1994: 41f.), Wiater (1997: 229ff.), and Speth and Berner (2018: 185ff.), four social forms of instruction can be distinguished: frontal teaching, individual work, partner work, and group work. In the context of the present study project, the social forms of group work and frontal teaching are of particular relevance, as they are compared with one another.

Frontal teaching refers to a form of instruction in which communication is controlled exclusively by the teacher. Lessons are typically structured as teacher-centered presentations, and interaction among students is largely discouraged (cf. Paape/Maus/Kiereta 2021: 178; Ganser 2015: 80f.; Wiechmann 2011: 24f.). One advantage of frontal teaching is that it enables the transmission of large amounts of instructional content within a comparatively short period of time (cf. Paape/Maus/Kiereta 2021: 179).

By contrast, group work is a form of learning in which students work independently in groups consisting of at least three and no more than seven members on one or more tasks. The individual group members may either work on the same topic or be assigned different, complementary topics (cf. Bönsch 1995: 272ff.; Speth/Berner 2018: 244f.). The use of group work in classroom instruction is emphasized in the literature primarily because of its positive effects on the development of students' social competences and teamwork skills, which may, in turn, have a positive impact on their individual subject-specific learning success (cf. Becker 1994: 107).

In this study, the effectiveness of social forms is understood as their ability to promote subject-specific competence development and individual learning success. Prior knowledge, which in this study is defined as subject-specific prior knowledge, refers to any familiarity with the subject matter as well as relevant knowledge acquired through students' prior schooling that exists before the topic is addressed in the lesson (cf. Thaler 2021: 182f.; Freudenreich/Schulte 2002: 3). With regard to the type of school examined in this study, it can be assumed that students at vocational colleges have a more heterogeneous educational background than students at general education schools. Consequently, the relationship between prior knowledge and individual learning success is particularly relevant in vocational colleges, as some students may already possess relevant subject-specific knowledge, for example in the commercial field.

This leads to the question, especially in the context of vocational colleges, of which social form is most effective for the development of subject-specific competences, depending on students' individual prior knowledge. The research questions guiding this study are therefore as follows: Which social form is most effective for students' individual learning success when no prior knowledge is present? Does this change when students already possess prior knowledge?

Moreover, group work is frequently described as being particularly conducive to the development of social competence and teamwork skills (cf. Becker 1994: 107). However, it remains unclear whether subject-specific competence can be developed to a comparable extent in group work as in frontal teaching when students do not have prior knowledge of the respective topic. Alternatively, it may be the case that the more action-oriented nature of group work enhances learning success compared to frontal teaching, regardless of prior knowledge.

Previous studies examining the general effectiveness of different social forms with regard to individual learning success have yielded contradictory results. Dietrich (1969: 98), for example, identifies group work as a particularly effective social form, especially in terms of knowledge reproduction. Other studies, such as those by Roth (1967) and Meyer (1997), arrive at the opposite conclusion, reporting significantly higher individual learning success in frontal teaching settings (cf. Ganser 2015: 107–108; Meyer 1997: 70). By contrast, a study by Seifried, Brouer, and Sembill (2002: 575), conducted in the subject area of accounting at commercial vocational colleges, found that self-organized learning in group work led to higher learning success than traditional frontal teaching. At the same time, studies investigating the effectiveness of different social forms for individual learning success, including Seifried, Brouer, and Sembill (2002: 588), consistently emphasize the importance of additional influencing factors, such as students' individual prior knowledge.

Empirical findings on the relationship between prior knowledge and individual learning success in group work and frontal teaching remain limited. In the study by Seifried, Brouer, and Sembill (2002), students taught through frontal instruction were not able to achieve higher individual learning success than those working in groups, despite having greater prior knowledge of the subject matter.

The research findings on the effectiveness of frontal teaching and group work discussed above largely focus on direct comparisons between these social forms, while the role of prior knowledge in moderating their effectiveness for individual learning success has so far been only sporadically examined. Furthermore, there is a lack of empirical studies conducted in the context of commercial vocational colleges, as existing research has predominantly focused on general education schools. The extent to which findings from general education contexts can be transferred to vocational colleges therefore remains insufficiently explored. Against this background, the present study investigates how group work and frontal teaching influence individual learning success, with particular consideration of students' prior knowledge in vocational college settings.

3 Generation of Hypothesis

The aim of instruction is to maximize each student's individual learning success through a systematically and sustainably structured sequence of teaching and learning situations. In this process, learners' skills, abilities, and subject-specific knowledge are to be developed (cf. Lipowsky 2015: 70). Through the targeted selection of appropriate social forms, individual learning success can be optimized at different phases of a lesson (cf. Klippert 2001: 264).

Overall, only a limited number of studies have examined subject-specific prior knowledge in relation to the effectiveness of different social forms with regard to individual learning success. One possible reason for this is that subject-specific prior knowledge plays a particularly important role in vocational colleges, despite the fact that this type of school has received relatively little research attention. The study by Seifried, Brouer, and Sembill (2002) addresses prior knowledge only marginally and arrives at results that contradict the prevailing view in the literature, as represented, for example, by Renkl (2015: 213ff.) and Kirschner, Sweller, and Clark (2006: 75). However, the sample size in this study is very small, and the authors themselves acknowledge that its findings are therefore of limited significance (cf. Seifried/Brouer/Sembill 2002: 587ff.). Another study by Seifried (2008: 245f.), which is also based on a small sample, concludes that students with little prior knowledge participate less actively in frontal teaching and consequently achieve lower individual learning success than in group work.

Nevertheless, the literature repeatedly emphasizes the relevance of prior knowledge for individual learning success in self-organized and cooperative learning settings and, in the absence of subject-specific prior knowledge, highlights the advantages of frontal teaching instead (cf. Renkl 2015: 213ff.; Kirschner/Sweller/Clark 2006: 75). According to Meyer, frontal teaching is particularly suitable when students' orientation knowledge first needs to be established or when a new domain of knowledge is introduced (cf. Schmidt 2003: 16). When prior knowledge is already available, however, the focus shifts towards the advantages of group work, as students can draw on their existing knowledge to support the learning process and do not necessarily require the strong instructional guidance characteristic of frontal teaching (cf. Renkl 2015: 213ff.; Kirschner/Sweller/Clark 2006: 75).

As the role of prior knowledge in relation to group work and frontal teaching has so far been insufficiently investigated and existing empirical findings partly contradict dominant theoretical assumptions, the present study examines whether the prevailing position in the literature, as represented by Renkl (2015: 213ff.) and Kirschner, Sweller, and Clark (2006: 75), can be confirmed in practice or whether the contradictory results reported by Seifried, Brouer, and Sembill are replicated. For this reason, the hypotheses are derived from the theoretical literature rather than from the available empirical findings.

On the basis of the literature reviewed, it is assumed that, at commercial vocational colleges, frontal teaching is more effective than group work in promoting subject-specific competence when introducing a new topic to students who have no prior subject knowledge. Accordingly, the first hypothesis is formulated as follows:

Hypothesis 1: *When introducing a new topic, frontal teaching leads to greater individual learning success for students without relevant prior knowledge than group work.*

When students possess a basic level of knowledge in the form of subject-specific prior knowledge, group work is considered to be more effective for their individual learning success (cf. Renkl 2015: 213ff.; Kirschner/Sweller/Clark 2006: 75). In this case, the advantages of group work are assumed to outweigh its potential disadvantages. Group work is theoretically justified by the assumption that knowledge is primarily constructed through interaction among participants engaged in discussion (cf. Renkl 2015: 20f.). Articulating one's own viewpoints and

arguments enables learners to compare their existing knowledge with that of others and, if necessary, to revise and refine their own understanding (cf. Petko/Reusser 2005; Renkl 2015: 20f.; Hannken-Illjes 2018).

The expansion of individual knowledge and understanding is particularly likely when learners already possess a foundational level of subject knowledge and are therefore able to build on an existing knowledge base (cf. Gruber/Stamouli 2015: 32f.). Group work phases in classroom instruction may also enhance the performance of students, especially those who are assumed to have weaker learning performance, by granting a certain degree of freedom for co-construction and active participation. This opportunity to contribute and to assume responsibility for collective group outcomes can support students' personal development, as group work may be experienced as a productive challenge (cf. Euler et al. 2016: 611ff.).

On this basis, the second hypothesis is formulated as follows:

Hypothesis 2: *When introducing a new topic, group work leads to greater individual learning success for students with relevant prior knowledge than frontal teaching.*

4 Research design

To test the hypotheses, a quantitative analysis was conducted based on data collected from students at five different vocational colleges. Two classes from each college were included, resulting in a total sample of $n = 119$ students from ten classes. Specifically, three classes from the Vocational School II (two classes from the Department of Business and Administration and one class from the Department of Wood Technology), four classes from the Higher Commercial School, one class from the Business Grammar School, and two classes from the dual system (one class each for the training occupations of draughtsperson and hairdresser) were examined. In selecting the classes, care was taken to include only the lower grades of multi-year programs to minimize prior knowledge in economics from the ongoing course of study at the vocational college. The random selection of classes and the heterogeneous distribution of prior knowledge resulted in unequal sample sizes for the groups V+, V-, Gru classes, and Fro classes (see Chapters 4.2 and 4.3).

During the study, an “island lesson” on a new teaching topic was conducted in all ten classes. In five classes, the topic was taught using frontal teaching, while the other five classes worked on the same topic in a group work format. For the remainder of this study, the classes that received the content through frontal teaching are referred to as Fro classes, whereas those that engaged in group work are referred to as Gru classes. The teaching materials provided to the students were standardized across all Gru classes, and likewise, uniform materials were used in all Fro classes. Additionally, all ten lessons addressed the same topic to ensure comparability across classes.

During the topic development phase, the Gru classes received three different informational texts on various forms of payment, as well as tables for reproducing and applying the learned knowledge. These materials were worked on collaboratively as part of a group puzzle. In contrast, the Fro classes received the same content through a teacher-led lecture, supported by a digital presentation, followed by joint completion of the same reproduction and application tasks in plenary.

Following the topic development phase, both Fro and Gru classes completed an individual work phase, in which students independently reproduced the acquired knowledge in a questionnaire comprising 12 single-choice items. These questionnaires were collected by the teachers for evaluation. Only the results from this individual work phase were used for data collection and to determine individual learning success. This phase is particularly suitable for assessing individual learning outcomes, as all tasks were completed independently.

Table 1: Overview of lesson design - FroClasses & GruClasses

	5 FroClasses	5 GruClasses
1st teaching phase (topic development)	Frontal teaching	Group work
2nd teaching phase (reproduction/application of learned knowledge)	Individual work	Individual work

In the questionnaires, which the students completed individually during the second phase of the lesson, they were also asked to indicate the school-leaving qualifications they had obtained to date, including the type of school they had attended. Multiple responses were allowed. Additionally, students were asked whether they had

previously received business-related instruction outside of their current course of study. This information was used to assess the students’ prior knowledge. The group of students identified as having a high level of prior knowledge is referred to as V+, whereas those with limited prior knowledge are referred to as V-.

5 Results of the study

5.1 Evaluation procedure

The questionnaires, which all classes completed individually following the respective topic development phase, served as the basis for evaluation. These questionnaires were scored individually using a model solution. In addition, students were classified as having either a high or low level of prior knowledge based on their school-leaving qualifications and the types of schools they had attended. This classification was determined according to the presence or absence of economics as a subject in the curriculum of the respective school type (see Table 2). The additional, direct question regarding previous economics lessons in the students’ school careers served as a supplementary check and, if necessary, allowed for the correction of the prior knowledge assessment.

Table 2: Assessment of prior knowledge according to school-leaving qualification and type of school attended

Great prior knowledge (V+)	Little prior knowledge (V-)
<ul style="list-style-type: none"> – Secondary school leaving certificate after grade 9 / grade 10 (at a general education school) – Secondary school leaving certificate after grade 9 / grade 10 (at a vocational college) – Fachoberschulreife/Realschulabschluss (at a vocational college) – Fachhochschulreife (school/complete) (at a vocational college) – General / subject-linked higher education entrance qualification (at a vocational college) – General higher education entrance qualification (at a vocational college) – Completed vocational training as _____ – Abandoned vocational training as _____ 	<ul style="list-style-type: none"> – Fachoberschulreife/Realschulabschluss (at a general school) – Fachhochschulreife (school/complete) (at a general school) – General higher education entrance qualification (at a general school)

During the evaluation and scoring of the individually completed questionnaires, two extreme outliers were identified, each achieving only 3 out of 12 points. These cases were attributable to a complete lack of responses on the back of the questionnaire and were therefore excluded from the analysis. This resulted in a final sample of $n = 117$.

To test the hypotheses regarding the relationship between prior knowledge and individual learning success in frontal teaching and group work, an independent samples t-test was conducted. The data met the necessary assumptions for the t-test, namely normal distribution and homogeneity of variance. Homogeneity of variance was verified using Levene's test. The t-test was employed to determine whether the observed differences were statistically significant or could have occurred by chance. A significance threshold of $\alpha \leq 0.05$ was applied, corresponding to a confidence level of over 95 % for a non-random result (cf. Schnell/Hill/Esser 2013: 441ff.).

For hypothesis 1, the t-test compared the results of students with low prior knowledge (V-) in the Fro and Gru classes to determine whether the difference in individual learning success was significant. For hypothesis 2, the results of students with high prior knowledge (V+) in the Fro and Gru classes were compared in the same manner. Following the determination of statistical significance, the effect size was calculated using Cohen's d. Effect sizes are interpreted as follows: $d > 0.2$ represents a small effect, $d > 0.5$ a medium effect, and $d \geq 0.8$ a large effect (cf. Janczyk/Pfister 2015: 80). All statistical analyses were performed using the SPSS software package.

5.2 Results for hypothesis 1

Hypothesis 1: *When introducing a new topic, frontal teaching leads to greater individual learning success for students without relevant prior knowledge than group work.*

The V pupils in the Fro classes and the Gru classes ($n=53$) are compared. Hypothesis 1 is reformulated in the following static form:

$$H0 : \mu_{FroV-} \leq \mu_{GruV-} \text{ and } H1 : \mu_{FroV-} > \mu_{GruV-}$$

In order to be able to accept hypothesis 1, the null hypothesis should be rejected on the basis of the results of the statistical analyses presented here.

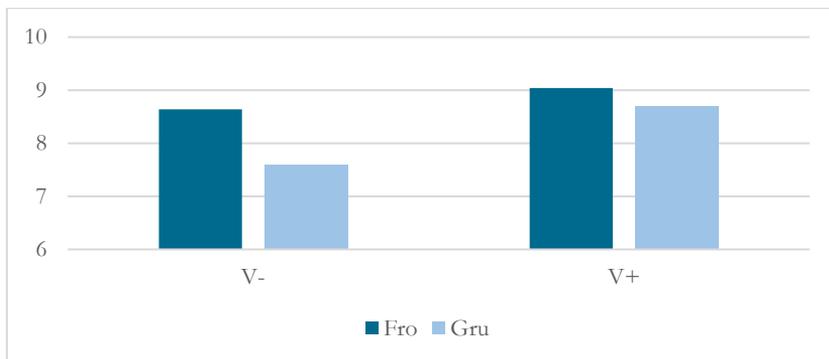


Figure 1: Mean value comparison (general overview)

Table 3: Statistical values for hypothesis 1

Social form	n	Mean value	SD	Standard error of the MW
Fro V-	14	8.64	1.499	.401
Gru V-	39	7.59	1.534	.246

The mean score of the V pupils in the FroK classes is higher (MW=8.64) than the mean score of the Gru classes (MW=7.59). In Figure 1, the mean values are once again visualised in an overall overview (including the mean values of the V+ classes, which are examined in more detail in Chapter 4.3). The standard deviation of 1.499 in the Fro classes and 1.524 in the Gru classes, and thus independent of the social form, is quite homogeneous for all V students.

Table 4: t-test for hypothesis 1

Levene test		t-test for equality of means							Cohen's d
F	Significance	t	df	Sig. (2-sided)	Mean difference	Standard error of the difference	95% confidence interval er difference		
							At	Upper	
.053	.819	2.216	51	.031	1.053	.475	.099	2.007	d=0.66

Since the significance of the Levene test of 0.819 is greater than 0.05, variance homogeneity can be assumed for the sample. The results of the t-test show that the deviating mean values of the V pupils in the Fro and Gru classes are a statistically significant difference, since the two-sided significance of 0.031 is below the specified alpha error of 0.05. The Cohen's d of 0.66 as a measure of variance homogeneity can be assumed for the sample. The Cohen's d of 0.66 as a measure of effect size signals a moderately strong effect.

Thus, for the first hypothesis, the H0 can be rejected and the H1 established in this study can be confirmed.

5.3 Results for hypothesis 2

Hypothesis 2: *When introducing a new topic, group work leads to greater individual learning success for students with relevant prior knowledge than frontal teaching.*

The V+ pupils in the Fro classes and the Gru classes (n=64) are compared here. The same prerequisites for confirming the hypothesis apply here as with hypothesis 1. Thus:

$$H0 : \mu_{GruV+} \leq \mu_{FroV+} \quad \text{and} \quad H1 : \mu_{GruV+} > \mu_{FroV+}$$

In order to be able to accept hypothesis 2, the null hypothesis should therefore also be rejected here on the basis of the results of the statistical analyses presented below.

Table 5: Statistical values for hypothesis 2

Social form	n	Mean value	SD	Standard error of the MW
Fro V+	38	8.71	1.487	.241
Gru V+	26	9.04	1.562	.306

The mean score of the V+ students in the Gru classes is 9.04, which is only slightly higher than in the Fro classes (MW=8.71). As can be seen in the comparison of means in Diagram 1, the V+ pupils perform somewhat better overall than the V-pupils, although the difference between the means of the Fro classes and Gru classes is significantly less pronounced for the V+ pupils. The standard deviation of 1.487

in the Fro classes and 1.562 in the Gru classes is also quite homogeneous among the V+ pupils.

Table 6: t-test for hypothesis 2

Levene test		t-test for equality of means							Cohen's d
F	Significance	t	df	Sig. (2-sided)	Mean difference	Standard error of the difference	95% confidence interval of the difference		
							At	Upper	
.060	.808	-.849	62	.399	-.328	.386	-1.100	0.444	d=-0.21

The results of the Levene test also signal a homogeneity of variance in the sample due to the significance of 0.808, so that the requirements for the t-test are fulfilled. The two-sided significance of 0.399 determined in the t-test is greater than the specified alpha error of 0.05, so that the results for hypothesis 2 must be evaluated as not statistically significant. The effect size of $d=0.21$ determined using Cohen's d would also only indicate a small effect, even if the result were significant.

Thus, due to the lack of statistical significance of the results, H_0 can be confirmed in this case, so that hypothesis 2 must be rejected.

6 Conclusion, limitations and outlook

Within the framework of this study, it can be concluded that - at least for students without prior knowledge - there is a relationship between individual learning success, prior knowledge, and the didactic design in the development of a new teaching topic in business lessons at vocational colleges. By confirming hypothesis 1, this study provides evidence that students without prior knowledge in economics achieve higher individual learning success when a new topic is developed through frontal teaching rather than through group work. Hypothesis 2, which addressed students with prior knowledge, could neither be confirmed nor refuted based on the data collected. Nevertheless, the markedly different outcomes for students with and without prior knowledge fundamentally underscore the heterogeneity of prior knowledge among vocational college students and highlight the importance of considering this factor in lesson design.

However, this study has several limitations, and the results should therefore be interpreted with caution, serving primarily as indicative rather than conclusive evidence for practice. First, the sample size is relatively small—particularly within the subgroups (FroV-: $n = 14$; FroV+: $n = 38$; GruV-: $n = 39$; GruV+: $n = 26$)—which limits the generalizability of the findings. Future research would benefit from a larger-scale study to validate these results in a more representative sample.

Additionally, individual learning success is a multifactorial construct and cannot be attributed solely to didactic design or the social form employed. Beyond internal learner-related factors, various external factors - such as lesson timing, classroom atmosphere, and teacher-student interactions - also influence individual learning outcomes. In the present study, potential confounding factors included structural variations, such as the students' status as internship participants, as well as differences arising from five different prospective teachers, their individual teaching styles, and the nature of their relationships with the students. Data were collected exclusively through questionnaires, which may also introduce limitations.

Another limitation concerns the procedure for assessing prior knowledge. In this study, prior knowledge was inferred from students' previous educational qualifications, based on the presence or absence of economics in the curriculum of the school type they attended. However, the educational backgrounds classified as "high prior knowledge" or "low prior knowledge" were highly heterogeneous, ranging from programs in which economics was a minor subject taught for a few years, to programs with a strong economic focus where topics were covered intensively, as well as programs with varying thematic emphases in economics. A finer differentiation of prior knowledge (e.g., high, moderate, low, none) would have been possible. More comprehensive and precise assessment methods exist, but they are often time-consuming. Given that the island lesson topic, "payment transactions," represents a very basic element of economics instruction, a simpler approach was adopted for pragmatic reasons.

Despite these limitations, the findings allow for a practical recommendation: the individual prior knowledge of students in business lessons at vocational colleges should be explicitly considered and incorporated into the selection and planning of didactic designs.

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