Clearing House Unterricht

Short Review

How effective is the Flipped Classroom? The first scientific findings for secondary education

Work on subject matter at home and practice it in the classroom: Flipped Classroom literally turns the classic sequence of lessons around. This innovative method is becoming increasingly popular among teachers and students. Its learning effectiveness has also been the subject of increasing scientific research in recent years. The meta-analysis »Effectiveness of the Flipped Classroom on Student Achievement in Secondary Education: A Meta-Analysis« by Wagner, Gegenfurtner, and Urhane (2020) is the first to summarize all available findings for secondary school students and to examine whether Flipped Classrooms affects student learning, and if so, how.

INTRODUCTION. Teaching and learning according to the Flipped Classroom approach is becoming ever more popular. Teachers at schools and universities are increasingly creating videos with learning content that students can use to independently learn subject matter in a self-regulated manner. In this way, time at school can be better spent intensively working together to deepen learning on what was initially studied at home.

META-ANALYSIS AT A GLANCE

Focus of the study	Effectiveness of Flipped Classroom instruction
Target group	Secondary school students
Average effect size	Medium to large effects in favor of Flipped Classroom instruction
Further findings	The number of available studies does not yet allow for more differentiated findings

From the point of view of educational psychology, this approach gives learners more control, to better adapt content learning to their own pace. Moreover, there is more time in the classroom for targeted support and feedback when solving tasks and for applying the learning content. Additionally, the Flipped Classroom offers opportunities for more interactive learning, which could have a positive effect on students' motivation.

In recent years, the subject of increasing scientific research has focused on whether this potential can actually be leveraged, and if so, how. This meta-analysis now provides comprehensive findings from secondary education.

WHAT IS A FLIPPED CLASSROOM?

The Flipped Classroom approach reverses the typical sequence of students learning content at school, then applying and practicing it through homework. Alternatively, with Flipped Classroom, students first work at home with the learning content, individually and independently, usually with the help of instructional videos. Next, the time spent together at school is used to further deepen their understanding of the learning content. These classroom application tasks can be worked on individually or cooperatively with constructive support from the teacher.

WHAT IS THIS STUDY ABOUT? In the meta-analysis, the authors examine the effectiveness of the Flipped Classroom approach with secondary school students. The meta-analysis focuses on studies that exclusively use learning videos to teach the material. Empirical studies on this were first published in 2012. Accordingly, the meta-analysis considers 44 experimental studies from six years of research (2012-2018). In total, these studies report 83 effect sizes on the performance of 2,323 students who learned with the Flipped Classroom approach, defined as learning with videos at home and then further interactive learning at school.

Table 1: Overview and description of the three different comparison categories.

Category/Analysis	Meaning	Study Design
One-Group Pre-Post Comparison (24 studies)	The effect describes the extent to which students know more or less after Flipped Classroom instruction than before.	One-group pre-post design: One group is taught with Flipped Classroom. Learning levels are measured before and after.
Two-Group Post Comparison (39 studies)	The effect describes the extent to which students who learned with Flipped Classroom subsequently know more or less than students who attended regular classes.	Two-group post-design: One group (experimental group) is taught with Flipped Classroom. Another group (control group) is taught regular classes. Learning levels are measured for both groups *after* instruction.
Two-Group Comparison of Change (20 studies)	The effect describes the extent to which the learning gain of students who learned with Flipped Classroom is larger or smaller than the learning gain of students who attended regular classes.	Two-group pre-post design: One group (experimental group) is taught with Flipped Classroom. Another group (control group) is taught in regular classes. For both groups, learning levels are measured *before and after* instruction.

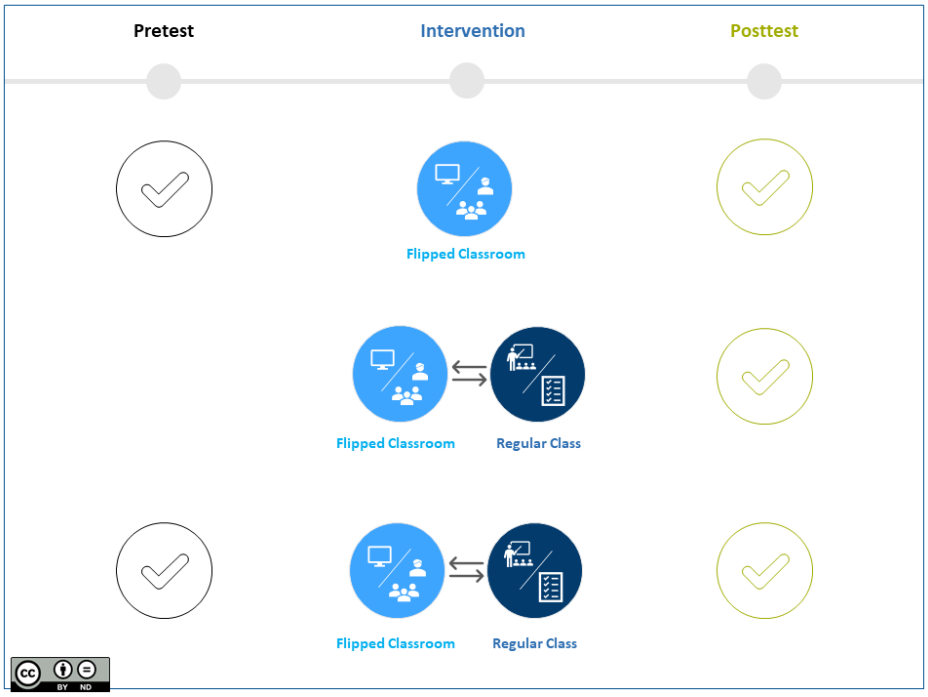
The authors take a nuanced approach to their analyses. They take into account the fact that experimental comparisons vary in rigor across studies. This means that depending on the nature of the underlying experimental comparison, the results must also be interpreted differently. Therefore, the authors assign all studies to three typical categories of comparisons, from simple pre-post comparisons of one group, to a post-test comparison between experimental and control groups, to rigorous learning change comparisons between experimental and control groups (see *Table 1* and *Figure 1*). Then authors calculate an average effect

(overall effect) for each of the three categories and conduct separate moderator analyses for each.

In addition, the authors use moderator analyses to examine four assumptions they derive from previous research findings:

- The assumption that the effectiveness of Flipped Classroom differs by school subject.
- The assumption that longer durations of Flipped Classroom should show smaller effects than shorter durations because students might get used to the method after a while, thus eliminating the so-called "novelty effect."
- The assumption that there are differences in the effects, depending on whether review quizzes on learned content are completed directly after the video viewed at home, or only later at school.
- The question of whether the additional use of learning management systems (such as Moodle) has a positive influence on the effects.

Figure 1: Overview of the different research designs that each meta-analysis examined.



WHAT DID THIS STUDY FIND? The results of the meta-analysis show that overall, secondary school students benefit from instruction based on the Flipped Classroom principle. The analyses show significant and positive overall effects[1] on student learning performance in all three comparison categories. In the »one-group pre-post comparison«category, the largest overall effect was found to be $d = 1.14$, indicating that students are adding to their learning in

[1]All findings apply to the analyses in which individual extreme values (so-called outliers) were excluded due to their distorting effect on the overall effect.

a measurable way through Flipped Classroom instruction, as they show a significant increase in knowledge from the pretest to the posttest.

In the other two (more rigorous) categories, the studies used control groups in the form of regular classes (in the traditional sequence) for comparison. Here, the overall effects are smaller, but still substantial and significant. Students in a Flipped Classroom learned more compared to students in regular classes. For two-group posttest comparisons, the effect size was d = 0.55, and for two-group change comparisons (most rigorous), the effect size was d = 0.45. These results serve as evidence that Flipped Classroom instruction can be more effective than instruction delivered in a traditional format. The moderator analyses came to different results depending on the comparison category (see *Table 1*). Moreover, only a small number of studies were included in each individual moderator analysis. Therefore, the meta-analysis could not contribute any clear findings about the authors' assumptions regarding further influencing factors.

HOW DOES THE CLEARING HOUSE UNTERRICHT EVALUATE THIS STUDY? The *Clearing House Unterricht Research Group* evaluates the meta-analysis using the following five questions, guided by the Abelson criteria (1995):

How substantial are the effects? The average effect sizes are in the medium (d = 0.45/0.55) to high range (d = 1.2) according to the typical classification by Cohen (1988). The effect size of d = 0.45 in the analysis of studies with controlled comparisons of change means that slightly more than 67% of learners in Flipped Classrooms made larger learning gains than the average learner in the regular classrooms.

Analogous to previous findings (see Cheung & Slavin, 2016), the meta-analysis shows that the more rigorous and thus more reliable study designs that allow for two-group change comparisons (category 3) have lower effect sizes. Nevertheless, the average effect size is still in the medium range, indicating consistency of the positive effect of Flipped Classroom offerings in secondary education. Another meta-analysis (van Alten et al., 2019), based primarily on studies from higher education, also found a positive overall effect (g = 0.36) for Flipped Classrooms.

In assessing all effect sizes in this meta-analysis, it is worth qualifying these findings by noting that the relatively small number of included studies were mostly based on small samples, and outcomes were rarely based on standardized achievement tests (as shown in the study example of this short review). It is known from research that these factors can also have a significant impact on outcomes. Thus, a larger number of primary studies that meet stronger validity criteria will be needed to demonstrate how robust the findings of this meta-analysis are.

How differentiated are the results? The analyses focused on secondary school students and were not further differentiated within this stage of education. With regard to school subjects, findings were compared from the areas of mathematics/computer science, science/technology, and language/humanities. Depending on the study design category, the moderator analyses provided different findings. Therefore, they do not allow for a clear

assessment of whether Flipped Classroom offerings differed in effectiveness between different school subjects. Moreover, all outcomes within the meta-analysis refer to student performance. Other possible outcomes, such as student motivation or engagement, were not investigated.

How generalizable are the findings? The question of generalizability of the reported effects first focuses on the conditions examined in the meta-analysis that could limit the general effectiveness of Flipped Classroom. The meta-analysis identified positive effects under nearly all conditions studied. That is, students benefited in different subjects, such as math and science, and for different durations of the intervention (from less than four weeks to more than eight weeks). The same was true for different uses of quizzes or learning management systems in the context of Flipped Classroom. Basically, the findings indicate a positive effect of Flipped Classroom under different conditions. However, the meta-analysis could not sufficiently clarify the extent these positive effects differed from each other, since the moderator analyses led to different results (see overview table »Individual findings of the meta-analysis at a glance«). Other potentially-influential factors could not be tested due to the small primary study base. For example, it would have been informative to know whether teachers' or students' Flipped Classroom prerequisites in motivation or experience played a role.

What makes this meta-analysis scientifically relevant? Current studies and meta-analytic findings on Flipped Classroom primarily come from higher education (see van Alten et al, 2019). Since the school context is very different from the university context, meta-analyses that identify reliable findings for specific learner groups are important. This meta-analysis makes an important contribution in this regard. It provides an initial inventory for secondary education specifically and offers evidence regarding the effectiveness of Flipped Classroom for this context.

The fact that the authors not only consider different study designs, but also consistently divide them into different analyses, is an effective measure, especially given the frequent heterogeneous nature of studies in classroom research. In this respect, this meta-analysis can be considered groundbreaking. Furthermore, the meta-analysis clearly shows that more research is needed to provide reliable answers to questions about the effective use and design of Flipped Classroom instruction

How methodologically reliable are the findings? The transparency and justification of the methodological approach largely meets the standards criteria of common requirement guides (e.g. APA Meta-Analysis Reporting Standards). The information on the search, coding, and analysis of primary studies meets almost all quality standards. However, more detailed information could have been added about the study selection process, namely, from the studies that were considered for inclusion, exactly how they were selected. Further information on the assessment of the methodological approach can be found in our rating sheet.

CONCLUSION FOR CLASSROOM PRACTICE. Flipped Classroom addresses a common, central concern of teachers and learners: having more time in class to deepen content learning by discussing the content, and working together on content (application) tasks that are accompanied by targeted support and timely feedback for individuals or student groups. This possibility is further boosted by technological developments, which significantly facilitate the creation and use of video-based learning material.

This meta-analysis also provides initial evidence, based on current research, that instruction using the Flipped Classroom approach offers benefits in student learning and is an effective alternative or supplement to regular classroom arrangements. However, the number and quality of existing studies also shows that research in this area is still somewhat in its infancy, and it is crucial for different design options or deployment scenarios of Flipped Classroom to be investigated in further studies.

EXAMPLE STUDY

The study by Kostaris and colleagues (2017) took place in 8th grade computer science classes over an eight-week period. Class content included computer hardware components as well as basic principles of information processing and software design. The sample consisted of two school classes (23 students each), both taught by the same teacher.

To determine the effectiveness of Flipped Classroom, the teacher taught one class using Flipped Classroom (experimental group) and the other class in a regular class format (control group). Both classes were taught in a project-based manner, meaning that the students worked together on open-ended tasks that they had to plan and implement.

For the experimental group, the teacher created instructional videos on the content that students should watch to prepare at home. The class was then able to use the time in the classroom almost exclusively for joint work. On the other hand, in the control group, the content was developed through teacher lectures during in-person class. Then for the rest of the class time, students were able to work together on assignments and continue the work at home. The learning time, the learning content, and also the project-based teaching mode were thus the same in both study groups. The groups only differed in the design of in-person class time and the time at home.

Together with colleagues and researchers, the teacher developed a multiple-choice test based on the curriculum specifications. Using this test, the performance of the experimental group and control group was measured before and after the instructional sequence. Thus, the study implemented a study design on the basis of the change comparisons that could be made. Both groups performed better on the posttest than on the pretest, but the gain was greater in the Flipped Classroom group (d = 0.75).

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LINKS.

To the meta-analysis from Wagner and colleagues (2020).

To the study example from Kostatis and colleagues (2017).

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