

## How Beneficial and Satisfying Might a Flipped Classroom be to High-School Science Education? A Comparative Case Study

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### Abstract

The flipped classroom approach has become a popular pedagogical method in many educational institutions around the world. This hybrid learning approach integrates distance learning and face-to-face meetings. It flips the traditional approach: the teacher's lecture is delivered through online videos, while exercises and problem-solving take place in the classroom in small groups accompanied by guidance from the teacher. The purpose of the case study presented in this paper was to implement this innovative strategy in high-school chemistry education and examine the student's overall satisfaction. Furthermore, this study investigates the impact of the flipped classroom on in-class group work, in-class social interaction, and students' achievement, all in comparison with the traditional approach. Both qualitative and quantitative methods were applied and took the form of an online questionnaire along with feedback written by the students. A high level of satisfaction was reported in both the questionnaire responses and the free feedback. Many advantages and benefits were reported repeatedly in the students' feedback, though some disadvantages were also reported and beneficial recommendations proposed. Positive and significant differences were found for all the variables tested except student achievement, for which a positive but insignificant effect was viewed. Correlations between the self-efficacy, in-class group activity, in-class social interaction, and satisfaction variables were checked and found to be positive.

**Keywords:** flipped classroom, self-efficacy, in-class social interaction, satisfaction, student achievement.

### Introduction

The flipped classroom is an instructional strategy and a type of blended learning approach that reverses the traditional teaching environment by delivering instructional content by online videos. It moves activities and problem-solving, which require higher-order thinking skills and considered as homework in the traditional approach, into the classroom. In a flipped classroom, students often work in small groups in the class with guidance from the mentor. Theoretically, a flipped classroom can enhance student engagement and increase in-class social interaction, student-student and student-teacher, since it relies on small group working guided by the teacher. In this approach, the teacher performs as a "guide on the side" instead of "sage on the stage." Also, it can contribute to students' ZPD — zone of proximal development — and it provides for self-paced learning that is unlimited by time or place. In this novel approach, the researcher infiltrates, as a teacher and educator, into the digital world of high school students, through technology. Practically, this hybrid learning approach might be the perfect solution to the existing time-problem in high-school science education. There is a long science-syllabus required for the Bagrut exams, and there are not enough face-to-face lessons for teaching the whole required content and practicing it into small groups, in the class. The flipped classroom enables delivering the content (all of it or part of it), by on-line videos, and this way, it frees out class-time for small-group

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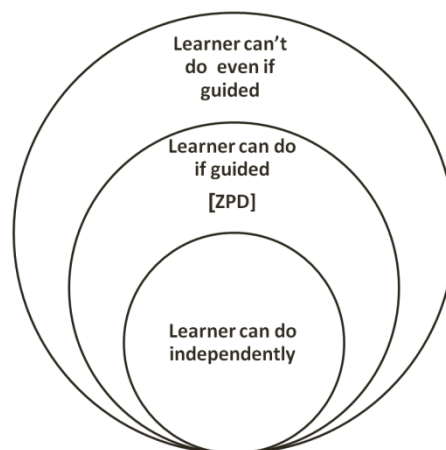
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working. Otherwise, face-to-face lessons are basically used for content-delivery. Furthermore, this study compares, measures, and evaluates the impact of the flipped classroom on in-class group activities, in-class social interaction, and student's achievement, all in comparison with impact of the traditional approach. Furthermore, the study explores students' overall satisfaction with the flipped classroom approach and uses written feedback gathered from the participants.

## Literature review

A flipped classroom (FC) consists of two parts: online video lectures as distance learning, and in-class face-to-face activities. However, pre-class text-reading is usually not considered a component of FCs (Bishop and Verleger, 2013). Bergmann and Sams (2012) were the first chemistry teachers to use the internet to make video lectures available to absent students. Since Bergmann and Sams's 2007 FC initiative, this novel instructional method has become viral.

The FC approach is valuable since it has many advantages over the traditional classroom (TC) approach: it provides for self-paced learning, it frees class time for teacher-guided small-group activities instead of lectures, it is more interesting, it is unlimited by time or place, it enables students to repeat and rewatch the video lectures, it results in higher student engagement, and it speaks the language of today's students by integrating technology as a flexible and appropriate learning tool for the twenty-first century (Bergmann & Sams, 2012; Herreid & Schiller, 2013). Another important benefit of the FC approach is the high involvement of the students in the teaching-learning process. The FC approach replaces traditional teacher-centered teaching with student-centered learning, thereby enhancing students' engagement (Gilboy et al., 2015; Chen, 2016). It enables more student-student and student-teacher interaction since it relies on small-group work (Chen, 2016; Clark, 2015). This social interaction contributes to the ZPD — zone of proximal development (Figure 1), as defined by Vygotsky (1978). ZPD refers to the difference between what a learner can do without help and what he or she can do with help. Vygotsky and other educators believe that the role of education is to give students experiences that are within their zones of proximal development, thereby encouraging and advancing their individual learning.



**Figure 1. ZPD Zone of Proximal Development**

Different empirical comparative studies showed FCs having a different impact on student achievement than TCs: higher achievement (Thai et al., 2017; Peterson, 2016), no change in achievement (Chen, 2016; Clark, 2015), and lower achievement (Gundlach et al., 2015). However, comparative studies showed higher overall student satisfaction with the FC approach as compared with the TC approach (Peterson, 2016; Stockwell et al., 2015). Moreover, Chou found a positive correlation between self-efficacy and student satisfaction with FCs (2017), and Thai et al. found that the FC approach had a positive impact on self-efficacy beliefs (2017).

Notably, the FC approach requires that students develop strategies for self-regulated learning (Sletten, 2017).

Existing alongside the many benefits of FCs are disadvantages, fears, and challenges regarding FCs. The FC approach might increase students' screen time; students might show resistance to this approach, especially if they have not experienced it before (Herreid & Schiller, 2013); it is hard for teachers to find good and suitable videos on the internet or record their own videos (Herreid & Schiller, 2013; Chen, 2016); some students might not watch the pre-class video lectures (Herreid & Schiller, 2013; Chen, 2016); and students cannot ask questions immediately after watching the video lectures. Ten guidelines and recommendations for overcoming the above-mentioned and other challenges were suggested by Lo and Hew (2017). Some of the recommendations were to prepare a short quiz right after the video lecture to ensure that all students watch it and to record short videos as a way to support both students and teachers.

### **The study**

The case study described in this paper was conducted in a private Arab high school in Israel in the spring. Two groups of students participated in the research: a control group made up of 22 students who learned in a TC approach, and an experimental group made up of 27 students who learned in a FC approach. In addition to learning in different approaches, the two groups had different teachers. Both groups were eleventh grade students, learned the same material on the chemistry of food, learned the subject on the same period of time – 5 weeks long, had 6 face-to-face lessons per week, and took the same exam at the end of the 5 weeks of the unit. The TC lessons included: teaching and delivering all the required content and sometimes group working in the time remaining (if any). In the intervention unit of the FC, each week included: one asynchronous lesson as an online video lecture and six face-to-face lessons included interactive activities in small groups. In the FC, all the content was delivered by on-line videos, and all the face to face meetings were used for small-group working. Very important considerations went into the development of the intervention unit: the students were given verbal and written explanations of the FC approach as well as its definition; student-teacher communication was opened up to allow the students to express themselves and the teacher to provide support; the teacher recorded short videos (4–13 minutes long); when recording the videos the teacher talked to the students as if they were present; a weekly 'Kahoot' game was held at the beginning of each face-to-face class the day after the students watched a video; no homework except watching the videos was given; and students with difficulties worked in small groups accompanied and guided by the teacher. These considerations are similar to some of the recommendations and guidelines proposed by Lo and Hew (2017).

### **Research questions**

The researchers formulated and investigated three main research questions:

1. How does the FC approach affect the following:
  - i. in-class group activities?
  - ii. in-class social interaction?
  - iii. Students' achievement?all in comparison with the TC approach?
2. How does the FC approach affect students' overall satisfaction?
3. What kind of correlations, if any, exists between self-efficacy, in-class group activities, in-class social interaction, and student satisfaction?

## Methodology

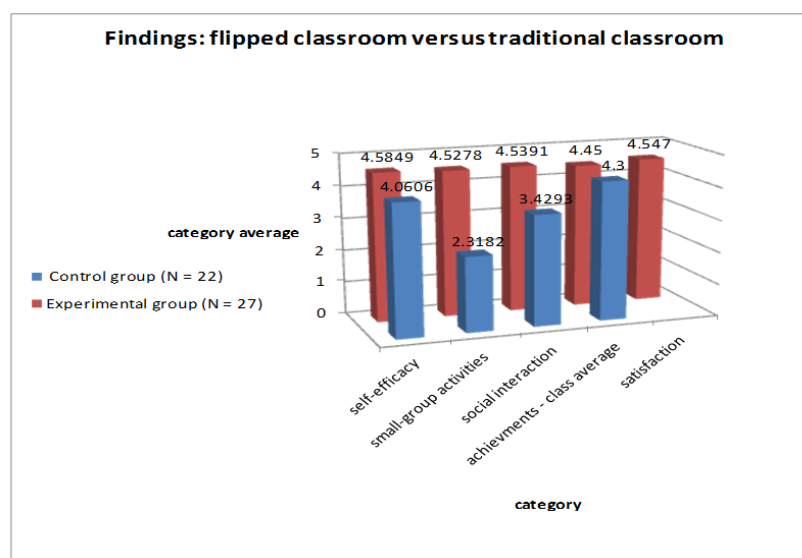
The research included the use of both qualitative and quantitative methods: online questionnaire and free feedback written by the students. The questionnaire consisted of 5-point Likert scale questions grouped into four parts, each part asking about a different aspect of the students' learning, namely self-efficacy using the Chen and Gully (1997) and Schwarzer and Jerusalem (1993) scales, in-class small-group activities, in-class social interaction, and satisfaction (using questions formulated specially for this research). The questionnaire was delivered at the end of the unit as a Google Doc, and the students filled it out anonymously. The students were told, in the written introduction of the questionnaire, that the questionnaire was for research purposes only. The experimental group was requested to fill out all four parts of the questionnaire, while the control group was requested to fill out the first three parts only. The results were analyzed by an SPSS program using a t-test and the Pearson correlation. Cronbach's alpha was calculated separately by the SPSS program for each part of the questionnaire: part 1, self-efficacy,  $\alpha=0.97$ ; part 2, small-group activities,  $\alpha=0.949$ ; part 3, social interaction,  $\alpha=0.892$ ; and part 4, satisfaction,  $\alpha=0.907$ . The feedback written by the students was read, coded, and categorized by the first researcher. The small number of participants was a main limitation in this case study.

## Findings

All the variables tested scored higher in the FC group than in the TC group (Table 1). Moreover, the results showed that the FC had a positive effect on in-class group activities ( $p<0.001$ ), in-class social interaction ( $p<0.001$ ), and student achievement in comparison with the TC. Significant differences were found on t-tests for some of the factors. Students' self-efficacy was also checked and found to be higher in the FC group ( $p<0.01$ ) (Chart 1).

**Table 1. Findings: FC versus TC**

Category	Experimental group (N=27)		Control group (N=22)		t-test
	Average	Std. Deviation	Average	Std. Deviation	
Self-efficacy	4.5849	0.51194	4.0606	0.76352	p=0.006
Small-group activities	4.5278	0.57735	2.3182	0.84931	p<0.001
Social interaction	4.5391	0.48891	3.4293	0.79704	p<0.001
Satisfaction	4.547	0.54823			
Achievements - class average	89%		86%		



**Chart 1. Findings: flipped classroom versus traditional classroom**

The students' overall satisfaction with the FC was high, as calculated from the results of the questionnaire, 4.547/5, and as mentioned in the students' written feedback. The latter was read, coded, and categorized into five categories. In category 1, general advantages of the FC, "enjoyable experiential method" was mentioned by 70% of the students in the experimental group, "thanks" was mentioned by 63%, "a strategy which develops self-learner skills" by 63%, "novel different approach" by 63%, "a strategy which develops learner responsibility" by 59%, "I liked it" by 48%, "effective project" by 48%, "academic strategy that prepares students for college" by 33%, "successful strategy" by 30%, "meaningful strategy" by 22%, and "it develops self-confidence" by 19%. Categories 2-5 are detailed in Table 2 and contain advantages and disadvantages of both the distance learning (watching online video lectures) and face-to-face (small-group activities) components. The written feedback also included recommendations and suggestions. For example, the students said that a forum for discussion is definitely needed and that the implementation of this approach for other subjects is required and highly recommended.

**Table 2. Findings: students' written feedback**

	<b>Advantages</b>	<b>Disadvantages</b>
<b>Distance learning</b>  <b>Online video lectures</b>	Online videos can be repeated and <u>rewatched</u> 74% Unlimited by time 74% Unlimited by place 41% Comfortable strategy 26% Allows free Googling during the online video lecture 26% Students can concentrate while watching the videos 19% It integrates novel technology 15% It enhances self-regulated learning 11% It allows absent students to complete what they missed 11% The student is responsible for writing down and summarizing the lecture 7.4%	No immediate questions are possible 52% Some students might not watch the pre-class online video lectures 19% The student is responsible for writing a summary and might make mistakes 7.4% Lower motivation to watch videos in comparison with face-to-face lesson 7.4% No discussion on the lecture 7.4% No eye contact exists 3.7%
<b>Face-to-face meetings</b>  <b>Small-group activities</b>	Small-group activities enhance sharing and cooperating 22% It enhances the development of cognitive skills 19% It develops social skills 11%	Small-group work takes more time than individual problem-solving 7.4% It allows freeloaders to freeload 3.7%

Correlations were tested using Pearson correlation: A medium-strong positive correlation was found between the integration of small-group activities and social interaction ( $r=0.669$ ,  $p<0.01$ ). A strong positive correlation was found between self-efficacy and social interaction ( $r=0.706$ ,  $p<0.01$ ). A medium positive correlation was found between self-efficacy and satisfaction ( $r=0.367$ ,  $p>0.05$ ).

## Discussion

Similar to previous studies, the current findings showed that the FC had a positive impact. In comparison with the TC, the FC resulted in (i) an increase in in-class group activities (Bergmann & Sams, 2012), (ii) an increase in in-class social interaction (Chen, 2016; Clark, 2015), and (iii) higher student achievement (Thai et al., 2017; Peterson, 2016; Chen, 2016; Clark, 2015). Some of the differences in comparison with the TC were significant. Furthermore, it was found that the students' overall satisfaction with the FC was high, as referred to in the research literature

(Peterson, 2016; Stockwell et al., 2015). Consequently, we highly recommend integrating the flipped approach in high-school education in general, and in high-school science education in particular. We can conclude that the FC is highly beneficial and strongly recommended in cases where we, as educators, wish to improve in-class social interaction.

Vygotsky pointed out a positive correlation between integrating small-group activities and social interaction (1978), and such a positive correlation was found in this study as well. We also found positive correlations between self-efficacy and overall student satisfaction, a correlation Chou referred to (2017), and between self-efficacy and social interaction, as Shea & Bidjerano found (2010). A question arises regarding the higher self-efficacy recorded in the FC: Does the FC positively affect students' self-efficacy, as found in a previous study (Thai et al., 2017)? Answering this question requires future comparative studies with pre-questionnaires administered to both groups.

Most of the advantages and disadvantages mentioned in the students' feedback were also mentioned by Bergmann and Sams (2012) and Herreid and Schiller (2013), and it seems that some of the disadvantages are unavoidable. The students proposed recommendations and suggestions such as creating a discussion forum and implementing this approach in other subjects. Those recommendations can come in handy when designing future FCs.

### **Contributions**

This case study makes both theoretical and practical contributions. First, it contributes theoretically by adding more information to the existing body of knowledge about FCs. As Lo and Hew write, "It appears that the research in K–12 FC education occupies only a small portion of the body of literature. More practical studies are recommended to investigate the effects and challenges of K–12 FCs" (2017). In addition, this study contributes to reducing an existing knowledge gap referred to by Stockwell et al.: "Blended learning is an emerging paradigm for science education that has not been rigorously assessed" (2015). Second, this research makes a practical contribution as well in that the feedback written by the students includes advantages and disadvantages of FCs and recommendations that can be beneficial to future research guiding the development of new FC programs. The findings of this study provide effective advice and suggestions to educators incorporating such an instructional method into their teaching, and they offer researchers insight into the value of this instructional model

### **Limitations**

There were several limitations of the research: small number of participants, there was no pre-questionnaire for the participant groups, the students' satisfaction with the TC was not checked, the different groups were taught by different teacher and the final-exams at the end of the unit were checked by the different teachers.

### **Recommendations and suggestions for future research**

General recommendations: In comparative research, it is preferable to have two groups learning with the same teacher, or at least to have the final exam checked and evaluated by the same teacher; a discussion forum or platform for the distance learning should be set up; a LMS (learning management system) for supervision should be required and a pre-questionnaire should be administered for both groups.

Future research might investigate the impact of the FC on self-efficacy beliefs, the effect of the FC on the development of strategies and skills for self-regulated learning, the impact of the FC on the same students' performance and achievement, and the effect of self-regulated learning on students' development into life-long learners.

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