How beneficial and satisfying a flipped classroom might be on high school science education? A comparative case study

**Abstract**

The flipped classroom approach has become a popular pedagogy in many education institutions around the world. This hybrid learning integrates both: distance learning and face to face meetings. It flippes the traditional approach: the teacher's lecture is delivered through on-line videos, while exercises and problem solving take place at the classroom, in small groups, accompanied by guidance of the teacher. The purpose of the case study, presented in this paper, is to implement this innovative strategy in the high school chemistry education and examine the student's over-all satisfaction. Furthermore, this study investigates the impacts of the flipped classroom on: in-class group working, in-class social interactions and student's achievements, all in comparison versus the traditional approach. Both qualitative and quantitative methods were applied: on-line questionnaire and feedback written by the students. A high range of satisfaction was reported in both methods. Many advantages and benefits were reported repeatedly on the student's feedback, some disadvantages and beneficial recommendations were also proposed. Positive and significant differences were found in all the variables tested, except student's achievements; although a positive effect was viewed, but not significant. Correlations between variables: self-efficacy, in-class group activities, in-class social interaction and satisfaction, were checked, and found as positive.

**Keywords** flipped classroom, self-efficacy, in-class social interaction, satisfaction, student's achievements.

**Introduction**

Flipped classroom is an instructional strategy and a type of blended learning that reverses traditional teaching environment by delivering instructional content by online videos. It moves activities and problem solving, that are considered as homework on the traditional approach, into the classroom. Oftenly, students work in small-groups in the class, with the guidance of the mentor. Theoretically, flipped classroom may enhance student's engagement, increase in-class social interaction by working into small groups with the presence of the teacher as a guide on the side instead of sage on the stage. Also, it may contributes to the ZPD- Zone of Proximal Development and it provides a self-paced learning, unlimited by time or place. In this novel approach, the researcher infiltrate, as a teacher and educator, into the digital world of high school students, through technology. Practically, this study compares, measures and evaluates the impacts of the flipped classroom upon: in-class group activities, in-class social interaction and student's achievements, all in comparison with the traditional approach. Furthermore, the study explorers the student's over-all satisfaction of the flipped classroom approach and gathers written feedback of the participants.

**Literature review**

Flipped classroom (FC) consists of two parts: on-line video lectures as a distance learning, and in-class face to face activities. However, text-reading as a pre-class reading is usually not considered as a FC (Bishop and Verleger, 2013). Bergmann and Sams (2012), were the first chemistry teachers who used on-line videos to spread lectures through the internet for absent students. Since 2007, Bergmann and Sams FC initiative, this novel instructional method has become viral.

The FC approach is valuable since it has many advantages over the traditional classroom approach (TC) : it provides self-paced learning; it frees the class time for small-groups activities guided by the teacher instead of lectures; it is more interesting; unlimited by time or place; enables repeating and re-watching the video-lectures; it reflects higher engagement of the students; it speaks the language of today's students by integrating technology as a flexible appropriate learning strategy for the 21 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. It is a student-centered learning strategy, which replaces the traditional teacher-centered teaching strategy, so, it enhances the student's engagement (Gilboy et al., 2015; Chen, 2016). It enables more student-student and student-teacher interaction since it relies on small-group working (Chen, 2016; Clark, 2015). This social interaction contributes to the ZPD- Zone of Proximal Development 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.

Different empirical comparative studies showed different results concerning the impact of the FC over the student's achievements as compared with TC: higher achievements (Thai et al. 2017; Peterson, 2016), neutral achievements (Chen, 2016; Clark, 2015), lower achievements (Gundlach et al. 2015). However Comparative studies showed higher over-all student's satisfaction of the FC approach as compared with the TC (Peterson, 2016; Stockwell et al. 2015). Moreover, a positive correlation between self-efficacy and student's satisfaction of the FC was found by Chou (2017). Besides, a positive impact of the FC approach over self-efficacy beliefs was found by Thai et al. (2017). Notabely, learning by the FC approach needs strategies development of self-regulated learning (Sletten, 2017).

Notably there along with the many benefits ther are disadvantages, fears and challenges regarding FC. It might increase screen time; Students might show resistance, especially if they did not experience this approach before (Herreid & Schiller, 2013); It is hard for teachers to find good and suitable videos on the net, or record their own videos (Herreid & Schiller, 2013; Chen, 2016); Some of the students might not watch the pre-class video lectures (Herreid & Schiller, 2013; Chen, 2016); Students cannot ask immediate questions. Ten guidelines and recommendations were suggested by Le and Hew (2017), in order to overcome the challenges mentioned above and others. Some of the recommendations: to prepare a short quiz right after the video lecture, to insure that all the students watched it, to record short videos and to support both, students and teachers as well.

**The study**

The case study described in this paper was conducted in a private Arab high school in Israel at spring. Two groups of students participated in the research: a control group - students who learned in TC and experiment group - students who learned in FC approach. Both groups are 11th  grade student who learnt the same material, Chemistry of food, but in different approaches and with different teachers too. Both groups took the same exam at the end of the unit. The intervention unit extended over 5 weeks. Each week included one a-synchronous lesson: an on-line video lecture and 6 face to face lessons: interactive activities in small groups. Very important considerations were taken while developing the intervention unit: Verbal and written explanations and definition of the FC were given to the students; Student-teacher communication was opened in order to allow self expression and provide teacher support; Short videos were recorded by the teacher (4-13 minutes long); The teacher talked to the students as if they were present on recording the videos; A weekly "Kahoot" game was held at the beginning of each face to face class, a day after watching the video; No homework were given except watching the videos; Students with difficulties worked in small groups accompanied and guided by the teacher. Those considerations are similar to some of the recommendations and guidelines proposed by the researchers Le and Hew (2017).

**Research Questions**

Three main research questions were formulated and investigated by the researchers:

1. How does the FC affect:
2. in-class group activities
3. in-class social interaction
4. student's achievements in comparison with TC?
5. How does the FC affects the students over-all satisfaction?
6. What kind of correlations, if exist, are there between: self-efficacy, in-class group activities, in-class social interaction and satisfaction?

**Significance of the study**

This case study has both theoretical and practical contributions. First, as a theoretical contribution, it adds more information to the existing body of knowledge about the FC. "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 FC" (Lo & Hew, 2017). Besides, this study contributes to reduce the existing gap referred by Stockwell et al. (2015): "Blended learning is an emerging paradigm for science education that has not been rigorously assisted". Second, this research has a practical contribution as well. The feedback written by the students which includes advantages, disadvantages and recommendations can be beneficial for future research as guidelines for developing new FC programs.

**Methodology**

The case study described in this paper was conducted in a private Arab high school in Israel. Two groups of students participated in the research: Control group-TC, 22 students and experiment group-FC, 27 students. The research included both qualitative and quantitative methods: on-line questionnaire and a free feedback written by the students. A 5 scale lykert questionnaire was confirmed of 4 parts, each part asked about a different aspect: self-efficacy taken from Chen and Gully (1997); Schwarzer and Jerusalem (1993), in-class small group activities, in-class social interaction and satisfaction (formulated especially for this research). The questionnaire was delivered at the end of the intervention unit, as anonymous google-docs. The students were told, as written on the introduction of the questionnaire, that it is for research purposes only. The experiment group was requested to fulfill all the 4 parts of the questionnaire, while the control group was requested to fulfill the first 3 parts only. The results were analyzed by SPSS program, using T-Test and Pearson correlation. Alpha cronbach was calculated separately by spss program for each part of the questionnaire: part (1)- self-efficacy α=0.97, part (2) small-group activities α=0.949, part (3)- social interaction α=0.892, part (4)- satisfaction α=0.907. The feedbacks written by the students were read, coded and categorized by the first researcher. A small number of participants was a main limitation in this case study.

**Findings**

All the variables tested were scored higher on the FC, as compared with the TC (Table 1). Moreover, the results showed positive effect of the FC on: in-class group activities (p<0.001), in-class social interaction (p<0.001) and student's achievements in comparison with the TC. Significant differences were found on T-Test regarding some of the factors. Student's self-efficacy was also checked and found to be higher on the FC (p=0.006) (Chart 1).

Table 1 – Findings: FC versus TC





Chart 1 – Findings: flipped classroom versus traditional classroom

The student's over-all satisfaction from the FC was high as calculated from the results of the questionnaire 4.547/5, and as mentioned on the student's written feedback. The feedbacks written by the students were read, coded and categorized into 5 categories: category (1) – general advantages of the FC, such as: "enjoyable experiential method" was mentioned by 70% of the students in the experiment group, "thanks" 63%, "a strategy which develops self-learner skills" 63%, "novel different approach" 63%, "a strategy which develops the learner responsibility" 59%, "I liked it" 48%, "effective project" 48%, "academic strategy that prepare students for the university" 33%, "successful strategy" 30%, "meaningful strategy" 22%, "it develops the self confidence" 19%. Categories 2-5 are detaild on Table 2, it contains advantages and disadvantages of both components: distance learning - watching on-line video lectures, and face to face meetings – small-groups activities. The written feedback also included recommendations and suggestions, such as: a forum for discussion is necessarily needed and implementation of this approach on other subjects is required and highly recommended. Specific notices regarding the videos were mentioned by the students: "obvious explanation" 19%, "kahoot game was interesting" 11%, "short videos" 7.4%, "the videos were well designed and built-in" 7.4%, "the teacher had a sense of humor" 3.4%, "I felt as if the teacher is in front of me" 3.4%.

Table 2- Findings: student's written feedback

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| --- | --- | --- |
| Disadvantages | Advantages |  |
| No immediate questions are possible 52%Some students might not watch the pre-class on-line video lectures 19%The student is responsible about 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 upon the lecture 7.4%No eye contact exists 3.7% | On-line videos can be repeated and re-watched 74%Unlimited by time 74%Unlimited by place 41%Comfortable strategy 26%Allows free googleing during the on-line video lecture 26%The students watch the videos while he feels in concentration 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 about writing and summarizing the lecture 7.4% | Distance learningOn-line video lectures |
| Small- groups working needs more time if compared with individual problem solving 7.4%It allows hitchhikers to appear 3.7% | Small- group activities enhance sharing and cooperating 22%It enhances development of cognitive skills 19%It develops social skills 11% | Face to face meetingsSmall-group activities  |

Correlations were tested by Pearson: A medium-strong positive correlation was found between integrating small-groups 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*<0.01 ).

**Discussion**

Similar to previous studies, the current findings showed a positive impact of the FC in comparison with TC upon: (i) an increase in In-class group activities (Burgman & Sams, 2012); (ii) an increase in in-class social interaction (Chen, 2016; Clarck, 2015); (iii) higher student's achievements (Thai et al., 2017; Peterson, 2016; Chen, 2016; Clark, 2015). Some of the differences were significant in comparison with the TC. Furthermore, it was found that the student's over-all student's satisfaction of the FC was high as referred on research literature (Peterson, 2016; Stokwell et al., 2015). Consequently, it is extremely recommended to integrate the flipped approach in high school education in general, and in science high school 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.

A positive correlation was found between integrating small-groups activities and social interaction as pointed by Vygotsky (1978). Another positive correlations were found between self –efficacy and over-all student's satisfaction as referred bu Chou (2017) and between self-efficacy and social interaction as found by Shea & Bidjerano (2010). Another question arises regarding the higher self-efficacy recorded on the FC: does the flipped affectes positively student's self-efficacy, as found on previous study (Thai et al., 2017). An answer for this question requires future comparative study with pre-questionnaires for both groups.

Most of the advantages and disadvantages mentioned in the student's feedbacks were mentioned also by Bergmann and Sams (2012) and Herreid and Schiller (2013), and it seems that some of them are unavoidable. Extra recommendations and suggestions were proposed by the students such as a discussion forum and implementing this approach on other subjects. Those recommendations can be handy on future FC designing.

**Contributions**

This case study has both theoretical and practical contributions. First, as a theoretical contribution, it adds more information to the existing body of knowledge about the FC. Besides, this study contributes to reduce the existing gap in Blended learning as an emerging paradigm for science education that has not been rigorously assisted. Second, this research has a practical contribution as well: the feedback written by the students which includes advantages, disadvantages and recommendations can be beneficial for future research as guidelines for developing new FC program. The findings of this study provide educators with effective advices and suggestions when incorporating such instructional method in teaching. It offers researchers insights and value of the instructional model.

**Limitations**

Main limitations of the research are: small number of participants, there was no pre-questionnaire for the participant groups; the student's satisfaction on the TC was not checked; there was no forum or a platform for discussion for the distance learning; there was no LMS (learning management system) for supervision; there were different teachers for the different groups and the requested written free feedback included no guidelines.

 **Recommendations and Suggestions for future researches**

General recommendations: in a comparative research it is preferable to use two groups who learn with the same teacher, or at least the final exam have to be checked and evaluated by the same teacher; a forum for discussion shall be opened, LMS should is required and pre-questionnaire should be done for both groups.

Future research might investigate: the impact of FC over self-efficacy beliefs; the effect of the FC over developing self-regulated learning strategies and skills; the impact of the FC upon the same student's performance and achievements and the effect of the self-regulated learning upon developing a life-long learner.