

# Learning Styles and Flipped Classroom: An Experience in Secondary School

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**Abstract.** Flipped Classroom (FC) has been gaining prominence in recent years and multiple articles have appeared that highlight its ability to increase the academic performance of the students who use it. This research asks how students' academic outcomes vary when using FC compared to traditional class based on their learning style. The sample used to carry out the research were two groups of 3rd level of Secondary Education who took math classes using FC during a quarter. The methodology used has been quantitative, at the beginning of the quarter all students took a questionnaire to determine their learning style (CHAEA questionnaire) and also, before and after each topic, conducted evaluation tests. The results show that students improve their academic performance by using FC compared to the traditional class; however, this improvement is not statistically significant. When we focus on the different learning styles, different results appear depending on the block of mathematical content treated and the active style is the one that gets the best results. The main contribution of this research lies in the study of the correlation between academic results and the learning style of each student.

**Keywords:** Flipped Classroom, Mathematics, Academic Results, Secondary Education, Learning Style.

## 1 Introduction

The FC is a pedagogical model that is based on the investment of time and the role of students and the teacher [1]. When using the FC the transmission of theoretical concepts in class is usually replaced by the viewing of online videos at home by the students [2]. In this way students have already received the contents and face-to-face time in class can be used for top-level activities of bloom taxonomy [3] such as applying, analyzing, evaluating or creating [4]. Students go from passive recipients in the traditional model to having an active participation in the FC [5]. Moreover, the teacher goes from being a mere transmitter of knowledge in the traditional class to a guide and creator of learning scenarios in the FC [6]. Currently in the international databases, there are more than 5000 scientific documents on different areas and

aspects of the FC [7]. This issue highlights the impact that the FC is currently having on the world of education and how important it is for its future.

On the other hand, learning styles in education is one of the most studied fields, but there is no universal definition of this concept [8]. Despite this, there is a consensus that it refers to each student's way of learning [9]. Authors such as [10-16], among others, have developed different types of learning styles and created instruments to classify students, but the most used in Spanish is the Honey-Alonso Questionnaire on Learning Styles (CHAEA) [17].

Students are a source of basic information to assess the quality, relevance and fairness of their training, as well as the strengths and weaknesses of the learning process [18]. This information is nourished by two sources: the learning outcomes and the assessments of their experiences during their training [19].

The objective of this research is to analyze the results of students' assessments based on the learning style.

This research raises the following hypotheses:

H1- The academic results of students with active learning style when using the FC get better results than students who follow the traditional class.

H2- Students' learning style conditions their academic performance when using FC compared to traditional class.

## **2 Theoretical framework**

The FC began to become known from 2007, when two teachers Jonathan Bergman and Aarom Sams professors of chemistry at Woodland Park High School in Colorado, video-posted Power Point presentations from their classes and published them online, for students who could not attend class. His surprise was that his videos went viral and many students began to watch them [20]. Another milestone that helped popularize fc was the emergence of the Khan Academy website, founded by Salman Khan in 2006, where videos of different subjects could be found [21].

Regarding the academic performance, you get from using FC instead of the traditional class in the ESO math area, most research supports that they increase. An example of this is the research of [22-29] and [30] among others. On the other hand, [31] claim that on an algebra issue the academic results were similar in both groups.

In relation to learning styles, there have been many attempts by researchers to define them [8]. In the 1940s, researchers focused on cognitive elements or psychological aspects [32]. Later there is a third trend that proposes the synthesis of both approaches that argues that the style of learning is constituted by cognitive style and learning strategies [33]. [34] Indicated that motivation, emotions and sociological aspects are variables that affect learning styles. In the 1980s with the increase in research in learning styles, the affective dimension began [35]. In the 1990s, [32], researched the relationship not only of cognitive style with learning strategies but also with the affective dimension and motivational aspect. From Goleman's so-called emotional intelligence [36] he resurfaces interest in the inclusion of the affective, as a way of indogging to deepen the theory of learning styles. [37] Analyzes different tools

and tools to diagnose learning styles and finds only six that analyze cognitive and affective styles together, among which the CHAEA questionnaire.

[38] Describes the characteristics of people with predominance in any of the learning styles, in Table 1 are the main ones.

**Table 1.** Characteristics according to learning style

Learning style	Main characteristics
Active Style	Emphasis on concrete experience. They are students who are fully and unbiasedly involved in new experiences.
Reflective Style	Emphasis on reflective observation. They are students who like to consider experiences and observe them from different perspectives.
Theoretical Style	Emphasis on abstract conceptualization. They adapt by integrating observations into logical and complex theories. They approach problems in a vertical.
Pragmatic Style	Emphasis on active experimentation. Its strong point is the practical application of ideas. They like to act quickly and confidently with those ideas and projects.

A study conducted by [39] using the CHAEA questionnaire, indicated that learning styles are not associated with age or gender. On the other hand, [40] found that learning styles are heterogeneous depending on the university career.

### 3 Methods

A quantitative approach has been used in this research. The scope of the research is correlational, in claiming to know the relationship between the learning style of the students and their academic performance when using the FC.

The participants in this research have been two groups of 3rd Compulsory Secondary Education (ESO) of the Ermengol IV Institute of the town of Bellcaire d'Urgell in Spain. The class A of 3rd level of secondary school A had 19 students and the class B with 18 students, of which 62% were girls and 38% were boys. The components of the classes did not vary throughout the research, and were already created at the start and were homogeneous. Students used FC throughout the first trimester of the course in math classes.

The instruments used have been a questionnaire and evaluation tests. On the one hand, the Honey-Alonso Learning Styles Questionnaire (CHAEA) consisting of 80 questions (20 items for each of the four learning styles) to which it responds dichotomy way by expressing whether you agree or disagree. The maximum score in each style (Active, Reflective, Theoretical and Pragmatic) is 20. At the start of the quarter, all students took the CHAEA questionnaire to determine their learning style.

In 1988 Honey and Mumford created the LSQ (Learning Styles Questionnaire), detecting four learning styles: Active, Reflective, Theoretical and Pragmatic. This four styles were took it by CHAEA (Honey-Alonso Questionnaire on Learning Styles) [33].

On the other hand, the evaluation tests consisted of ten questions related to the knowledge acquired by students on the subject to be addressed at one point each. A pre-evaluation (Pretest) and a final evaluation (Postest) were performed on each topic. The evidence contained the same questions only varied the figures contained in the advertised ones. Also after 4 months of carrying out the final evaluation of item 1 they were again asked to perform the same test, to see how their knowledge of topic 1 had varied over time. In this case we had a pretest, pre-evaluation and two postest, final evaluation and evaluation after 4 months.

Three topics were made from different blocks of the math subject. Item 1: Fractions, belonging to the numbering and calculation block; topic 2: Geometric places, block space and shapes and theme 3: Polynomials, block changes and relationships.

In topic 1 the students of 3rd ESO A used the master class and those of 3rd ESO B the FC methodology. In the next topic, they changed and the students of 3rd ESO A were the ones who used the FC and the 3rd ESO B master class.

Before each class, students of FC group had to watch at home a video of a maximum of 10 minutes, made by the teacher and with content of the subject. The videos were available in Moodle and were posted on the Edpuzzle page, which allowed the videos to contain questions and not be advanced.

Once in class they had to ask questions and doubts that had arisen from the video seen at home. After students were placed in groups of four (the members changed in each new topic) and carried out activities related to the contents seen at home. After every activity, a volunteer exhibited his solution on the board and the teacher corrected it and commented for all students.

## 4 Results

Below are the academic results obtained by students according to their learning style. To achieve this, students have previously been divided among the four styles from their responses to the CHAEA questionnaire. All 37 students answered the questionnaires, of which 62% were girls and 38% were boys.

**Table 2.** Results of evaluations unit 1

		Average pre-evaluation (pretest 1)	Average evaluation (postest 1)	Increase
Active Style	3rd ESO A (Master)	5,03	8,01	+2,98 (+59,24%)
	3rd ESO B (FC)	4,29	7,94	+3,65 (+85,08%)
Reflective Style	3rd ESO A (Master)	5,31	8,46	+3,15 (+59,32%)
	3rd ESO B (FC)	5,45	8,13	+2,68 (+49,17%)
Theoretical Style	3rd ESO A (Master)	5,88	8,09	+2,21 (+37,58%)
	3rd ESO B (FC)	6,11	8,40	+2,29 (+37,47%)

Pragmatic Style	3rd ESO A (Master)	4,68	7,95	+3,27 (+69,87%)
	3rd ESO B (FC)	4,76	8,01	+3,25 (+68,27%)
TOTAL	3rd ESO A (Master)	5,16	8,10	+2,93 (+56,97 %)
	3rd ESO B (FC)	5,09	8,11	+3,02 (+59,33 %)

Table 2 shows the results obtained by students in topic 1 corresponding to that of fractions belonging to the numbering and calculation block. We can see that the control group (3rd ESO A) goes from an average of 5.16, in the previous evaluation, to 8.10, which represents an increase of 2.93 points (+56.97%). On the other hand, the experimental group (3rd ESO B) in the pretest gets 5.09 and reaches 8.11 in the posttest, which means an increase of 3.02 points (+59.33%). Thus, we can see that the two groups start from almost the same note and reach it, this is collaborated by the results obtained with the T-Student test (table 3) for independent samples.

**Table 3.** Results of the T-Student test unit 1

	Pretest	Posttest	3rd ESO A	3rd ESO B
			(Master)	(FC)
			Pretest-Posttest	Pretest-Posttest
Active Style	0,301	0,942	<0,001	<0,001
Reflective Style	0,913	0,776	<0,001	0,002
Theoretical Style	0,857	0,841	0,011	0,002
Pragmatic Style	0,940	0,967	0,005	0,003
TOTAL	0,887	0,983	<0,001	<0,001

The first two columns in Table 3 correspond to the T-Students test for separate samples and all their values are  $p > 0.05$ , so the results of the two groups do not differ either in the pretest or posttest. This implies that, by not differing in pretest, they are comparable groups. However, not differing in posttest means that the differences in results obtained by experimental or control groups are not statistically significant. Still, it is true that those who used FC get a bigger increase.

If you look at the results obtained by the students in each of the different types of learning (table 2), we can see that the active students are the ones who get the most increase when using the FC. They start on average 4.29 and reach 7.94 increasing by 3.65 points (85.08%), while the control group is on average 5.03 and reaches 8.01, an increase of 2.98 points (59.24%). The active type group when using the FC achieves an increment of 0.67, on average, higher than the control group.

In theoretical and pragmatic students the difference in results between the control and experimental group is very small, does not exceed 1%; in these cases, the use of the FC has given the same result as the traditional class. Finally, in reflexive types it has been the control group that has obtained the best results, 0.47 points of higher average in the increase than the experimental group.

The last two columns in Table 3 show the results of the T-Students test for related samples. In all cases the results have been  $p < 0.05$ , this implies that the difference in notes between the pretest and posttest obtained are not the result of chance, they are statistically significant. Therefore, the improvement of the notes is due to the use of the FC and of the traditional class, in each case.

**Table 4.** Results of evaluations unit 2

		Average pre-evaluation (pretest 2)	Average evaluation (postest 2)	Increase
Active Style	3rd ESO A (FC)	3,57	7,71	+4,14 (+115,96%)
	3rd ESO B (Master)	2,91	6,5	+3,59 (+123,36%)
Reflective Style	3rd ESO A (FC)	4,23	8,14	+3,91 (+92,43%)
	3rd ESO B (Master)	4,57	6,86	+2,29 (+50,10%)
Theoretical Style	3rd ESO A (FC)	3,56	7,35	+3,79 (+106,46 %)
	3rd ESO B (Master)	4,91	7,34	+2,43 (+49,49%)
Pragmatic Style	3rd ESO A (FC)	3,15	6,99	+3,84 (+121,9%)
	3rd ESO B (Master)	3,54	6,78	+3,24 (+91,52%)
TOTAL	3rd ESO A (FC)	3,59	7,55	+ 3,96 (+110,30 %)
	3rd ESO B (Master)	3,91	6,84	+2,92 (+74,93 %)

Table 4 shows the results obtained by students in topic 2 that corresponded to that of geometric places belonging to the space and shape block. It can be seen that the students of the control group (3rd level B) departed with an average of 3.91 in the pretest and reached 6.84 in the postest, reaching an increase of 2.92 points (74.93 %). On the other hand, students in the experimental group (3rd level A) went from 3.59 to 7.55 on average with an increase of 3.96 points (110.30%). Thus, in this second topic, students who used the FC scored an average of 1.04 points (35.37%) more increase than the students who used the traditional class.

**Table 5.** Results of the T-Student test unit 2

	Pretest	Postest	3rd ESO A (FC) Pretest-Postest	3rd ESO B (Master) Pretest-Postest
Active Style	0,352	0,217	< 0,001	0,003
Reflective Style	0,844	0,427	0,029	0,011
Theoretical Style	0,234	0,996	0,009	0,013
Pragmatic Style	0,694	0,903	0,011	0,024
TOTAL	0,549	0,282	< 0,001	< 0,001

All and this difference of more than one point, the results of the T-Students test (table 5) tell us that the differences in results obtained are not statistically significant. As in topic 1 the T-Students in the pretest and postest is  $p > 0.05$  and the differences in notes between the pretest and postest obtained are statistically significant.

In Table 3 we can see that the active, theoretical and pragmatic types, which used the FC, double the average obtained in the previous evaluation. Moreover, in the case of the reflective type they get 1.62 points more increase from the control group, that is, their grade improves by 42.33% compared to what increases that of the control group.

Thus, in the topic of geometric places belonging to the space and shape block, all styles except the asset surpass the control group, highlighting the reflective style students who get the most increase from the control group.

**Table 6.** Results of evaluations unit 3

		Average pre-evaluation (pretest 3)	Average evaluation (postest 3)	Increase
Active Style	3rd ESO A (Master)	3,14	5,83	+2,69 (+85,66 %)
	3rd ESO B (FC)	2,27	4,61	+2,34 (+103,08 %)
Reflective Style	3rd ESO A (Master)	3,95	6,19	+2,24 (+56,70 %)
	3rd ESO B (FC)	3,40	5,53	+2,13 (+62,64 %)
Theoretical Style	3rd ESO A (Master)	2,93	6,58	+3,66 (+124,57 %)
	3rd ESO B (FC)	3,59	7,19	+3,60 (+100,27 %)
Pragmatic Style	3rd ESO A (Master)	3,34	5,97	+2,63 (+78,74 %)
	3rd ESO B (FC)	2,79	5,35	+2,56 (+91,75 %)
TOTAL	3rd ESO A (Master)	3,30	6,07	+2,77 (+83,93 %)
	3rd ESO B (FC)	2,97	5,57	+2,60 (+87,54 %)

Table 6 shows the results obtained in topic 3 corresponding to that of polynomials belonging to the block changes and relationships. Students in the control group (3rd level A) get an average of 3.30 in the previous evaluation and increase to 6.07 in the assessment of the subject, reaching an increase of 2.77 points corresponding to 83.93%. In addition, students in the experimental group (3rd level B) go from 2.97 to 5.57 with an increase of 2.60 points by 87.54%. All and that the increase in the two chaos is very similar the students of the FC group get a higher percentage increase, 3.61% more.

If you look at the results obtained by each type of learning style, those of the active, reflective and pragmatic type get a higher percentage increase relative to the control group. These stand out those of the active type that double the results obtained in the previous evaluation and obtain a 17.42% increase than those of the control group. On the other hand, the control group gets the greatest increase in its valuations.

**Table 7.** Results of the T-Student test unit 3

	Pretest	Postest	3rd ESO A (Master) Pretest-Postest	3rd ESO B (FC) Pretest-Postest
Active Style	0,220	0,245	0,004	< 0,001
Reflective Style	0,611	0,624	0,023	0,012
Theoretical Style	0,535	0,688	0,004	< 0,001
Pragmatic Style	0,589	0,683	0,028	< 0,001
TOTAL	0,446	0,423	< 0,001	< 0,001

When performing the T-Students test for separate samples and related samples (table 7) we get the same results as in the previous topics. That is, the valuations of the control and experimental group do not differ between them in both pretest and postest and the difference in notes between the pretest and postest obtained by each group are statistically significant.

**Table 8.** Results of unit 1 evaluations after four months

	Average	Difference with	Difference with
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			pre-evaluation	final evaluation
Active Style	3rd ESO A (Master)	6,89	+1,86 (+36,97 %)	-1,11 (-13,98 %)
	3rd ESO B (FC)	6,51	+2,21 (+51,74 %)	-1,43 (-18,01 %)
Reflective Style	3rd ESO A (Master)	6,84	+1,53 (+28,81 %)	-1,63 (-19,14 %)
	3rd ESO B (FC)	7,18	+1,73 (+31,74 %)	-0,96 (-11,68 %)
Theoretical Style	3rd ESO A (Master)	7,30	+1,43 (+24,14 %)	-0,79 (-9,76 %)
	3rd ESO B (FC)	8,27	+2,16 (+35,35 %)	-0,13 (-1,54 %)
Pragmatic Style	3rd ESO A (Master)	6,84	+2,16 (+46,15 %)	-1,11 (-13,96 %)
	3rd ESO B (FC)	7,28	+2,52 (+52,94 %)	-0,73 (-9,11 %)
TOTAL	3rd ESO A (Master)	6,95	+1,79 (+34,68 %)	-1,15 (-14,19 %)
	3rd ESO B (FC)	7,23	+2,14 (+42,04 %)	-0,87 (-10,85 %)

Table 8 shows the results of the evaluation of item 1 made after 4 months of final evaluation. Students who used FC in topic 1 (3rd level A) with respect to the previous assessment have increased by 2.14 points (42.04%) and in contrast those of the control group by 1.79 (34.68%), obtaining a 7.36% increase in the experimental group. In relation to the final evaluation, the students in the control group decreased by 1.15 points (14.19%) and the DSs lost an average of 0.87 points (10.85%), 3.34% less loss. Thus, we can say that the assessments of the knowledge of the students who used the FC in topic 1 after 4 months are better than those of the control group.

The results obtained by FC students are better than those obtained by the control group, when compared with results of the previous evaluation. Highlighting those of an active type with an increase of 14.77% more than that obtained by the control group. In relation to the final evaluation, all styles in the sense of the asset have a smaller difference in the FC than in the traditional class. The most significant is the case of the theoretical type that only decreases by 0.13 points (1.54 %) what was achieved in the final evaluation.

**Table 9.** Results of the T-Student test unit 1 (pre-evaluation - 4 months)

	Pretest	Posttest	3rd ESO A	3rd ESO B
			(Master)	(FC)
		Pretest-Posttest		Pretest-Posttest
Active Style	0,301	0,623	0,004	0,003
Reflective Style	0,913	0,730	0,021	0,036
Theoretical Style	0,857	0,386	0,026	0,029
Pragmatic Style	0,940	0,653	0,030	0,005
TOTAL	0,887	0,523	< 0,001	< 0,001

When performing the T-Students test for separate samples and related samples (table 9) we get the same results as in the previous topics.

**Table 10.** Results of the T-Student test unit 1 (Evaluation - 4 months)

	Pretest	Posttest	3rd ESO A	3rd ESO B
			(Master)	(FC)
		Pretest-Posttest		Pretest-Posttest
Active Style	0,942	0,623	0,016	0,123
Reflective Style	0,776	0,730	0,005	0,319
Theoretical Style	0,841	0,386	0,266	0,864



Pragmatic Style	0,967	0,653	0,060	0,418
TOTAL	0,983	0,523	< 0,001	0,036

Table 10 shows that the improvements obtained by students of a theoretical and pragmatic type, both in the case of the control and experimental group, are randomly attributable, are not statistically significant. The same is true of those of the active and reflective type of the experimental group.

## 5 Discussion

The results show that students using the FC have a greater increase in the evaluation, of pretest with respect to posttest, than those using the traditional methodology. These results in the evaluation are consistent with those obtained in different researches of the FC and the mathematics carried out by [22-30].

On the other hand, we find that the results show that these differences in the academic performance of the students who used the FC or the traditional methodology are not statistically significant. Therefore, we cannot categorically affirm that they are the result of the use of FC, all and appear in the different topics and in the two groups. It should be noted that the control group and the experimental group has been changing in each topic, and in all cases, the experimental group has obtained better academic results. These results can also be found in other researches such as that conducted by [31]. Another reason for this fact could be based on [50] because there are no statistically significant differences in academic outcomes between FC and unvested, if two classes use active methodologies.

## 6 Conclusion

Two hypotheses had been raised in this research, the first saying that the academic results of students with active learning style when using the FC get better results than students who follow the traditional class.

Indeed, the results have shown that in the different topics of mathematics the students who have used the FC have obtained better results in the postest and a greater increase from the pretest than the students who used the traditional class. In addition, the ones that have been the most active learning style students. In item 2 (Geometric Places) is where this difference was greatest, the control group averaged 6.84 and the experimental group by 7.55, which means a difference of 0.77 points on average (10.38% increase). Also in this topic 2 the increase experienced by the experimental group between the pretest and postets was +3.96 points (+100.30 %) +2.92 points (+74.93%) that the students of the control group obtained on average, thus improving by 25.37% more.

It was also found that the use of the FC provides greater assimilation of long-term content. Since in the postest of topic 1 performed 4 months after finishing topic 1, students who used FC obtained a higher average grade and a greater increase from the first test pretest than the students in the control group as shown in the results.

The second hypothesis was that students' learning style conditions their academic performance when using FC compared to traditional class.

As seen in the results, students' academic performance has varied according to their learning style. In topic 1 (Fractions) the posttest results were very similar, but not so the increase experienced between the pretest and the posttest. Active students using the FC achieved a 25.84% increase than those in the master class. In contrast, in the item 2, (Geometric Places) students who used reflexive type FC scored an average of 18.65% more score than those in the control group, and a 42.33% increase between pretest and posttest. In topic 3 (polynomials) again active-style FC students are the ones who achieved the best results, obtaining 26.46% more average posttest score than those of the master class of the same style. Finally, in the posttest of topic 1, conducted 4 months later, the FC students of theoretical style were the ones who made the most difference from those of the traditional class with an increase of 13.28% more.

We can see that active-style students are the ones who, when using the FC, improve their academic performance more than those who use the master class. In addition, that those of theoretical style when using the FC are the ones that best retain knowledge over time.

The results obtained in this research will allow teachers to have an approximate idea of which type of students get the best academic performance when using FC. Helping to make the decision to use the FC, with a certain group of students, in the event that you are considering it. For example, if an active learning style predominates in your class, you will get better academic performance when using FC than if reflective-style students predominate.

The research has limitations related to the sample size; the class of 3rd level A had 19 students and the 3rd level B 18 students. In addition, the time students have been using the FC has been reduced, one quarter. That is why it would be interesting to replicate research with more students and for longer. A post-test was also planned after 4 months under topics 2 and 3, but the 2020 pandemic situation prevented it.

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