

Flipped Classroom as an Active Strategy in Higher Education

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Abstract

The flipped classroom modality is a teaching and learning methodology with great projection within higher education. This method, based on Information and Communication Technologies (ICTs), has been implemented in person in the Integrator I course: Chemical, Clinical, Forensic and Biopharmaceutical Laboratory, of the fifth year of the Chemistry and Pharmacy degree at Andrés Bello University, developing didactic sequences through the use of active participatory methodologies, such as Case Analysis and Collaborative Learning, using the Flow chart tool for the organization of information in the practical classes of Management and Quality Control, Food Analysis and Clinical Biochemistry, which leads to the development of competencies, with the aim of achieving significant learning in students. A methodological dossier of classes was planned in 5 phases: pre-class phase, initial phase of the class, class development phase, final phase of the class and phase after the end of the class. The results obtained show that the 20 students meet the achievement indicators, mainly as Outstanding and Competent in the 3 practical works carried out, which were evaluated using a rubric and grading and comparison guidelines. The evidence of the study was carried out using a comparison guide for observers, a learning perception evaluation form and interviews with teachers. The results obtained are conclusive in that the design and implementation of the didactic sequences promote meaningful learning in the flipped classroom training model.

Keywords: flipped classroom, ICTs, active methodologies, methodological dossier, learning, laboratory.

1. Introduction

Currently, taking into account the development that digital technology has achieved, derived from the confinement caused by the COVID-19 pandemic, the Andres Bello University develops face-to-face education in its teaching activities; therefore, it is the task of teachers to continue implementing active methodologies in the teaching and learning process, mediated by the use of Information and Communication Technologies (ICTs) in University teaching, as it was implemented in emergency remote education [1].

The flipped classroom modality, despite being known since 2007 by professors Jonathan Bergman and Aaron Sams of the Woodland Park Institute in Colorado, USA [2], is becoming more widespread worldwide in different subjects and educational stages, although it does not have many empirical studies in Latin America, which constitutes a strength for its study and implementation.

The flipped classroom method strengthens the efficiency of the face-to-face class, increases the opportunities for active learning, the student builds his knowledge, being responsible for his own learning, generating spaces that allow them to build knowledge at their own pace. For their part, the teacher assumes the role of guide, designing activities and strategies that promote the construction of learning [3], having the time of the face-to-face class to interact with the students as they creatively participate in the subject, becoming the learning centre which

implies that the parties acquire different roles from those applied in traditional education [4].

An important aspect within the teaching and learning strategies that contribute to the development of competencies is prior knowledge, which promotes meaningful learning, where students associate new information with what they already have, readjusting and reconstructing both information, which complies with Ausubel's theory of meaningful learning, which is opposed to rote learning [5]. In addition, the constructivist paradigm of John Biggs must be taken into account, which states that learning occurs when a student faces different learning activities. However, in this context, the student can perform deep activities that involve creating new structures with the content [6], or, on the contrary, perform superficial activities that only involve simple information processing, with a summary accumulation of unstructured data [7].

Another important aspect pointed out by Vygotsky is that learning requires social interaction and individual interaction, which allows the individual to advance from the area of real development (current learning) to the area of potential development (learning to be achieved), for which support is required [8]. This induction or mediation can be supported by the teacher and even by collaborative work with peers. It is worth mentioning that, to apply these active methodologies, the teacher must perform a diagnosis of the student's prior knowledge, and then carry out motivating activities such as

graphic organizers in asynchronous time, generating feedback instances that give information to the student regarding their learning process [9]. On the other hand, technology plays an important role within the flipped classroom methodology, as it provides students with access to the content to develop these skills [10].

In this context, the Chemistry and Pharmacy program at Andres Bello University has taken on this challenge with a clear focus on the evaluation and continuous improvement of its training processes [11]. To this end, the Integrator I course has been implemented in person through the use of a flipped classroom. In this way, learning begins when students access the corresponding contents of the subject, placed in the Blackboard virtual classroom, a site for interaction between students and teachers that facilitates academic activities for the creation of new knowledge through the application of educational tools and methodologies [12].

For the development of this model, a methodological dossier has been designed with didactic sequences, developing five phases of the class for the three selected practical works, implementing active-participatory methodologies such as case analysis and collaborative work, assisted by ICTs, and evaluating satisfaction in the phases of the proposal, which supports the interest in achieving the learning outcomes of the study plan and the development of competencies, with the aim of obtaining meaningful learning with the participation of students.

The competencies acquired and developed by students describe levels of achievement, indicators and credits, relating didactics, assessment and feedback strategies, which supposes the integration in students of oral and written expression skills, knowledge, motivation, attitudes and behavior.

2. Methodology

This Integrating Course I: Chemical, Clinical, Forensic and Biopharmaceutical Laboratory is taught in the fifth year of the Chemistry and Pharmacy degree and is part of the Student Learning Assessment process implemented by Andres Bello University, being an integrating course of prior knowledge acquired during the degree. This modality is a self-regulation mechanism of the Internal Quality Assurance System (IQAS) whose main purpose is to ensure the level of achievement of the learning outcomes committed to in the graduation profile and programs of the degree.

As an active methodology, we have proposed to carry out an inverted class where students relate their own knowledge through the study of the bibliography sent from the ICTs and the laboratory guide, using as a learning tool a flow chart that involves the analysis of cases and the analytical techniques necessary for the development of the practical. For the development of this work, the following practical works were selected:

Practical Work 1: Validation of a Quantitative Analytical Method by UV Spectrophotometry.

- In-person laboratory: quantitatively validate an analytical method by UV-Visible Spectrophotometry, demonstrating that the method is suitable for the indicated purpose.
- Autonomous work: preparation of the practical through the laboratory guide and the study of previous readings and bibliographic review; elaboration of a validation protocol for analytical methods.

- Summative evaluation: entry control; validation protocol for analytical methods; analytical method validation report and conduct in the practical.

Practical Work 2: Food Analysis: Fats, Proteins, Sugars and Sodium Content.

- In-person laboratory: determination of the fat content of a food sample by solid-liquid extraction (Soxhlet extraction); determining the concentration of free amino nitrogen present in the milk sample by phenolic titration or the Sorenson-Walker method; determining the concentration of carbohydrates in a sugar-free drink by the colorimetric phenol-sulfuric acid method; determining the chloride content in foods, using the Mohr precipitation method.
- Autonomous work: preparation of the practical using the laboratory guide and the study of previous readings and bibliographic review; elaboration of a flow chart.
- Summative evaluation: entry control; flow chart; final report of the practical and conduct in the practical.

Practical Work 3: Clinical Biochemistry: Evaluation of Renal Function (Clinical Case): Creatinine, Calculation of Glomerular Filtration Rate, Protein Index, Microalbuminuria, Glycemia and Cholesterol.

- In-person laboratory: Study the clinical case submitted, analyzing the biological samples and, based on the results obtained, provide recommendations that contribute to decision-making regarding the diagnosis, treatment and referral of the person with Chronic Kidney Disease (CKD).
- Autonomous work: Preparation of the practical through the study of the clinical case, the laboratory guide, and the study of previous readings and bibliographic review. Elaboration of a flow chart.
- Summative evaluation: entry control; flow chart; final report of clinical case analysis and conduct in the practical.

2.1. Design of a methodological dossier with teaching sequences

For the organization of the methodological design, five phases were carried out, each of them contemplating a set of activities that are developed to fulfill each of the moments of the work [13].

Pre-class phase: Through ICTs, teachers send the necessary resources so that students can develop, through autonomous work, the active methodologies, creating a flow chart and studying the practical or clinical case. This is done through the laboratory guide, the study of previous readings and the bibliographic review.

Development phases of the face-to-face class: This phase follows the organization of the teaching and learning process of the face-to-face class in the following moments:

Initial phase of the class: At the beginning of the session, the students carry out an entry control of the practical, based on the study of the topic carried out in their hours of independent work, facilitated by the guidance of the teachers. This control lasts 20 minutes and is evaluated through a grading guideline. Next, the teacher carries out group feedback with the results of the control, motivating discussion and interest in the practical, which in this way develops the students' competencies through the conceptual and procedural contents of the practical being studied [14]. Once this stage has finished, the teacher introduces the practical work to start a brainstorming session and motivate the participation of

the students through the application of prior knowledge and the information obtained through autonomous work.

Development phase of the class: The teacher implements methodological learning strategies, such as the collaborative learning methodology. In this instance, students collaboratively evaluate the techniques contained in the validation protocol (Practical work 1) and the proximal analysis techniques, using the flow chart tool (Practical work 2). In Practical work 3, the methodology for studying a clinical case is implemented, which corresponds to the evaluation of renal function, which leads to the subsequent analysis of different analytical techniques. It is necessary to consider, within the rhythm of the practical class, the alternation, where at certain times the teacher intervenes and at others, the students have space to work applying the knowledge. During the development of the practical, the students, through collaborative work, develop the skills of creativity, communication and collaboration [15].

Final phase of the class: In this phase, the teacher provides feedback on the class through questions from the teachers to students, and they evaluate what they learned and the usefulness of the learning strategies and methodologies developed, such as case analysis and collaborative learning.

Post-class phase: Within the independent work, students must make a final report with the results obtained from the practical, filling out the report guide placed in the virtual classroom, which will be reviewed by the teacher through a grading rubric. It should be mentioned that the student's autonomous work is based on reviewing the resources and carrying out the activities that are available on the platform to then use them in the classroom.

2.2 Achievement Indicators

For the definition of achievement indicators, qualitative and quantitative indicators are considered, provided by different sources of information. The organization of the class is inserted in the planning carried out for the semester based on the Syllabus as a permanent learning tool for students and teachers, being the articulation and coherence between the learning outcomes, the general training skills, the performance indicators and the evaluation system used in the subject. All this occurs in a certain context, depending on the teaching-learning methodology selected and the time available. In addition, the teacher organizes the activities in order to give a certain rhythm to the class [16].

2.2.1. Learning outcomes (LR):

LR1. Validate analytical techniques in chemical, clinical and forensic laboratories, to ensure the quality and reliability of the results.

LR2. Analyze samples, in general, to solve an analytical problem.

LR3. Analyze biological and expert samples to support clinical diagnosis and forensic medical research.

General training skills: Critical Thinking and Oral and Written Communication.

2.2.2. The Performance Indicators: Assessment Instrument; Weighting and achievement levels applied for practical works 1, 2 and 3 of Integrative Laboratory I are the following:

1. Flow chart; Assessment Instrument: Grading Rubric; Weighting: 15 %. Design of protocol for the resolution of an analytical problem related to the pharmaceutical industry.
2. Entry control; Assessment Instrument: Grading Guideline; Weighting: 40 %. Implements analysis protocols for the resolution of an analytical problem related to the pharmaceutical industry.
3. Results Report; Assessment Instrument: Grading Rubric; Weighting: 40 %. Communicates the results obtained, making use of written communication.
4. Behavior; Assessment Instrument: Checklist; Weighting: 5 %.

It should be noted that Behavior is transversal in the indicators, and the rest of the indicators correspond to scientific skills. The final sum associated with each activity results in an evaluation percentage of 100 %, equivalent to 100 points.

The achievement levels applied to the performance indicators in obtaining the results are the following:

Outstanding: 6.0–7.0 points; Competent: 5.0-5.9 points; Basic: 4.0–4.9 points; Not achieved: 1.0–3.9 points. Where 7 points is the maximum score achievable.

2.3 Description of the verification methods:

The instruments to evaluate the practical works are the following:

2.3.1 Class observation checklist: This is an evaluation instrument used to verify the presence or absence of knowledge, skills, attitudes or values. The behaviors to be observed are: attitude and behavior towards activities proposed by the teacher, the climate in the laboratory, the motivation and participation of the students and the academic relationship between student and teacher. The comparison guideline applied consists of 8 indicators and is carried out by 2 observing teachers in the 3 practical sessions (Scheme 1).

Scheme 1. Classroom observation checklist.

CLASS OBSERVATION CHECKLIST

Name of the evaluating teacher: _____

Name of the teacher in charge of the class: _____

Date: _____

Number of students to be observed _____

INDICATORS	COMPLY	DOES NOT CUMPLY	OBSERVATIONS
1. There is an adequate disposition of the students towards the activities proposed by the teacher in the laboratory session.			
2. The students are attentive to the instructions of the teacher to develop the laboratory session.			
3. A fluid relationship is maintained in terms of transfer and explanation of information between teacher and students.			
4. More than two thirds of the students are attentive to the instructions of the teacher.			
5. There is great participation in the laboratory by the entire group.			
6. There is a fluid interaction between the students of each group.			
7. There is an adequate disposition of the students in the development of the activities of the laboratory session.			
8. Tension is demonstrated through body movements in the development of the laboratory session.			

2.3.2. Learning assessment and perception form: This is an instrument whose objective is to gather information about the students' opinions regarding the system applied in class and whether it is in line with the learning outcomes of the course. This form contains a set of statements regarding which students can express their degree of agreement or disagreement regarding the strategies used to carry out the practical exercises, which are aimed at finding students' prior knowledge in relation to the different subjects taken during the degree, which leads to new significant learning. The form is applied at the end of the three practical works to a sample of 20 students taking the Integrator I subject: Laboratory Chemical, Clinical, Forensic and

Biopharmaceutical at the School of Chemistry and Pharmacy of the Andres Bello University (Scheme 2).

Scheme 2. Learning Assessment and Perception Form.

LEARNING ASSESSMENT AND PERCEPTION FORM

The objective of the instrument to be used is to gather information about the students' opinion on the system applied in class and whether it is in accordance with the learning outcomes of the course. You will find in this form a set of statements with respect to which you can express your degree of agreement or disagreement.

- The strategies used during the previous studies, aimed at the development of critical thinking and oral and written professional technical language, have allowed you to meet the requirements to carry out the activity.

(5)	(4)	(3)	(2)	(1)
Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree

If you show any degree of disagreement, suggest improvement activities.

- ¿Do you consider that everything presented in the area of Validation of Analytical Methods is relevant to your professional development?

(5)	(4)	(3)	(2)	(1)
Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree

If you show any degree of disagreement, suggest improvement activities.

- Consider that the activity presented in the Food area has allowed the participation of all colleagues in the execution and analysis of the data obtained.

(5)	(4)	(3)	(2)	(1)
Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree

If you show any degree of disagreement, suggest improvement activities.

4. Consider that the level of prior knowledge in the area of Clinical Biochemistry enabled your satisfactory performance during the development of the activity.

(5)	(4)	(3)	(2)	(1)
Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree

If you show any degree of disagreement, suggest improvement activities

5. Do you consider the Flipped Class format to be interesting for collaborative work and the development of meaningful learning?

(5)	(4)	(3)	(2)	(1)
Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree

If you show any degree of disagreement, suggest improvement activities.

2.3.3. Interview with teachers: This is an instrument that aims to find out the opinion of teachers regarding the active methodology “flipped classroom” in the course Integrator I: Chemical, Clinical, Forensic and Biopharmaceutical Laboratory, where three of the practical works are part of the flipped classroom as an active strategy in the teaching of

Pharmaceutical Chemists. In this approach, the aim is to get students to manage their learning through autonomous work, interacting with the resources available asynchronously on the platform and contributing during the development of the practical in a collaborative way (Scheme 3).

Scheme 3. Interview with teachers

INTERVIEW WITH TEACHERS

Name of interviewee: _____

Name of interviewer: _____

Date: _____

Dear Professor, we have asked you to participate in the following interview, which aims to implement the active methodology “flipped classroom” in an integrative laboratory, which seeks to get students to manage their learning through autonomous work, interacting with the resources available asynchronously on the platform and contributing during the development of the practical in a collaborative way.

The subject Integrator I: Chemical, Clinical, Forensic and Biopharmaceutical that you teach at the School of Chemistry and Pharmacy of the Andrés Bello University has been selected to apply the corresponding studies and analysis.

In order to comply with this part, it is necessary that you can answer the following questions:

1. The objectives of the Integration Laboratory I include the generation of a methodological dossier, with teaching sequences and flipped classroom strategies of a methodological dossier, with didactic sequences and flipped classroom strategies. How has the experience of working in the flipped classroom system been? And do you think that through this format collaborative work can be generated?
2. Meaningful learning in the integrator sessions is a fundamental tool since the student associates the new information with the information he or she already has. By implementing active-participatory methodologies of the proposed dossier in the flipped classroom model, do you consider that the purpose of achieving meaningful learning and student participation is met?
3. How would you evaluate the process of the educational strategy used in the development of the laboratory, known as “Flipped Classroom” from the perspective of meaningful learning and collaborative work?

3. Development

3.1. Design of a methodological dossier with teaching sequences

In the flipped class methodology, through the design of a methodological dossier, five phases of the class are implemented (pre-class phase, initial phase of the class, phase in development of the class, final phase of the class and phase after the class), in practical works 1, 2 and 3.

Phases of the flipped class:

Pre-class phase: Teachers send resources and students carry out autonomous work.

Development phases of the face-to-face class:

Initial phase of the class: Students carry out an entry control and teachers provide feedback on the control and introduce the practical through a brainstorming session.

Phase in development of the class: Students present the validation protocol and/or flow charts, evaluating the techniques contained therein. Teachers and students implement active methodologies, such as collaborative work and case analysis.

Final phase of the class: To conclude the face-to-face session in the three practical sessions, the teacher concludes the class by providing feedback through questions to the students. In this procedure, the students evaluate what they have learned and the usefulness of the strategies and methodologies developed.

Post-class phase: The students, in their hours of autonomous work, prepare the final report with the results obtained in the practical sessions, and the teacher reviews the documents generated by the students (“Final report of the practical session”) through a grading rubric.

To achieve the goals set, the students must be in constant communication and feedback with each other, which develops social skills.

It should be noted that, for this type of inverted class modality, each phase has its importance within the process of designing the methodological dossier, which gives rise to a new paradigm ICTs assisted education, where the teacher becomes a tutor of learning through the sending of resources and the students build their own knowledge and are responsible for organizing their time in a better way, taking advantage of the previous knowledge acquired during the course [17]. This dossier has a clear pedagogical sense, so this aspect is considered an achievement for this type of modality; especially when compared to what is reported in the scientific literature, where traditional classes are considered to have a total of three phases

(initial phase of the class, phase in development of the class and final phase of the class) [18].

3.2. Levels of achievement

Based on the studies carried out by the students during their hours of autonomous work, they, through the flow chart tool, organize the processes and activities to facilitate decision-making, promoting learning.

It should be noted that, to assess the achievement of the expected learning, the students carry out an entry control prior to the practical, analysis protocols and validation of the analytical methods, and reports with the analysis results. All of the above favors significant learning, which is confirmed in Tables 1, 2 and 3, where the entry control notes, flow charts, final report and behavior linked to the three practical works are reported.

Table 1. Results of the Performance Indicator as a solution to an analytical problem related to the pharmaceutical industry. LR1

INTEGRATIVE CHEMICAL, CLINICAL, FORENSIC AND BIOPHARMACEUTICAL LABORATORY				
NRC 12290	PRACTICAL WORK 1			
No. of students	Entry Test	Flow Chart	Reports	Behavior
1	7	5.8	6.4	7
2	6.1	5.8	6.2	7
3	6.4	5.5	6.4	7
4	6.1	5.7	6	7
5	6.2	6.1	6.2	7
6	7	6	6.5	7
7	7	5.8	6.4	7
8	6.4	5.5	6.4	7
9	7	5.7	6	7
10	5.8	6.3	6.8	7
11	6.8	6	6.5	7
12	6.8	5.8	6.2	7
13	6.1	6.1	6.3	7
14	7	6.1	6.3	7
15	6.8	5.4	6.3	7
16	6.8	5.6	6.4	7
17	7	5.4	6.3	7
18	6.8	6.1	6.2	7
19	6.1	6.3	6.8	7
20	7	5.6	6.4	7
Practical work 1. Validation of a Quantitative Analytical Method by UV Spectrophotometry.				
NRC Course Reference Number; LR1: Learning outcomes				

Table 2. Results of the Performance Indicator as a solution to an analytical problem related to the pharmaceutical industry. LR2

INTEGRATIVE CHEMICAL, CLINICAL, FORENSIC AND BIOPHARMACEUTICAL LABORATORY				
NRC 12290	PRACTICAL WORK 2			
No. of students	Entry Test	Flow Chart	Reports	Behavior
1	5.3	6.2	6	7
2	6.7	6.2	6.5	7
3	7	6.3	6.5	7
4	7	6.6	6.5	7
5	5.3	6.6	6.4	7
6	4.4	6.2	5.7	7
7	5.3	6.2	6	7
8	4.9	6.3	6.5	7
9	7	6.6	6.5	7
10	5.3	7	6.3	7
11	7	6.2	5.7	7
12	6	6.2	6.5	7
13	7	7	6	7
14	7	7	6	7
15	6.1	6.3	5.9	7
16	5.3	7	6.1	7
17	6.1	6.3	5.9	7
18	5.7	6.6	6.4	7
19	5.3	7	6.3	7
20	5.3	7	6.1	7
Practical work 2: Food Analysis: Fats, Proteins, Sugars and Sodium Content.				
NRC Course Reference Number; LR2: Learning outcomes				

Table 3. Results of the Performance Indicator as a solution to an analytical problem related to the pharmaceutical industry. LR3

INTEGRATIVE CHEMICAL, CLINICAL, FORENSIC AND BIOPHARMACEUTICAL LABORATORY				
NRC 12290	PRACTICAL WORK 3			
No. of students	Entry Test	Flow Chart	Reports	Behavior
1	7	5.5	6.5	7
2	6	7	7	7
3	7	6.2	6.5	7
4	5.5	7	6.7	7
5	6	6.2	6.3	7
6	6	7	7	7
7	7	5.5	6.5	7
8	6	6.2	6.5	7
9	6	7	6.7	7
10	6	7	6.3	7
11	7	7	7	7
12	5	7	7	7
13	7	7	6.5	7
14	6.5	7	6.5	7
15	6	6.2	6.7	7
16	6.5	5.5	6.7	7
17	7	6.2	6.7	7
18	6	6.2	6.3	7
19	6.5	7	6.3	7
20	5.5	5.5	6.7	7
Practical work 3: Clinical Biochemistry: Evaluation of Renal Function (Clinical Case): Creatinine, Calculation of Glomerular Filtration Rate, Protein Index, Microalbuminuria. Glycemia and Cholesterol.				
NRC Course Reference Number; LR3: Learning outcomes				

The achievement levels obtained for each performance indicator in the three learning outcomes are shown in table 4.

Table 4. Achievement levels obtained from each performance indicator in the three learning outcomes.

Practical 1: Validation of an Analytical Method by UV Spectrophotometry (LR1)				
Practical 2: Food Analysis: Fats, Proteins, Sugars and Sodium Content. (LR2)				
Practical 3: Clinical Biochemistry Evaluation of a Clinical Case. (LR3)				
Performance Indication	1. Protocol design for solving an analytical problem related to the pharmaceutical industry			
Achievement level (%) / Practical (LR)	6.0 - 7.0	5.0 -5.9	4.0 -4.9	1.0 - 3.9
Practical 1 (LR1)	40	60	-	-
Practical 2 (LR2)	100	-	-	-
Practical 3 (LR3)	80	20	-	-
Performance Indication	2. Implements analysis protocols for solving an analytical problem related to the pharmaceutical industry.			
Achievement level (%) / Practical (LR)	6.0 - 7.0	5.0 -5.9	4.0 -4.9	1.0 - 3.9
Practical 1 (LR1)	95	5	-	-
Practical 2 (LR2)	50	40	10	-
Practical 3 (LR3)	85	15	-	-
Performance Indication	3. Communicates the results obtained, making use of written communication.			
Achievement level (%) / Practical (LR)	6.0 - 7.0	5.0 -5.9	4.0 -4.9	1.0 - 3.9
Practical 1 (LR1)	100	-	-	-
Practical 2 (LR2)	80	20	-	-
Practical 3 (LR3)	100	-	-	-
Performance Indication	4. Behavior			
Achievement level (%) / Practical (LR)	6.0 - 7.0	5.0 -5.9	4.0 -4.9	1.0 - 3.9
Practical 1 (LR1)	100	-	-	-
Practical 2 (LR2)	100	-	-	-
Practical 3 (LR3)	100	-	-	-
Outstanding 6.0-7.0; Competent 5.0-5.9; Basic 4.0-4.9 and Not Achieved 1.0-3.9				
LR: Learning outcomes				

In the results of the implementation of active participatory methodologies and tools for the organization of information in the flipped classroom model, qualifications with a Competent and Outstanding performance level have been achieved in the 3-practical works. It should be noted that in practical 2, in addition, a 20% Basic performance level is obtained in the entry control. However, in none of the practical works a Not Achieved performance level is obtained, a result that supports the use of the Flipped Classroom as a model that contributes to the development of various competencies, developing knowledge, abilities and skills, in addition to the exchange of opinions, responsibility and motivation [19].

It is important to note that Behavior is a cross-cutting indicator where, as a means of evaluation, a Checklist is applied to each student. The results obtained show that 100% of the students obtain an Outstanding level of achievement. These results demonstrate the good behavior of the students in the development of these practical works.

3.3. Satisfaction in the phases of the proposal through verification methods

This section evaluates the satisfaction of the phases of the class, the methodological implementation that promotes significant learning and the collaborative work and case analysis in the flipped classroom model.

Class satisfaction is assessed using an observation instrument using a checklist, which is applied to 20 students, two teachers, and in the 3 practical classes by two observers [20, 21].

Student satisfaction is assessed at the end of the Integrative Laboratory I period, where a learning assessment and perception form is applied, in order to perform an analysis for the continuous improvement of the teaching-learning process.

Regarding the satisfaction interview carried out with the two teachers, we can mention that the objective is to know their opinions on the implementation of the active methodology of the flipped classroom in an integrative laboratory, where students achieve their own learning through autonomous work, interacting with the resources available asynchronously on the platform and contributing during the development of the practical works in a collaborative way.

3.3.1. Classroom observation checklist

Table 5. Summary of the checklist of the observing teachers (Scheme 1).

INDIC.	P. W	COMPLY		DOES NOT COMPLY		OBSERVATIONS	
		Obs 1	Obs 2	Obs 1	Obs 2	Obs 1	Obs 2
1	1	x	x			Students carry out activities in an orderly and logical manner.	No
	2	x	x				
	3	x	x				
2	1	x	x			Students maintain a good disposition to the activities.	No
	2	x	x				
	3	x	x				
3	1	x	x			The teacher explains and answers students' questions.	No
	2	x	x				
	3	x	x				
4	1	x	x			Students are willing to participate in the activities.	No
	2	x	x				
	3	x	x				
5	1	x	x			Work is done collaboratively	No
	2	x	x				
	3	x	x				
6	1	x	x			Students interact with each other with their ideas	No
	2	x	x				
	3	x	x				
7	1	x	x			There is a good disposition to carry out the activities.	No
	2	x	x				
	3	x	x				
8	1	x	x			No	Tension and rigidity are observed in some students
	2	x	x				
	3	x			x		
INDICATORS: 1. There is an adequate disposition of the students towards the activities proposed by the teacher in the laboratory session. 2. Students are attentive to the teacher's instructions to develop the laboratory session. 3. A fluid relationship is maintained in terms of transfer and explanation of information between teacher and students. 4. More than two-thirds of students are attentive to the teacher's instructions. 5. There is great participation in the laboratory by the entire group. 6. There is fluid interaction between students in each group. 7. There is an adequate disposition of students in the development of the activities of the laboratory session. 8. Tension is shown through body movements in the development of the laboratory session.							
INDIC: Indicators; P.W: Practical Work; Obs: Observer							

We consider that both teacher observers participated together in the three practical works 1, 2 and 3 (Table 5). Observer 1 considered that the 8 indicators reflected in the comparison table (Scheme 1) were met in the three practical works, demonstrating that there was willingness, attention, participation and interaction of the students during them. However, observer 2,

when analyzing practical works 1, 2 and 3, considered that the indicators were met, except in practical exercise 3, where in indicator 8, related to “tension through body movements”, he considered that the students were not very enthusiastic about generating answers to the teacher's questions.

3.3.2. Learning assessment and perception form

Table 6. Results of the learning assessment and perception form (Scheme 2).

Nº Question	Strongly agree	Agree	Moderately agree	Disagree	Strongly disagree
1	17	3	0	0	0
2	15	3	2	0	0
3	16	3	1	0	0
4	18	2	0	0	0
5	18	1	1	0	0

No. Question/ Focus of the question

1. The strategies used during previous studies.
2. The Validation of Analytical Methods as a relevance for your professional development
3. You consider that the activity presented in the Food area has allowed the participation of the students.
4. You consider that the level of previous knowledge in the area of Clinical Biochemistry favored your satisfactory performance.
5. Flipped classroom for collaborative work and in the development of meaningful learning.

Regarding student satisfaction through the learning assessment and perception form (Scheme 2), it can be argued that most of the forms present satisfactory results with a level of total satisfaction (Strongly Agree: 84%), (Agree: 12%) and (Moderately Agree: 4%). In addition, no results in Disagree or Strongly Disagree were presented in any of the forms, nor was there any suggestion for improvement.

The results of Moderately Agree were the opinion of five students; two of them refer to the previous knowledge in the area of Clinical Biochemistry of practical work 3, and although they do not show their degree of disagreement or suggest improvement activities, they correspond to two students who require improving their previous knowledge regarding the subject. Therefore, it is an opinion that must be taken into account in the considerations of this work.

Another result of Moderately Agree corresponds to practical work 2, where a student considers that the activity presented in the Food Analysis has moderately allowed his participation in the execution and in the analysis of the data obtained. Although he does not show his degree of disagreement or suggest improvement activities, it is possible that he requires improving his knowledge regarding the subject. Therefore, it is an opinion that must be taken into account in the considerations of this work.

The last result of Moderately Agree corresponds to question 5 of the form, where the student has answered that he is moderately in agreement with the flipped classroom format for collaborative work in the development of meaningful learning, although he does not show his degree of disagreement or suggest activities for improvement.

We consider it an achievement of this experience that there were no results of Disagreement or Strongly Disagree in any of the forms, but it is considered a weakness that there were no suggestions for improvement.

3.3.3. Interviews with Teachers

Regarding the satisfaction interview conducted with the two teachers (Scheme 3), we can mention the following [22]:

Summary of interviews with teachers:

- In the evaluation of the flipped classroom:

- o The autonomous work of the students is highlighted.
- o The ICTs resources are valued.

- It encourages cooperative work between students:
 - o The promotion of cooperative work in hours of autonomous work is valued.

- Evaluation of strategies in meaningful learning:
 - o It is part of continuous improvement, forming part of meaningful learning.

- Importance of the evaluation of teaching practice:
 - o The student is highlighted as the center of learning and the teacher as the facilitator of resources.

- Integration of students in the development of activities:
 - o It is part of continuous improvement, favoring meaningful learning.

The two teachers value the flipped classroom strategy significantly, highlighting that the resources provided through ICTs allow the development of independent work by students so that they feel that they are the architects of their learning. They also highlight the value of collaborative work carried out between students, promoting reflection and critical thinking in the development of activities, which leads to meaningful learning, allowing the student to feel that he is the center of his own learning. In addition, the role assumed by the teacher as guide, organizer and facilitator of teaching resources is valued, which prepare the prelude to the face-to-face class, in which more relevant activities are carried out. Consequently, we can affirm that the flipped classroom strategy is innovative, since it promotes independent and collaborative work, marking a trend in educational models.

The incorporation of the flipped classroom in the integrative laboratory is part of an assessment plan (continuous improvement) to achieve significant student learning. This allows the teacher to be continuously specializing and being able to change the teaching tools that are frequently used. This flipped classroom model presents as advantages the saving of time inside and outside the classroom and collaborative work, according to individual needs and interests, fostering autonomy in an ethical manner and, therefore, promoting the formation of responsible and self-taught students, thus improving the quality of education.

Making a connection between the result of the Evaluation and Perception of Prior Learning Form and the results of the analysis of the Observation Checklist carried out in practical work 3, we found that there is a correspondence between the opinions of Moderate Agreement of two students regarding the form, where the students require improving their previous knowledge of the Clinical Biochemistry subject, and the opinion of the observer regarding practical work 3, in which the students are stressed to answer the teacher's questions. These opinions must be taken into account in the study considerations.

It is worth mentioning that the incorporation of the flipped classroom in the integrative laboratory is part of a continuous improvement plan from the pedagogical point of view to achieve significant student learning. This allows the teacher to be continuously specializing and to be able to change the pedagogical tools that he frequently uses [23].

4. Conclusions

The five phases within the methodological dossier were designed and implemented in the 3 practical sessions carried out, which have a clear pedagogical sense, contributing to the development of competencies and promoting meaningful learning in students. This process of building learning is linked to the hours of autonomous work, where the student manages to establish new learning due to a process of accommodation and adaptation that is finally assimilated in the cognitive structure of the student.

The methodologies implemented in the flipped classroom model (Case Studies and Collaborative Learning) in the three practical works within the methodological dossier use ICTs, employing scientific information that develops in students, knowledge, abilities, skills, exchange of opinions, responsibility and motivation. These competencies have been developed by the students through the flow chart tool, with which they organize the processes and activities to facilitate decision-making, thus favoring meaningful learning and contributing to the 20 students meeting the achievement indicators, mainly as Outstanding and Competent in the 3 practical exercises carried out, which were evaluated using a rubric and grading and comparison guidelines.

When evaluating satisfaction in the methodological implementation phase, we can highlight that, in the observation comparison guideline, in general, the 8 indicators are met in the three practical works, demonstrating that there is attention, disposition, interaction and participation of the students, except for practical work 3, where observer 2 states that indicator 8 is not met, where rigidity is observed in the students in the feedback process.

Regarding student satisfaction through the learning assessment and perception form, most of the forms present satisfactory results with a level of total satisfaction (Strongly Agree: 84%), (Agree: 12%) and (Moderately Agree: 4%). In addition, no results of Disagree or Strongly Disagree were presented in any of the forms, nor were there any suggestions for improvement.

There is a correspondence between the opinions of two students with a Moderate Agree regarding the evaluation form and perception of learning, where the students need to improve their previous knowledge of the Clinical Biochemistry subject, and the opinion of the observing teacher regarding practical class 3 of the same subject, in which it is observed that the students are stressed to answer the teacher's questions. These results allow us

to detect cross-information that is part of a continuous improvement plan from a pedagogical point of view to achieve meaningful learning.

In the satisfaction interview conducted with teachers, it should be noted that the flipped classroom strategy is an educational trend that has turned the traditional teaching model around, by focusing on the student's learning needs, taking advantage of classroom time with meaningful learning activities, where the teacher is the facilitator of the resources and the students build their own learning, which is why it is an innovative experience.

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