The impact of continuous teacher training based on the flipped classroom on teaching practices and learner performance

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Article Info

ABSTRACT

The study presents the contribution of in-service teacher training based on the flipped classroom on teaching practices and on learner performance. To meet the objective of this research, an experiment was carried out on a sample of five college teachers of two different subjects and 200 learners divided into two groups (experimental and control). The study used teacher observation before and after the training, two evaluative tests with the learners and a questionnaire with the learners at the end of the experiment. We collected the data, analyzed it, then presented and interpreted the results. The results show that the flipped classroom has a positive impact on teachers' teaching practices and learners' performance.

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1. INTRODUCTION

The flipped classroom, a pedagogical innovation gaining prominence, redefines the conventional classroom structure by transferring course content online for pre-class study, typically in the form of videos. This approach prioritizes in-person class time for interactive, collaborative, and practical activities. The potential benefits extend to both educators and learners, fostering personalized learning, and enhanced classroom dynamics.

Continuous teacher training targeting the flipped classroom model aims to equip educators with the necessary skills for effective implementation within their specific contexts. This training encompasses various forms, including workshops, teaching resources, and ongoing support. Numerous studies have explored the impact of continuous training on teaching practices and learner performance. For instance, Bergmann and Sams [1] observed a significant improvement in teaching practices, learner engagement, and academic performance following continuous teacher training. Tucker [2] also highlighted positive outcomes, such as enhanced job satisfaction and improved classroom management.

This study contributes to this growing body of research by examining the significance of continuous teacher training based on the flipped classroom. Our research question centers on understanding the impact of this training on teaching practices, including learner engagement and practical activities, as well as its influence on learners' academic performance [3]. To address this question, we employ observation grids and

questionnaires, focusing on both teachers and learners. The subsequent sections delve into a comprehensive review of the literature on continuous training, teaching techniques, and the flipped classroom.

Continuous teacher training is a process of learning and professional development that aims to strengthen teachers' pedagogical skills and keep them up to date with the latest educational research and techniques, in order to help them adapt to changes in the education system [4]. This training can take different forms, such as workshops, conferences, seminars, online courses, mentoring programs, or exchanges of good practice [5]. The objectives of continuous teacher training are manifold. They include improving teachers' pedagogical skills [6], gaining a better understanding of learners' needs and characteristics [7], and supporting the use of new technologies in teaching [8], awareness of inclusion and diversity issues [9], and the development of innovative and effective teaching techniques [10]. Ongoing training for teachers is essential to ensure high quality teaching and learner success [7]. This training enables them to keep up to date with advanced pedagogy and new teaching methods, and to continue to develop professionally throughout their careers [5].

Pedagogical techniques play an essential role in the teaching and learning process, such as the different approaches, methods and strategies used by teachers to promote the acquisition of knowledge and the development of skills in learners [11]. They may vary according to educational contexts, school levels and objectives, and encompass aspects such as lesson planning, the way in which the class is managed, the teaching resources used, the assessment of learning, the individualization of teaching, pedagogical differentiation, and the integration of technologies. A great deal of research and study has been carried out to guide teachers in improving their techniques. Among the most relevant references is Hattie [12], which summarizes the results of numerous research studies on the factors influencing student learning. A book review [13] provides a comprehensive framework for implementing effective teaching techniques.

The history of the flipped classroom dates back to the 1990s, when some teachers began experimenting with alternative pedagogical approaches to encourage student engagement and learning. However, the flipped classroom approach as we know it today was popularized in the 2000s when Bergmann and Sams [1], [14] began recording their lectures and making them available to their students online, to allow students to learn concepts at their own pace, at home, and to spend more time in class on interactive and collaborative activities. They found that this approach allowed students to acquire the basic knowledge before coming to class, enabling them to work on more complex tasks and deepen their understanding with the help of the teacher and their peers. The popularity of the flipped classroom has continued to grow with the development of online technologies and platforms that allow teachers to easily create, share and distribute educational resources such as videos, readings, and interactive exercises [14]. Another major player in the history of the flipped classroom is Khan Academy [15]. Khan Academy created an online platform offering thousands of free educational videos in a variety of fields, enabling students around the world to learn at their own pace and independently [16].

Today, the flipped classroom is increasingly being adopted in schools around the world, offering learners a more personalized, interactive, and collaborative learning experience. Teachers who use this approach often see an increase in learner engagement and motivation, as well as a better understanding of concepts through technical activities and in-class discussions. Through this research, we aim to not only contribute to the understanding of the flipped classroom but also to provide insights that inform educational policies and promote the adoption of this innovative pedagogical approach [17].

2. METHOD
2.1. Sample
2.1.1. The teachers
In this study, we specifically targeted five college teachers from different academic disciplines to gain a comprehensive understanding of their technological capabilities and their integration of digital tools in their teaching practices. To achieve this, we administered a detailed placement test to evaluate multiple facets of their technological proficiency and pedagogical practices involving information and communication technologies (ICT). Through this comprehensive placement test, we aimed to paint a detailed picture of the teachers' current ICT use, identify gaps in their technological skills, and understand their readiness to adopt and implement advanced digital tools in their teaching practices. This information is vital for designing targeted professional development programs that can support teachers in effectively integrating ICT into their classrooms to enhance teaching and learning.

2.1.2. Learners
The study considered a sample of (N=200) divided into two groups: experimental (N1=101) and control (N2=99). In the experimental group, teachers were allowed to start the flipped classroom activities in their own classrooms. This gave them the opportunity to discuss the experiment with their learners, in

particular the fact that this teaching approach allows everyone to learn at their own pace and to receive the material (course, activity) online a week in advance on their mobile devices (smartphones, tablets). The role of the control group, on the other hand, is to take their pre-test and post-test, and to learn their lessons using the traditional method. The size of our sample is adequate, it is useful to refer to standard recommendations in the field of social sciences and education. It has been suggested that a sample size of 200 participants may be sufficient to detect medium-sized effects with acceptable statistical power, typically set at 0.80 [18].

2.1.3. Subject sample

There are several subjects taught in secondary school. We chose life and earth sciences (SVT) and science of physics and chemistry (PC) for several reasons. First, SVT, as well as physics and chemistry, are subjects that deal with rich and complex scientific concepts and natural phenomena. The flipped classroom allows learners to explore these concepts at their own pace and ask questions in class to deepen their understanding. Second, SVT and PC often involve experiments and technical activities to illustrate scientific concepts. By using the flipped classroom, teachers can devote more classroom time to these activities, encouraging learner engagement and hands-on learning. Finally, SVT and PC can benefit from the use of visual aids such as videos, simulations, and animations to illustrate scientific concepts. The flipped classroom allows learners to consult these materials at home and discuss their observations and questions in class.

Table 1 appears to present data on different classes and teachers as part of an experimental study. The column labeled "Teacher" shows the different teachers involved in the study, with each teacher identified by a letter (A, B, C, D, E). The "Class" column specifies the class level and the specific identification of each class, such as "2APIC2," which indicates the second year, group 2. The "type of class" column indicates whether the class is designated as experimental or control. The "number of students" column lists the number of students in each class. Finally, the "learning subject" column indicates the subject taught in each class, such as SVT or PC.

Table 1. Breakdown of classes by teacher and subject

Teacher	Class	Type of class	Number of students	Learning subject
Prof A	2APIC2	Experimental	30	SVT
	2APIC5	Control	30	
Prof B	2APIC2	Experimental	30	PC
	2APIC5	Control	30	
Prof C	1APIC3	Experimental	42	SVT
	1APIC7	Control	41	
Prof D	1APIC3	Experimental	42	PC
	1APIC7	Control	41	
Prof E	3APIC1	Experimental	29	PC
	3APIC4	Control	28	

2.2. Data collection tools

We used a variety of data acquisition tools: observation was carried out for five teachers and 101 learners, over four lesson sessions, in order to assess changes in teachers' teaching practice. It also focused on aspects such as classroom organization, interactions with learners, and activities using the flipped classroom pedagogical approach. During this observation, we examined a number of issues concerning teachers and learners, both during out-of-class and in-class activities. The points examined included distance and face-to-face teaching techniques, techno-pedagogical techniques, diversity of digital teaching aids, and methods to overcome the lack of ICT. Next, a questionnaire was administered to teachers before and after the in-service training to assess their perception of the flipped classroom, their level of confidence in using this approach, and the changes made to their teaching practice. Another 8-item questionnaire was administered to learners to assess their satisfaction, commitment, and perception of the impact of the flipped classroom on their learning.

2.3. Method of analysis

The quantitative data collected from the questionnaires can be analyzed using statistical package for the social sciences (SPSS) [19] to assess differences before and after the flipped classroom. This makes it possible to determine whether teachers' and learners' perceptions have changed and whether these changes are statistically significant. Qualitative data from the interviews can be analyzed using content analysis methods [20], such as thematic analysis, to identify emerging themes and patterns. This provides an in-depth understanding of teachers' experiences, changes in teaching practice, and challenges encountered. Observations can be analyzed using pre-established observation grids [21] to assess changes in teachers' pedagogical practices. This can include attributes such as the use of IT materials, learner engagement, and

classroom interactions using a rating scale for each of these criteria: very satisfactory, satisfactory, somewhat satisfactory, unsatisfactory, and not achieved.

3. RESULTS AND DISCUSSION
3.1. The effect on teachers' teaching techniques

We decided to organize the results obtained from the observation of the lesson sessions as shown in Table 2, according to five main variables. The first variable concerns the teaching methods used outside the classroom. This includes the teaching strategies that teachers implement to prepare students prior to classroom sessions, such as the distribution of reading material, preliminary assignments, and the use of online platforms for discussion and group work. The second variable focuses on the teaching methods used in class. It examines how teachers structure and conduct face-to-face lessons, focusing on interactive activities, group discussions, and practical exercises that reinforce students' active learning.

The third variable analyses the teaching methods associated with the use of technology. This includes the integration of digital tools and online resources into teaching practices, such as multimedia presentations, interactive simulations, and online quizzes. The fourth variable relates to the nature of the media used, examining the types of teaching aids employed, such as educational videos, infographics, and podcasts. Finally, the fifth variable deals with alternative strategies in the absence of ICT. This category explores the alternatives that teachers use when access to technology is limited or non-existent, such as small-group discussions, paper-and-pencil projects, and oral presentations. By grouping the results in this way, we were able to obtain a clear and structured view of the different teaching approaches observed and their relative effectiveness.

Table 2. The results obtained from observation of the lesson sessions

Variables	Prof A		Prof B		Prof C		Prof D		Prof E	
	Before	After	Before	After	Before	After	Before	After	Before	After
Teaching practices outside the classroom (4 pts)	2	4	3	4	2	3.5	2	2.5	2	3
Classroom teaching practices (4 pts)	2	4	3	3.5	2	3	1.5	3	0.5	2.5
Techno-pedagogical practices (6 pts)	0	4	1	4	0	5	0	4	0	5
Type of teaching support (2 pts)	1.5	2	1	2	1	2	0.5	2	0	2
Strategies for avoiding the absence of ICT (4 pts)	1.5	3	3	4	1.5	3	2	3	3	3
Total (/20)	7	17	11	18	6.5	17	6	15	5.5	16

Note: pts= points

Prof A showed significant progress in all the aspects assessed as shown in Figure 1, with a particularly notable transformation in techno-pedagogical techniques. Before the training, Prof A started with a score of zero, indicating a total absence of these techniques in his teaching practice. However, after taking the course, Prof A achieved an impressive score of 4 out of 6, showing that he had effectively adopted the techno-pedagogical skills taught. This progress underlines the positive impact of the training on the ability to integrate ICT into teaching. The use of ICT has proved effective in improving the teaching and learning process, opening up new possibilities for teachers and learners. It makes education not only more interactive, but also more personalized, by enabling content to be adapted to individual student needs, and more accessible, by offering diversified teaching resources available online. This transformation at Prof A illustrates how targeted ICT training can enrich teaching practices, facilitating a more modern and dynamic approach to teaching that benefits both teachers and learners by creating a more engaging and inclusive educational environment [22].

In the case of Prof B, we observed a marked improvement in all digital uses, with particularly significant progress in teaching techniques both outside and inside the classroom, as shown in Figure 2. Before the course, Prof B had a score of 1 out of 6 in terms of technical teaching practices, but after the course this rose to 4 out of 6, demonstrating the positive impact of the flipped classroom on his various teaching techniques [23]. This progression illustrates how the flipped classroom can transform pedagogical approaches by making teaching more dynamic and interactive, while allowing students to be better prepared in advance of classroom sessions. Prof B also obtained the highest possible score (4 out of 4) for the strategies used to overcome the absence of ICT [24], demonstrating an excellent ability to adapt his teaching despite technological constraints. This achievement testifies to Prof B's flexibility and creativity in using available resources to ensure effective and continuous learning, even in the absence of ICT, and highlights the importance of in-service training for teachers in acquiring adaptive and innovative skills.
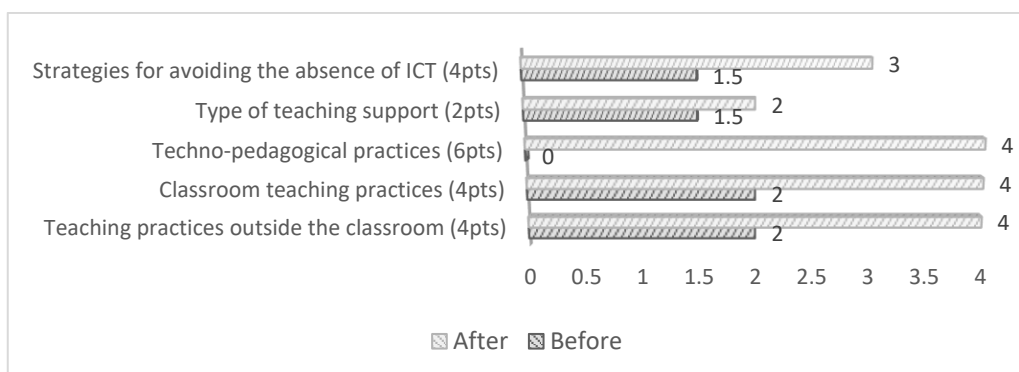
Figure 1. Observation results for "Prof A" before and after training
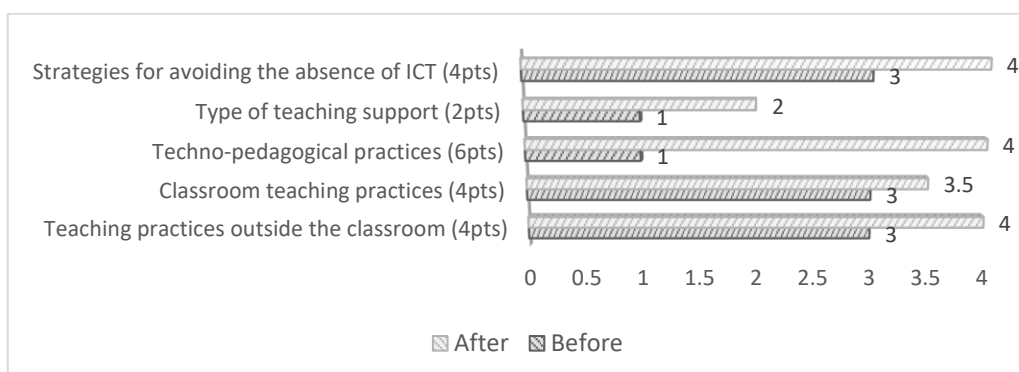

Figure 2. Observation results for "Prof B" before and after training

In terms of techno-pedagogy, Prof C's score rose from 0 out of 6 before the training to 5 out of 6 after it as displayed in Figure 3. Like the predecessors, this teacher has not yet integrated digital technologies into her classroom activities [25]. However, she is developing strategies that will enable her to put this new teaching approach (the flipped classroom) into practice [2], even in the absence of ICT, with a notable score of 3 out of 4 for these strategies. At the end of the course, there was an increase in activities carried out outside the classroom, with the score rising from 2 out of 4 to 3.5 out of 4, showing a more intensive adoption of autonomous and preparatory learning practices. In addition, there was a diversification of the teaching aids used, with the score rising from 1 out of 2 to 2 out of 2, illustrating a more varied and effective use of the teaching tools available [26]. This progress indicates not only a significant improvement in Prof C's techno-pedagogical skills, but also a growing willingness and ability to adapt and enrich her teaching methods to better meet the needs of her students, exploiting the principles of the flipped classroom to promote more interactive and engaging learning, even in the absence of advanced technological resources.
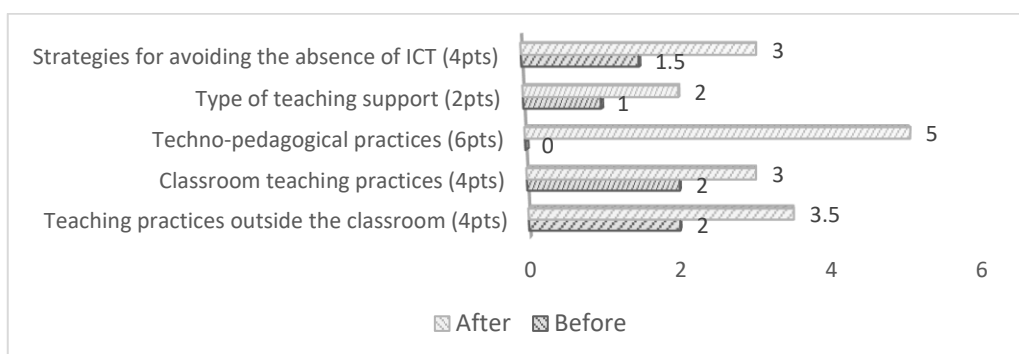
Figure 3. Observation results for "Prof C" before and after training

For Prof D, techniques used outside the classroom increased from 2 out of 4 to 2.5 out of 4, while techniques used in the classroom rose from 1.5 out of 4 to 3 out of 4, as presented in Figure 4. There was also a marked improvement in the diversity of teaching aids, from 0.5 out of 4 to 2 out of 4, and strategies for overcoming the absence of ICT were rated at 3 out of 4, compared with 2 out of 4 previously. As far as techno-pedagogical techniques are concerned, there has been a very remarkable evolution, from zero out of 6 before the training to 4 out of 6 after it, which means that teachers are increasingly using digital tools and online resources to supplement their lessons and make learning more interactive and engaging for learners [27]. This progression indicates not only an increased adoption of educational technologies but also an improvement in teachers' ability to integrate these tools into their pedagogy in an effective way. It also demonstrates the positive impact of in-service training on improving teachers' pedagogical skills, enabling them to fully exploit the potential of digital technologies to enrich the learning experience. The improvement observed by Prof D is testament to the effectiveness of the strategies put in place to overcome technological obstacles and underline the importance of pedagogical innovation in modern teaching.

In the case of Prof E, before the training, the techno-pedagogical score was 0 out of 6. However, after the training, this score rose to 5 out of 6, showing a significant adoption of techno-pedagogical techniques as shown in Figure 5. As with the previous teachers, digital technology was not integrated into classroom activities before the training, with a score of only 0.5 out of 4. Despite this, the teacher developed strategies that enabled him to put the flipped classroom into practice even in the absence of ICT [27], thus obtaining a consistent score of 3 out of 4 before and after the training. At the end of the course, we observed an increase in activities carried out outside the classroom, with the score rising from 2 out of 4 to 3 out of 4, reflecting greater use of preparatory tasks and independent exercises. In addition, there was a diversification of the teaching aids used, with an improvement in the score from 1 out of 2 to 2 out of 2, illustrating a more varied and effective adoption of the teaching tools available. These results show that, from training, Prof E has not only improved his techno-pedagogical skills, but has also enriched his teaching methods by adopting more interactive and engaging approaches for learners, even in the absence of advanced technologies.
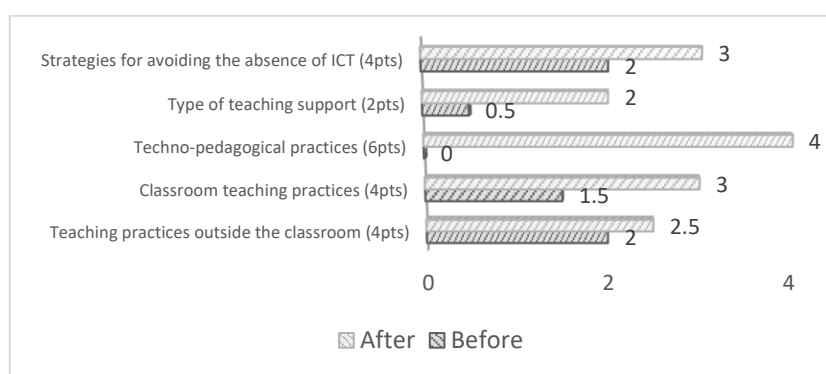

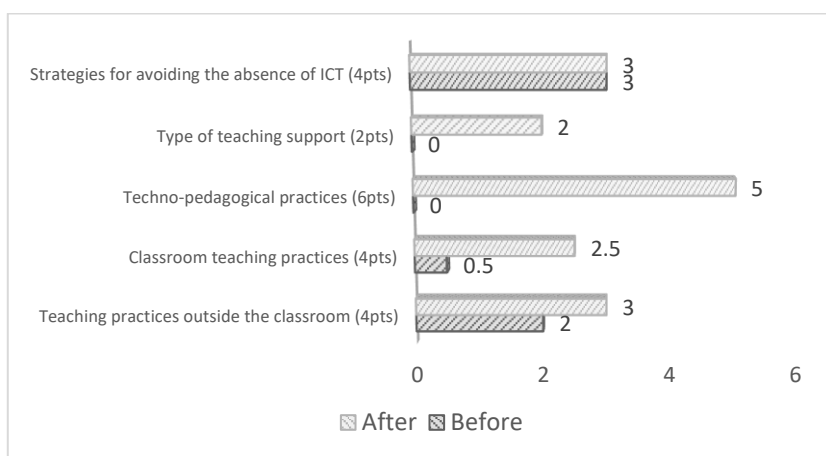Figure 4. Observation results for "Prof D" before and after training

Figure 5. Observation results for "Prof E" before and after training

Based on a comparison of teachers' individual profiles before and after training as seen in Figure 6, we will determine the effect of the flipped classroom on their teaching techniques by calculating gain indices [28]: the average gross gain (GBM) and average relative gain (GRM). The GBM represents the difference between the average after training and the average before training, thus reflecting what was actually gained. In contrast, the GRM measures the difference between what was actually gained and what could have been gained. The GRM is calculated using (1).

$$\frac{(average\ post-training-average\ pre-training)}{(average\ maximum-average\ pre-training)} \times 100 \tag{1}$$
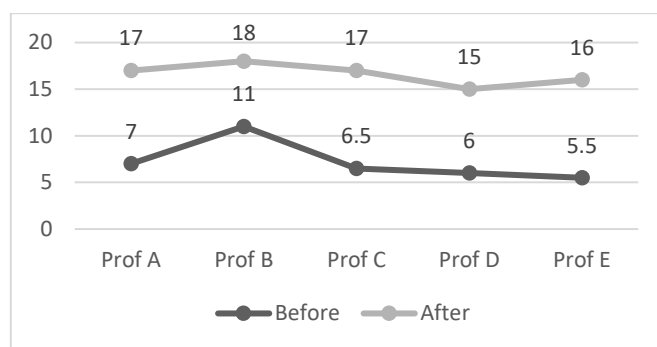
Figure 6. Comparison of teacher performance before and after training

To facilitate our study, we have presented the results as presented in Figures 7 and 8. From Figure 7, we can see that the two teachers Prof A and Prof B made the greatest progress with a GBM of "10.5" followed in descending order by Prof D (GBM=10), Prof C (GBM=9), and Prof E (GBM=7). The GBM is positive, which indicates that there has been an average improvement in teachers' performance after taking the training course, as well as the development of digital skills in teaching [18].

When the GRM exceeds 30%, the effect of the training is considered to be positive. By analyzing the results shown in Figure 8, we can conclude that the training had varied results in terms of improving teachers' skills. There was a gradual progression from 64% for Prof C to 72% for Prof C, 77% for Prof D and 78% for the two teachers Prof B and Prof E. This means that the teachers experienced a significant increase in their performance after the training [29].
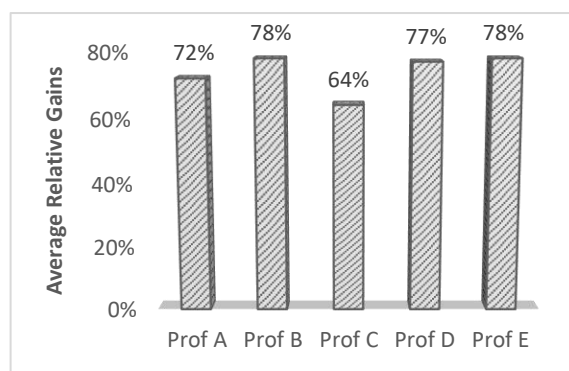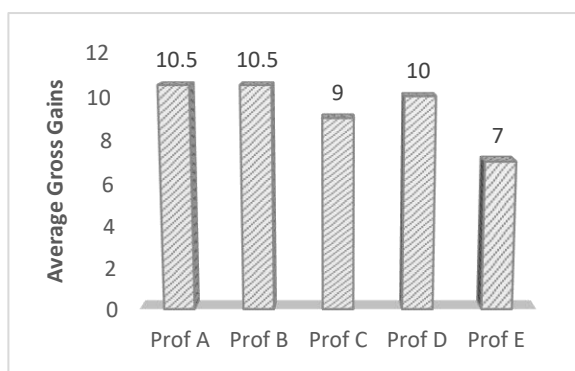

Figure7. Comparison of teachers' average gross gains

Figure 8. Comparison of teachers' average relative gains

3.2. The impact on learner performance

In order to measure the cognitive influences of the implementation of the flipped classroom approach, we administered pre- and post-test assessments to the learners, recording the results in Excel files. We also sent them an opinion questionnaire at the end of the experiment. The data from two tests are presented concisely in Table 3, which shows how the different classes are distributed between the teachers,

the types of class (experimental or control), the number of learners per class and the subjects taught. This data is essential for analyzing the results of the study and assessing the impact of the teaching intervention on learners' performance in different subjects and learning contexts.

Table 3. Learner performance in the two assessment tests

Teachers	Class	Nature of the class	Numbers	Discipline	Average pre-test	Average post-test	GBM
Prof A	2APIC2	Experimental	30	SVT	11.09	15.11	4.02
	2APIC5	Control	30		13.42	11.96	-1.46
Prof B	2APIC2	Experimental	30	PC	12.48	16.03	3.55
	2APIC5	Control	30		12.3	13.09	0.79
Prof C	1APIC3	Experimental	42	SVT	11.27	15.05	3.78
	1APIC7	Control	41		12.29	10.32	-1.97
Prof D	1APIC3	Experimental	42	PC	12.06	16.19	4.13
	1APIC7	Control	41		13.47	11.41	-2.06
Prof E	3APIC1	Experimental	29	PC	14.1	16.6	2.5
	3APIC4	Control	28		13.71	14.21	0.5

In Figure 9, we present the results of the experimental groups, followed by the results of the control groups for each teacher. For the experimental groups there is a remarkable progression and the differentiated score between the posttest means and the pretest means is significant such that the GMB of the experimental groups is equal to 3.6 and a GMR=46.15%. Concerning the control groups, we noted that the pre-test means were better than the post-test means, whose relative mean gain, which represents the difference between the two means, is equal to -0.84, hence the GMR=10.77%. We concluded that learners taught via the flipped classroom performed better than learners taught via the traditional method [26].
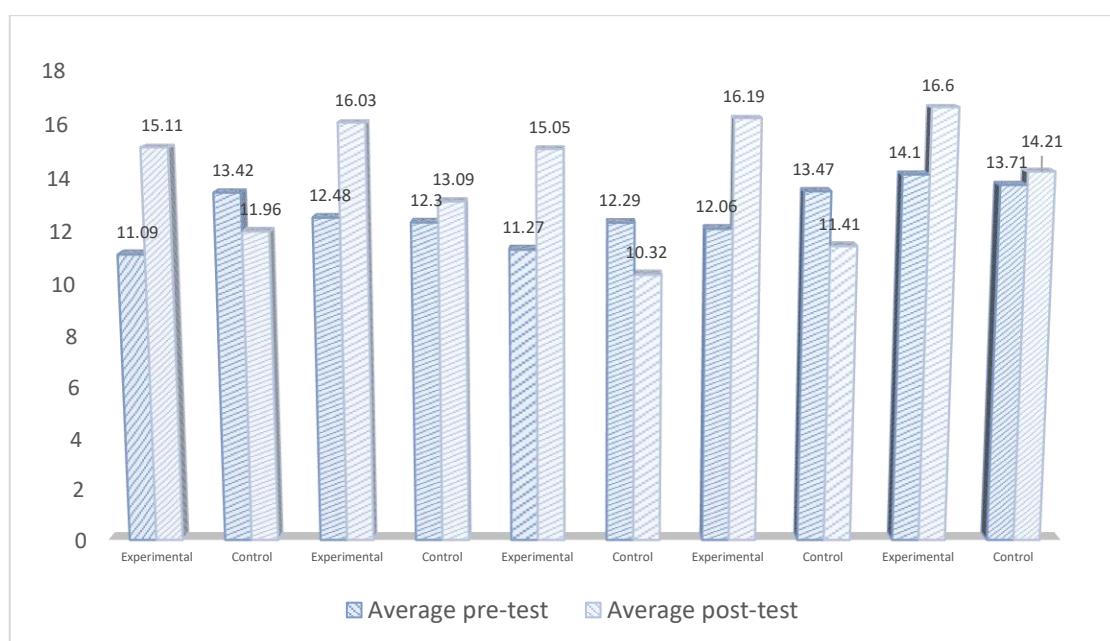

Figure 9. Results for each class before and after the experiment

3.3. Learners' views on flipped classroom teaching

In order to find out learners' views on the flipped classroom approach to teaching, we analyzed the questionnaire that was sent to learners in the experimental groups at the end of the experiment. The results are summarized in Figure 10. After the experiment, almost half of the learners in the experimental group (49.1%) strongly agreed that the fact of receiving the course content before attending reinforced their commitment to the face-to-face activities. In fact, it is said that the flipped classroom allows learners to better understand concepts and ask relevant questions during face-to-face sessions. As a result, learners are more engaged and motivated [1].
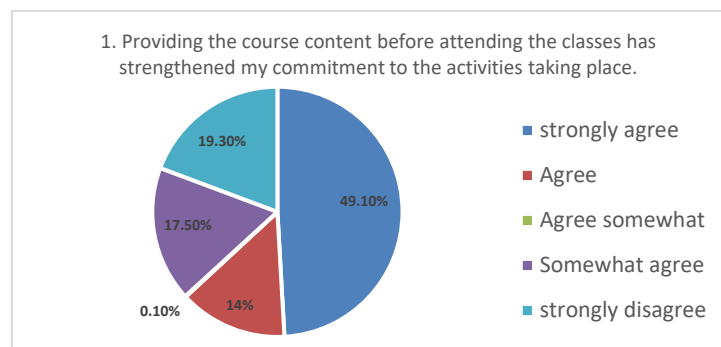
Figure 10. Results of the 1st item of the questionnaire sent to the experimental group

The result indicates that after practicing the flipped classroom almost the majority of learners (24.6% strongly agree and 45.6% agree) agreed with the statement that they only used the course materials provided by the teacher as presented in Figure 11. This suggests that these learners used only the resources provided by the teacher, which may indicate confidence and satisfaction with these materials [28]. This may also mean that the learners found the resources sufficiently complete and adapted to their needs, and therefore did not feel the need to look for other sources of information.

Figure 12 shows that, after using the flipped classroom, 33.3% of learners very much agreed and 31.6% agreed with the statement that they always carried out the activities requested by the teacher before coming to class. This suggests that the introduction of the flipped classroom has had a positive impact on learner engagement, as a majority of learners continue to carry out preparatory activities before lessons. This can be seen as a sign of motivation [30] and increased involvement of learners in their learning [31].
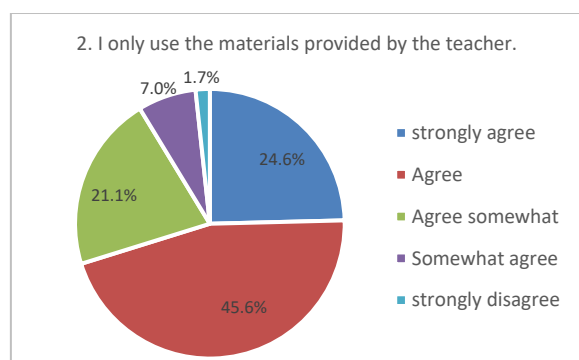
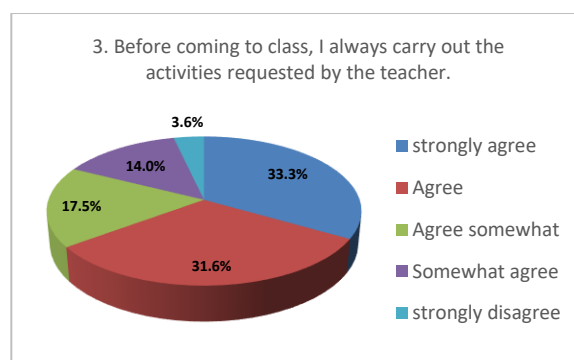Figure 11. Results of the 2nd item of the questionnaire sent to the experimental group

Figure 12. Results of the 3rd item of the questionnaire sent to the experimental group

After the experimentation, Figure 13 indicates that, most learners (28.1% strongly agree and 38.6% agree) agreed with the statement that group work promoted communication and exchange. This indicates that most learners perceived that group work was beneficial in facilitating communication and exchange [23], which can be seen as an encouraging outcome in terms of developing collaborative and communication skills [24]. Figure 14 indicates that, after experimenting with the flipped classroom, a majority of learners (24.6% strongly agree and 38.8% agree) agreed with the statement that group work helped them to better understand the lessons. This suggests that collaborative working was beneficial for better understanding of lessons, which can be seen as an encouraging result in terms of developing comprehension skills and collective learning [23].

After experimenting with the flipped classroom pedagogical approach, the result shows that most learners (33.3% strongly agree and 35.1% agree) agreed with the statement that the analysis and use of documents in class contributed to deepening the course content as shown in Figure 15. This implies that these learners perceived that this pedagogical approach was beneficial for a better understanding and appropriation of knowledge, which can be seen as an encouraging outcome in terms of developing analytical skills and resource use [30].
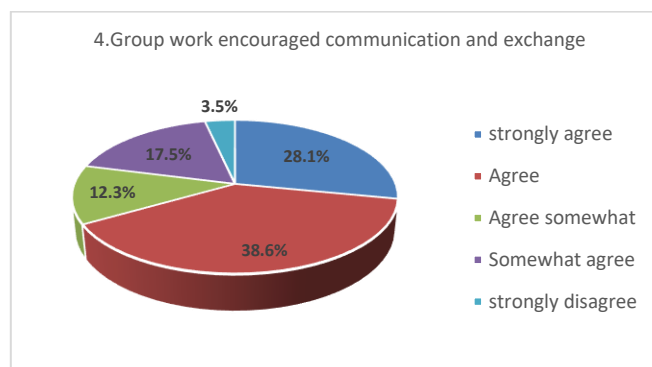
Figure 13. Results of the 4th item of the questionnaire sent to the experimental group
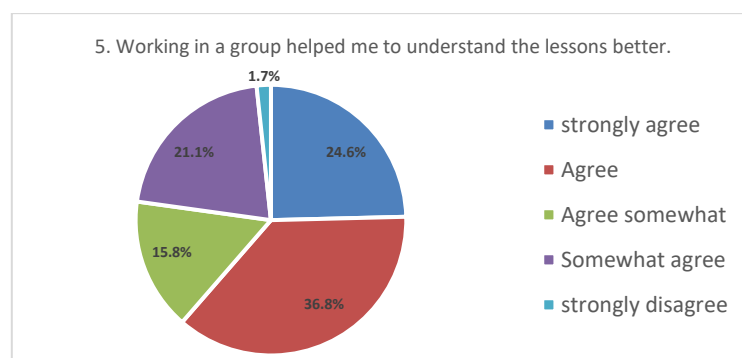
Figure 24. Results of the 5th item of the questionnaire sent to the experimental group
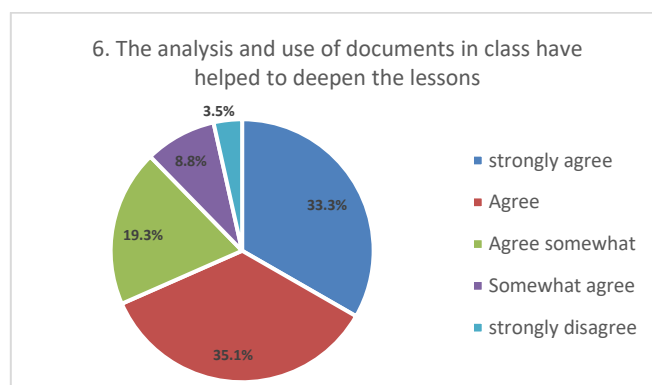
Figure 35. Results of the 6th item of the questionnaire sent to the experimental group

Most learners (42.1% strongly agree and 33.3% agree) agree with statement that the video vignettes helped make their learning easier as shown in Figure 16. This indicates that the videos were beneficial to their learning, providing them with a visual and interactive support that facilitated their understanding of the concepts and content. This result can be interpreted as a validation of the effectiveness of video vignettes in the flipped classroom context to make learning more accessible and engaging for learners [32].

The interpretation of the result in Figure 17 indicates that the majority of learners (52.6% strongly agree and 17.5% agree) agree with the statement that the flipped classroom increases the number of learning activities. This suggests that learners perceive that the flipped classroom offers more opportunities to actively participate in learning activities [1]. Increasing the number of learning activities can be beneficial as it allows learners to interact more with content, solve problems, collaborate with peers, and actively apply what they have learned [33]. This fosters a deeper understanding of concepts and better retention of information.
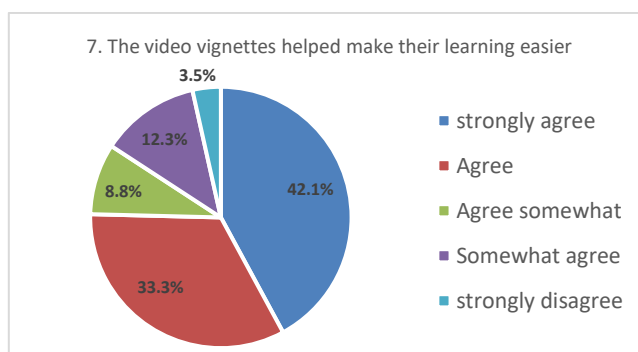
Figure 16. Results of the 7th item of the questionnaire sent to the experimental group
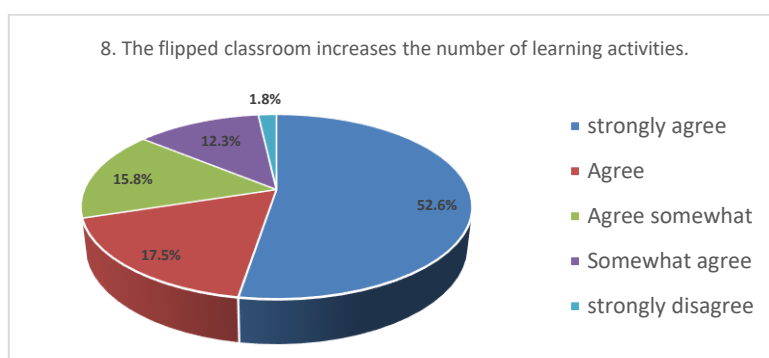

Figure 17. Results of the 8th item of the questionnaire sent to the experimental group

3.4. Study limitations

One of the major limitations of this study is the small sample size, consisting of just 200 participants. To assess whether our sample size is adequate, it is useful to refer to standard recommendations in the field of social sciences and education. A sample of 200 participants can be considered sufficient to detect medium-sized effects with acceptable statistical power, generally set at 0.80 [18]. This statistical power of 0.80 indicates that there is an 80% chance of detecting a real effect in the population studied, which is widely recognized as a reasonable threshold for empirical studies, offering a good balance between the probability of detecting real effects (reducing the risk of type II error) and the practicability of the research in terms of the cost and time required to recruit and test participants.

4.   CONCLUSION

Continuous teacher training centered on the flipped classroom model has a significant impact on teaching practices and learner performance, demonstrating the transformative potential of ongoing professional development. Adopting the flipped classroom approach, along with sustained training for educators, can revolutionize teaching methodologies, reshape traditional classroom dynamics, and enhance the overall educational experience for both teachers and students. Continuous teacher training in the flipped classroom framework fosters more interactive and student-centric learning environments, where educators gain proficiency in technology use, lesson restructuring, and personalized instruction, resulting in a dynamic and engaging classroom atmosphere. The positive correlation between continuous teacher training and learner performance highlights the academic benefits of the flipped classroom model. Effective implementation empowers students to take ownership of their learning, benefit from tailored instruction, and engage with educational content meaningfully. Supported by ongoing professional development, the flipped classroom emerges as a promising approach for improving pedagogical methods and student outcomes. Investing in continuous teacher training focused on the flipped classroom is a strategic approach to advancing teaching practices and enhancing learner performance within the broader context of educational reform. This underscores the importance of ongoing support and professional development initiatives in successfully integrating innovative teaching models and evolving towards effective, student-centered education.

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