CAPÍTULO 3

FLIPPED TEACHING METHODOLOGY AS A TEACHING-LEARNING PROCESS FOR THE SUBJECT OF ENERGY AUDIT. A CONTRIBUTION TO THE RENEWABLE ENERGY ENGINEERING DEGREE AT TECNM CAMPUS VERACRUZ

https://doi.org/10.22533/at.ed.487112415103

Data de subimissão: 07/11/2024 *Data de aceite: 11/11/2024*

Miguel Ángel Quiroz García
Doctor en Ciencias Pedagógicas
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México
http://orcid.org/0000-0001-5570-7444X

Carlos Roberto González Escarpeta
Máster en Ingeniería Electrónica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

Alma Genoveva Castro Valdés
Máster en Ingeniería Mecánica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

Citlalli Carolina Joaquín Méndez
Est. Lic. En Ingeniería Electrónica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

Oscar Omar Montalvo Pérez
Máster en Ingeniería Mecánica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

Angel Miranda Juárez
Máster en Ingeniería Mecánica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

Marycarmen Arana Altamirano
Licenciado en Ingeniería Electrónica
Tecnológico Nacional de México (TECNM)
- campus Veracruz, Veracruz, México

ABSTRACT: This paper presents the results of the praxis carried out during the March-July 2022 semester, at the end of the global pandemic. The subject is Energy Audit for the renewable energy engineering degree at the Tec de m Veracruz campus. The flipped classroom principle has been used, focusing on the higher level. The semi-presential or mixed learning modality was launched, in such a way that the strategies of the face-to-face and virtual parts were used, taking the best of each moment and complying with the canons that TECNM regulates in times of pandemic. Likewise, the aspect of helping students learn from each other in class is taken care of. It began with videos, slides, and other resources; the change occurred when the students formed teams to work on the assigned booklet of the program unit.
KEYWORDS: Flipped classroom, teaching resources, booklets, group learning

INTRODUCTION

"Progress consists of renewing oneself" is an idea that was taken up again in the early years of 2012 by Bergman and Sams. Through the flipped classroom that was born around those same dates and is used in the basic education level and that in recent years has been transformed and adapted for higher education

This is how the flipped classroom methodology is used in the TECNM Veracruz campus and thus be at the forefront of the preparation that the industry and companies around us require and is applied through praxis in the energy auditing field.

The application has consisted of the integration of the teacher-student duo and trying to get each student involved in the final product that is required to achieve the objective in the teaching-learning process of the subject in question

The result is to have a manual of notes prepared by the students themselves and that contains the entire current program of the subject, which in this case is energy auditing.

METHOD DESCRIPTION

Course Description

At the beginning of the semester, the professor presents the course syllabus, which is divided into five units. This systematic approach, common in flipped teaching, enables students to delve deeper into the subject matter while developing essential skills. In flipped classrooms, such a structure is vital to ensure that students can effectively self-direct their learning outside the classroom, as can be seen in Figure 1 (Strayer, 2012; Alten et al., 2022).

Team Building

To enhance collaboration, students are asked to form teams of 3-4 members, as seen in Figure 2. This team-based structure encourages diverse perspectives and shared responsibilities, essential for the successful completion of their project. In flipped teaching environments, teamwork is often emphasized to allow students to actively apply their knowledge (Bishop & Verleger, 2013; Shi et al., 2022).

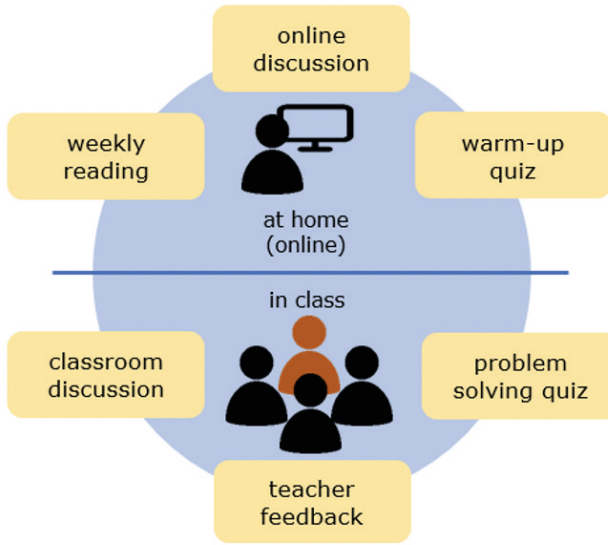


Figure 1.- Flipped teaching in the classroom

https://www.mextesol.net/journal/public/images/8501e761a5af118b64819c2e269b9360.png

Figure 2a. Group separation

Figure 2b. Group separation

https://www.danielcolombo.com/7-aspectos-que-inspiran-a-un-equipo-por-daniel-colombo/

Project Breakdown

The course project is organized into three distinct stages broken down in Table 1, which will be completed over a two-month period. Each stage consists of specific deliverables that contribute to the final text.

Project Phase	Deliverable	Description of the Activity
Phase 1: Creation	Fascicle in Spanish	The team will write a unit book in Spanish.
Phase 2: Translation	Fascicle in English	The team will produce an English translated version.
Phase 3: Presentation	Multimedia presentation	A PowerPoint presentation or similar format will be prepared to present the results.

Table 1. Project is organized into three distinct stages

Creation Phase

The first two weeks are dedicated to organizing activities for the creation of the booklets. Teams collaborate on research topics, assigning roles such as introduction writer, conclusion writer, bibliography compiler, and main body organizer, an example of ways of separation is shown in Box 2. This collaborative work reflects the flipped classroom model, where students take control of their learning process outside of the classroom and then come together for group activities during class time (Abeysekera & Dawson, 2015; Delozier & Rhodes, 2020). This ensures that all members contribute equally while honing their research and writing skills.

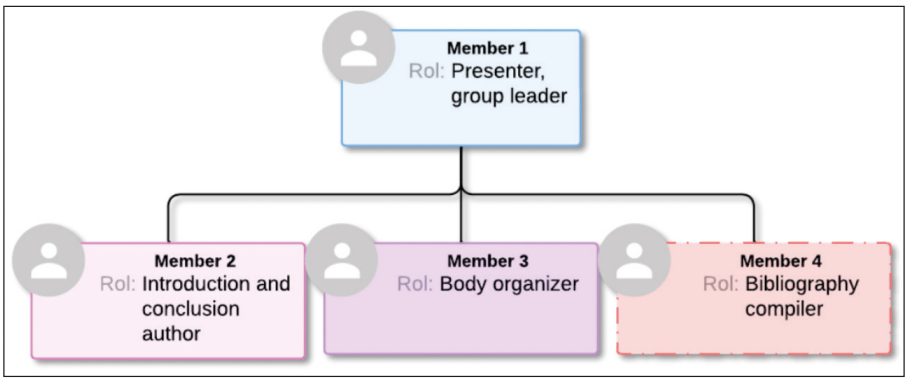
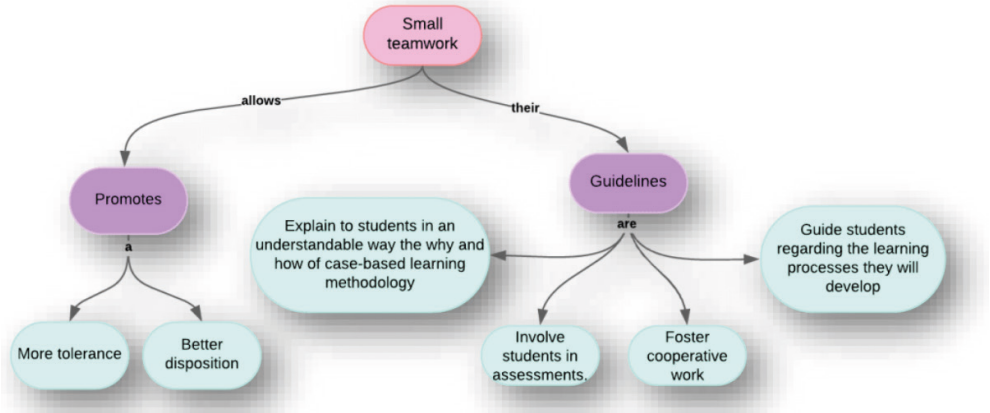


Table 2. Example of role separation



Fascicle Requirements

Each fascicle must meet several requirements as shown in Table 3

Presentation Guidelines

The complementary presentation is made at the end of the unit by a team member as seen in Figure 3, where the interaction of the authors of this research can be seen (in the left image Miguel Quiroz and on the right Citlalli Joaquín); it should consist of 15 to 20 slides that encapsulate the key points of each unit. Each team designates a leader responsible for communicating with the professor and ensuring that deadlines are respected.

Aspect	Description
Estructure	- Cover - Table of contents - Introduction - Main body (minimum 30 pages) - Conclusions - Bibliography - Questionnaire with at least 10 questions and answers
Format	- Font: Arial - Size: 12 - Margins: 3 cm (left), 2 cm (right, top and bottom)
Delivery	Pamphlets sent electronically through the Teams platform

Table 3. Fascicle Requirements

The emphasis on student leadership within the teams reflects the principles of flipped teaching, where students are often given the responsibility of leading discussions and projects (Bishop and Verleger, 2013; Shi et al., 2022).

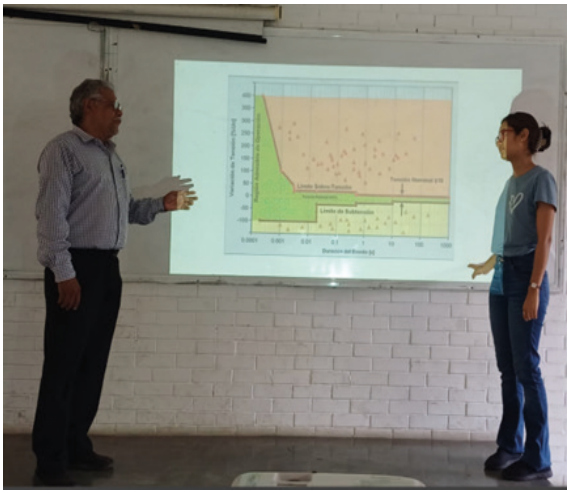


Figure 3a.- Presentation example

Figure 3b.- Presentation example

RESOURCES AND SUPPORT

To assist students in developing their project, the instructor provides a wealth of resources in the “Class Materials” section in Teams. This includes:

Current syllabus

- Links to guidelines on creating quizzes
- Instructions on booklet structure
- Tips for writing bibliographies
- Guidance on writing introductions

Providing these resources in advance aligns with the flipped classroom model, as it allows students to interact with the materials at their own pace before coming together to apply what they have learned in a more interactive classroom setting (Abeysekera & Dawson, 2015; Alten et al., 2022).

Delivery schedule The delivery process is clearly defined in Table 4 below:

Dates / Activities	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Organization								
Fascicle in Spanish								
Fascicle in English								
Presentation								

Table 4.- Delivery schedule

During this period, the instructor reviews all submissions and compiles them into a folder to form a complete text for the course. This ongoing review process is a hallmark of flipped teaching, where feedback is built into the learning cycle to ensure continuous improvement (Strayer, 2012; Delozier & Rhodes, 2020).

FINAL COMPILATION

By week nine, three folders are created:

1. Spanish Units
2. English Units
3. PowerPoint Presentations

Once all components are collected—cover pages, main bodies, introductions, conclusions—the final text is assembled. This includes a full cover page and bibliography. Merging Teams for Enhanced Collaboration

To further enhance the educational experience, (Figure 4) Teams 1 and 2 merge to form Group A, while Teams 3, 4, and 5 combine as Group B, as seen in Table 5. This strategic merger allows to produce two different texts, enhancing collaboration and resource sharing. Merging teams can be interpreted as an extension of the collaborative ethos of flipped classrooms, where mutual learning is an essential element (Bishop & Verleger, 2013; Shi et al., 2022).

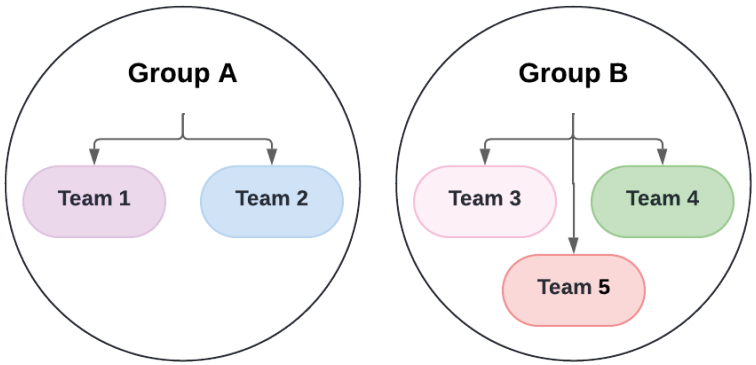


Figure 4.- Working in groups and teams

Figure 5a. Students conducting the final review

Figure 5b. Students conducting the final review

FINAL REVIEW

To ensure a high-quality product, a selected group of five highly skilled students (each a team member) will evaluate the compiled book against the initial outline. They will provide input as required to further elevate the final product, as seen in Figure 5. Peer review, as seen here, is a common practice in flipped classrooms, further empowering students to take ownership of their learning process (Bergmann & Sams, 2012).

CONCLUSIONS

The development of this project has shown that the creation of a collaborative textbook for the Energy Audit course not only facilitates the understanding of the theoretical components, but also lays the foundation for the improvement of numerous practical skills in students, such as collaboration, research and management. Through the implementation of the flipped classroom model, students assume a more active and autonomous role in their learning, which favors a deeper and longer-lasting understanding. The creation of booklets in different languages and the presentation of these documents promote individual autonomy. Likewise, the inclusion of a feedback cycle within the course contributes to the continuous improvement of performance and the quality of the result.

RECOMMENDATIONS

Researchers interested in continuing with this research could focus on several key aspects to improve the methodology used in the creation of collaborative textbooks in academic courses using the flipped classroom method.

It is suggested to increase the use of digital tools, promoting platforms such as Teams to improve communication and task monitoring between students and teachers. Furthermore, the integration of collaborative technologies, such as Google Docs, would allow for real-time modification of the file by all participants, thus facilitating co-authorship and coordination in the creation of the booklets. It would also be valuable to incorporate clear rubrics for peer reviews at different stages of the project. This would not only help students improve the content but would also allow them to develop critical skills by establishing specific criteria for evaluation and encouraging constructive discussions among teams.

REFERENCES

Abeysekera, L., & Dawson, P. (2015). Motivación y carga cognitiva en el aula invertida: Una revisión de la evidencia. Educational Media International, 52(1), 1-15.

Alten, J., et al. (2022). Efectos de la inversión del aula en los resultados de aprendizaje: Un meta-análisis.

Bergmann, J., & Sams, A. (2012). Flip Your Classroom: Reach Every Student in Every Class Every Day. ASCD.

Bishop, J. L., & Verleger, M. A. (2013). El aula invertida: Una encuesta de la evidencia empírica sobre los resultados de aprendizaje de los estudiantes. ASEE Annual Conference and Exposition, Conference Proceedings.

Delozier, S., & Rhodes, M. (2020). Aulas Invertidas: Una Revisión de Ideas y Recomendaciones.

Shi, Z., et al. (2022). Resultados de Aprendizaje de los Estudiantes en Entornos de Aula Invertida: Un Meta-Análisis.

Strelan, P., et al. (2021). Efectos de las aulas invertidas sobre el rendimiento y la satisfacción de los estudiantes: Un meta-análisis. Educational Psychology Review, 33(3), 843-868.

Strayer, J. F. (2012). ¿La clase invertida? Una clase para enseñar a los estudiantes a aprender. Educational Research Review, 7(4), 50-57.