Article **Journal of Technology and Education**
June 2022, Vol.6 No.15 1-7

Teaching of the subjects of Ecological Engineering and Air conditioning and refrigeration of the career of Electrical Mechanical Engineer of the FES Cuautitlán in the distance and mixed modality

Enseñanza de las asignaturas de Ingeniería ecológica y Aire acondicionado y refrigeración de la carrera de Ingeniero mecánico electricista de la FES Cuautitlán en la modalidad a distancia y mixta

HERNÁNDEZ-GÓMEZ, Víctor Hugo†* & CHAVARRÍA-ORTIZ, Gilberto

Universidad Nacional Autónoma de México, FES Cuautitlán, Estado de México, México

ID 1st Author: *Víctor Hugo, Hernández-Gómez* / **ORC ID:** 0000-0001-9315-5869, **Researcher ID Thomson:** S-6575-2018, **CVU CONACYT ID:** 122247

ID 1st Co-author: *Gilberto, Chavarría-Ortiz* / **ORC ID:** 0000-0002-5358-4260, **CVU CONACYT ID:** 1204605

DOI: 10.35429/JTAE.2022.15.6.1.7 Received: January 10, 2022; Accepted: June 30, 2022

Abstract

This article describes the teaching method of the subjects of Ecological Engineering and Air Conditioning and Refrigeration of the Electrical Mechanical Engineer career at FES Cuautitlán, for the distance and mixed modality. New didactic resources were developed to improve the teaching-learning process, such as class videos, notes, videos and support texts, infographics, mind maps, word search puzzles, crossword puzzles, to name a few, for each topic of the subjects. To concentrate the information and make it available to students at any time of the day, virtual classrooms were created in Classroom and Moodle. A section of practical activities that can be done from home, using easy-to-find and even recycled materials, was included. The virtual classrooms were tested during the 2022-2 semester, giving good opinions from the students who took the subjects, since, although the class was taught by zoom, if they could not take the class for work reasons, they could be regularized with the videos. of the class and of support to the subject, in the moment that they had free.

Moodle, Classroom, Mixed teaching

Resumen

En este artículo se describe el método de enseñanza de las asignaturas de Ingeniería ecológica y Aire acondicionado y refrigeración de la carrera de Ingeniero mecánico electricista de la FES Cuautitlán, para la modalidad a distancia y mixta. Se desarrollaron nuevos recursos didácticos para mejorar el proceso de enseñanza aprendizaje como videos de clase, apuntes, videos y textos de apoyo, infografías, mapas mentales, sopa de letras, crucigramas, por mencionar algunas, para cada tema de las asignaturas. Para concentrar la información y que estuviera disponible para los alumnos a cualquier hora del día, se elaboraron aulas virtuales en Classroom y Moodle. Se incluyó una sección de actividades prácticas que pueden realizar desde su casa, empleando materiales fáciles de encontrar e inclusive reciclados. Las aulas virtuales se probaron durante el semestre 2022-2 dando buenas opiniones por parte de los estudiantes que cursaron las asignaturas, ya que, aunque se daba la clase mediante zoom, si por cuestiones laborales no podían tomar la clase, podían regularizarse con los videos de la clase y de apoyo al tema, en el momento que tuviesen libre.

Moodle, Classroom, Enseñanza mixta

Citation: HERNÁNDEZ-GÓMEZ, Víctor Hugo & CHAVARRÍA-ORTIZ, Gilberto. Teaching of the subjects of Ecological Engineering and Air conditioning and refrigeration of the career of Electrical Mechanical Engineer of the FES Cuautitlán in the distance and mixed modality. Journal of Technology and Education. 2022. 6-15:1-7.

* Correspondence of the Author (E-mail: vichugo@unam.mx)
† Researcher contributing as first author.

Introduction

Due to the escalation of contagions registered in China, Europe and mainly the United States, the Mexican government, through the Ministry of Health, took the decision to declare 23 March 2020, the National Day of Healthy Distance, where health and social distancing measures were put into action to reduce the contagions caused by the SARS-CoV-2 coronavirus.

From that moment on, all on-site classes were suspended in all educational centres in Mexico. In the first instance, the Ministry of Public Education (SEP) established that all students should be at home, bringing forward the Easter holidays with the intention of developing an emergency plan to continue distance education.

The Universidad Nacional Autónoma de México (UNAM) followed the same guidelines adopted by the SEP, except that it brought forward the suspension a week earlier, due to calculations made by UNAM researchers regarding the number of predicted infections.

With the global health emergency, distance education had to be implemented as an emergency measure, which meant that the content of the syllabus was not covered. The SEP started to broadcast via internet, radio and television, so that the majority of students would have access to this knowledge.

In the case of the University, some of us professors contacted the students and held videoconferences through synchronous platforms such as Zoom or Meet, and classes were taught as much as possible. The problem with doing it this way is that not all students had access to this technology, either because they don't have it, couldn't rent an hour of internet, didn't have wifi or because they couldn't connect at that time.

To help reduce this situation, the PAPIME project "New didactic resources to improve the teaching-learning process for the subjects of Ecological Engineering and Air Conditioning and Refrigeration for the online and blended modalities, of the FESC's Mechanical and Electrical Engineering degree programme, code PE100222, was created with the aim of generating new didactic resources to improve the teaching-learning process for the aforementioned subjects, to be used in the online and blended modalities.

This includes creating virtual classrooms, so that students can use it without any time restrictions (asynchronous mode) and can keep track of the subject. The didactic material was developed in such a way that when we return to normality, it can be used to teach our classes in mixed or face-to-face mode.

We also have laboratory practices, notes and experimental prototypes that were developed in the PAPIME PE102015 and PE101218 projects, which were revised and updated, and the experimental prototypes were maintained. To complement the knowledge, educational resources from different UNAM repositories and other open access platforms were integrated.

It is worth mentioning that prior to the development of this project, during the pandemic it was necessary for the participants to take different courses, seminars and conferences on the generation of didactic material, evaluation methods and administration of the virtual classroom.

Dr. Víctor Hugo Hernández Gómez and Eng. Gilberto Chavarría Ortiz teach the Ecological Engineering subject in the Mechanical and Electrical Engineering course, from the 2012 curriculum. For several years they have been in constant communication to standardise the classes that each of them teaches to the students, the first action was in the extraordinary exams and then in the way of teaching the subject, which is now materialising during the pandemic through this project. In addition, Dr. Hernández established the same procedures for the other subject he teaches, Air Conditioning and Refrigeration.

To give the students a variety of platforms to use, Mr. Chavarría chose Moodle and Dr. Hernández chose Classroom. Once the platform was selected, they registered in the CUAIEED's Virtual Classroom database [I], reviewed the videos included in the page and logged in to each platform.

ISSN 2523-0360

Ecological Engineering course in Moodle

The virtual classroom was registered and started with a welcome message, then the objective of the subject, the course topics and the respective practices were generated. In this same section, the link to access the Zoom platform and connect in real time (online class) was embedded. This prevents the student from losing the link to access the Zoom platform and losing the possibility of having a remote link to the class. Figure 1 shows the objective and welcome to the course.

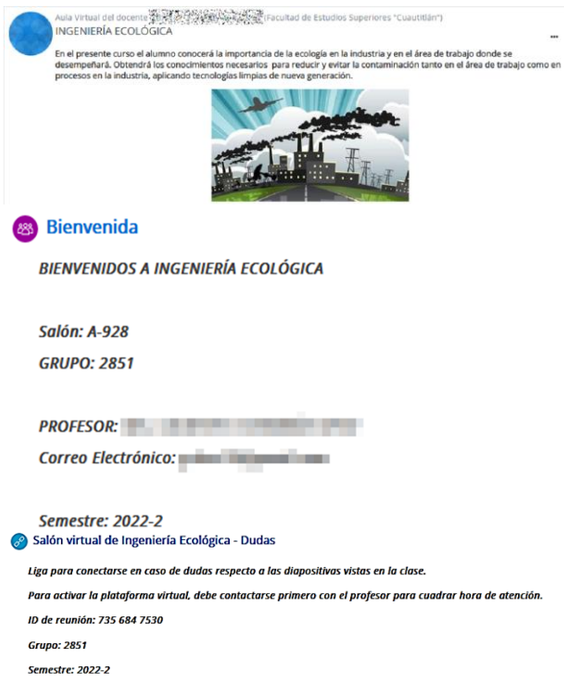


Figure 1 View of the presentation of the Ecological Engineering course created in Moodle
Source: Own elaboration

In the welcome section, important notices can be attached, both from the course itself and from the faculty. The exams that will be administered online are also embedded, with the instructions that must be followed in order to take them, as well as their grades, both partial and final. The teacher has the ability to activate or not such notices, since Moodle has this option.

The topics contained in the virtual classroom are the contents of the syllabus of the subject:

- General Aspects of Ecology and Environmental Contamination.
- Air Pollution.
- Water Pollution.
- Soil Pollution.
- Clean Energy.
- Thermal Pollution.
- Noise Pollution.
- Radioactive Pollution.

Moodle shows all the topics with their respective summary and an image according to the corresponding topic, as shown in figure 2.

Figure 2 View of the first topic of the course visualised by the student
Source: Own elaboration

Figure 3 shows a brief example of the content corresponding to the topic "Water pollution" that the ecological engineering student visualises.

Figure 3 View of the presentation of the topic "Water pollution"
Source: Own elaboration

The content published on the platform for each topic is as follows:

Slides presented in the virtual or face-to-face classes that serve as study guides for the student to supplement it with their class notes.

Research tasks.

Links of interest so that the student can complement what has been seen in the online classes. In this section it is possible for the student to collaborate to enrich the collection of articles, reports, reports, etc., which are of interest to both the teacher and the student.

Videos as complements to the topics seen in the online (or face-to-face) classes.

Laboratory practicals. Consists of five practicals, which are developed throughout the semester.

For the evaluation, different exams were generated and uploaded to the platform. During the exams, Moodle allows us:

- Real-time monitoring of the exam.
- Verify the number of students who have accessed the platform.
- View the grade obtained in the exam by the student.
- Review the student's exam manually.
- Download the grading table in an Excel format.

Figure 4 shows an example of an online exam tracking.

Figure 4 View of the presentation of the Water Pollution topic
Source: Own elaboration

When the exam is reviewed manually, Moodle indicates, for each question that makes up the exam, the answer history where the following data can be observed:

- Start time - time at which the student accessed the question.
- Time saved - time in which the student finished answering the question.
- Time of completed attempt - time at which the learner finished answering the quiz.

It is important to note that Moodle issues a warning message when the student is late in answering any of the quiz questions. When this happens, it means that the student opened a window outside the exam, which translates into the student reviewing the notes on the topics covered in the test.

Subjects Ecological Engineering and Air Conditioning and Refrigeration in the Classroom.

Figure 5 shows the virtual classrooms of each subject.

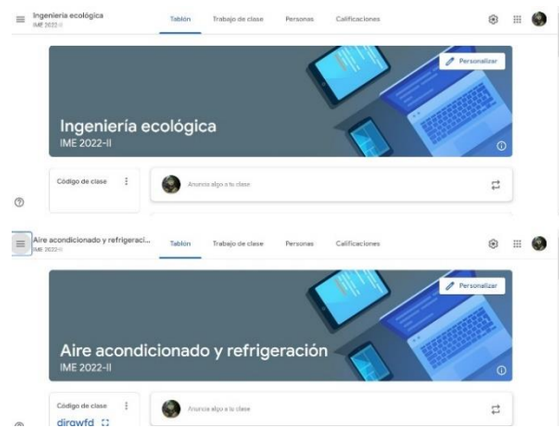


Figure 5 Virtual classroom in Classroom of the subjects involved
Source: Own elaboration

In the class work section, the following sections were included in each classroom:

Air conditioning and refrigeration:

End of semester

Presentation, agenda and references:

1. General Concepts
2. Psychrometric Processes
3. Characteristics of Supplied Air
4. Comfort Conditions
5. Calculation of Space Heat Load
6. Air conditioning alternatives
7. Heating and Cooling

Practical activities

Ecological Engineering.

End of semester

Presentation, syllabus and references.

1. General aspects of ecology and environmental pollution
2. Air pollution
3. Water pollution
4. Soil pollution
5. Clean energy
6. Thermal pollution
7. Noise pollution
8. Radioactive pollution

Practical activities

Figure 6 shows the sections of the Ecological Engineering course, as an example.

In the "Presentation, syllabus and bibliography" section, a video presentation of the course and the teacher, the syllabus of the subject, the UNAM and FESC semester calendar, instructions for the use of the Zoom and Classroom tools and the link to access the UNAM digital library were included.

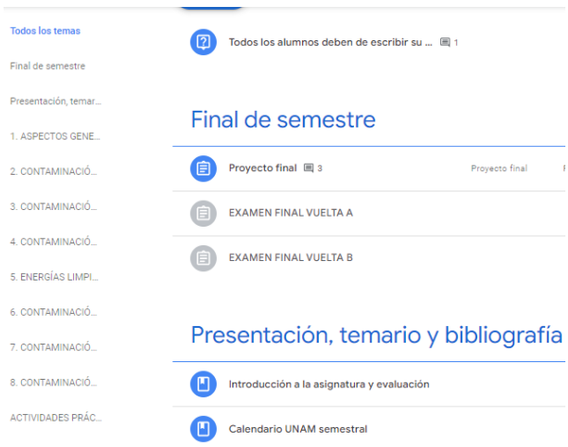


Figure 6 Classroom sections for the Ecological Engineering subject
Source: Own elaboration

In addition, in the case of the Air Conditioning and Refrigeration subject, the form, psychrometric tables and links to the support software were included. Figure 7 shows the breakdown of this section for the Air Conditioning and Refrigeration subject.

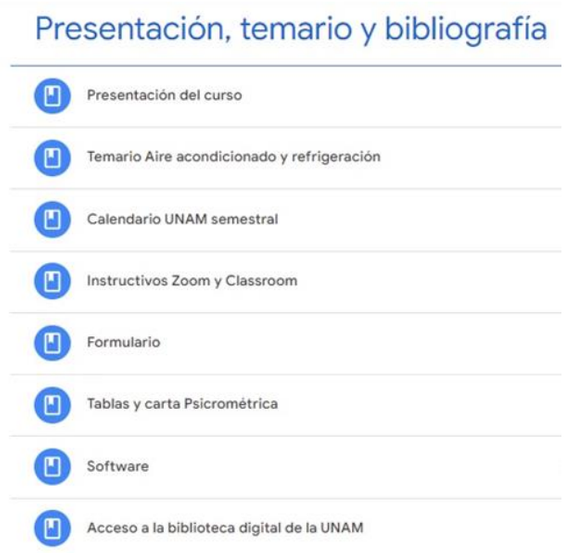


Figure 7 Presentation, syllabus and bibliography section of the Air Conditioning and Refrigeration subject
Source: Own elaboration

In each of the sections corresponding to the subject's syllabus, the video of the class, the presentation used in the video, the developed notes on the subject, links to support material such as UNAM repositories, YouTube, etc., asynchronous activities to be carried out by the students and a questionnaire on the subject were included. Figure 8 shows an example of the material included in each topic.

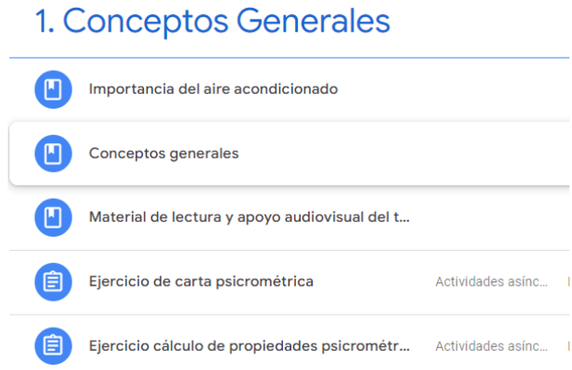


Figure 8 Material included in the General Concepts section of the Air Conditioning and Refrigeration subject
Source: Own elaboration

Figure 9 shows the material included in the sections "Importance of air conditioning" and "General concepts" in figure 8.

ISSN 2523-0360

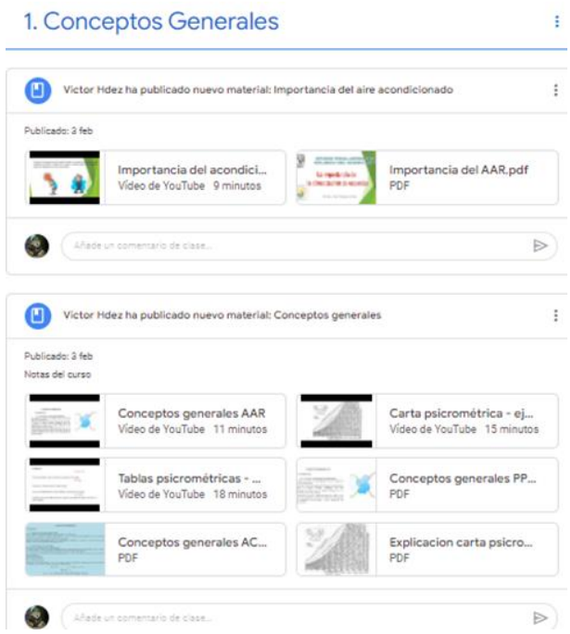
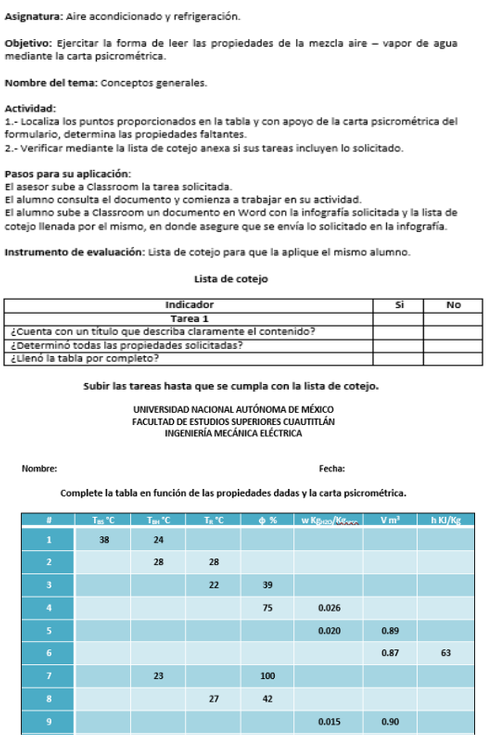


Figure 9 Material included in the sections "Importance of air conditioning" and "General concepts"
Source: Own elaboration

In the asynchronous activities, they were asked to solve crossword puzzles and word searches, explain a news item related to the topic, elaborate mind maps and infographics on each topic, and in each activity they were given a checklist to check that their activity included what was requested in the instructions.

Figure 10 shows an example of the asynchronous activities of the Air Conditioning and Refrigeration subject.



Asignatura: Aire acondicionado y refrigeración.

Objetivo: Ejercitar la forma de leer las propiedades de la mezcla aire – vapor de agua mediante la carta psicrométrica.

Nombre del tema: Conceptos generales.

Actividad:
1.- Localiza los puntos proporcionados en la tabla y con apoyo de la carta psicrométrica del formulario, determina las propiedades faltantes.
2.- Verificar mediante la lista de cotejo anexa si sus tareas incluyen lo solicitado.

Pasos para su aplicación:
El asesor sube a Classroom la tarea solicitada.
El alumno consulta el documento y comienza a trabajar en su actividad.
El alumno sube a Classroom un documento en Word con la infografía solicitada y la lista de cotejo llenada por el mismo, en donde asegure que se envía lo solicitado en la infografía.

Instrumento de evaluación: Lista de cotejo para que la aplique el mismo alumno.

Lista de cotejo

Indicador	Si	No
Tarea 1		
¿Cuenta con un título que describa claramente el contenido?		
¿Determinó todas las propiedades solicitadas?		
¿Llenó la tabla por completo?		

Subir las tareas hasta que se cumpla con la lista de cotejo.

UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
FACULTAD DE ESTUDIOS SUPERIORES CUAUTITLÁN
INGENIERÍA MECÁNICA ELÉCTRICA

Nombre: Fecha:

Complete la tabla en función de las propiedades dadas y la carta psicrométrica.

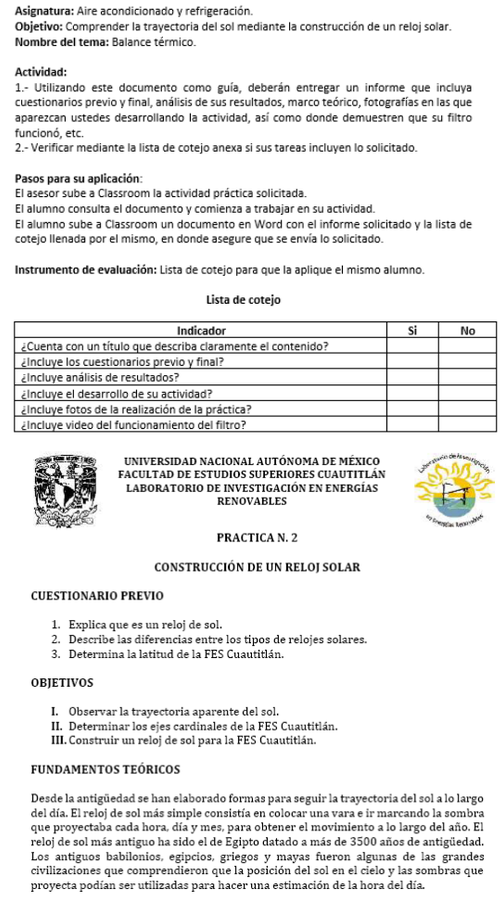
#	T_{BS} °C	T_{BH} °C	T_R °C	ϕ %	w Kg$_{H_2O}$/Kg$_{a.s.}$	V m³	h kJ/Kg
1	38	24					
2		28	28				
3			22	39			
4				75	0.026		
5					0.020	0.89	
6						0.87	63
7		23		100			
8			27	42			
9					0.015	0.90	

Figure 10 Asynchronous activity of the General Concepts section
Source: Own elaboration

In the practical activities section, the instructions to develop the practical were included and also the checklist was given so that they could make sure to deliver what was requested in the practical.

Figure 11 shows the practical activities of the Air Conditioning and Refrigeration subject and figure 12 shows an example of a practical with its respective checklist.

Figure 11 Practical activities of the subject Air conditioning and refrigeration
Source: Own elaboration



Asignatura: Aire acondicionado y refrigeración.
Objetivo: Comprender la trayectoria del sol mediante la construcción de un reloj solar.
Nombre del tema: Balance térmico.

Actividad:
1.- Utilizando este documento como guía, deberán entregar un informe que incluya cuestionarios previo y final, análisis de sus resultados, marco teórico, fotografías en las que aparezcan ustedes desarrollando la actividad, así como donde demuestren que su filtro funcionó, etc.
2.- Verificar mediante la lista de cotejo anexa si sus tareas incluyen lo solicitado.

Pasos para su aplicación:
El asesor sube a Classroom la actividad práctica solicitada.
El alumno consulta el documento y comienza a trabajar en su actividad.
El alumno sube a Classroom un documento en Word con el informe solicitado y la lista de cotejo llenada por el mismo, en donde asegure que se envía lo solicitado.

Instrumento de evaluación: Lista de cotejo para que la aplique el mismo alumno.

Lista de cotejo

Indicador	Si	No
¿Cuenta con un título que describa claramente el contenido?		
¿Incluye los cuestionarios previo y final?		
¿Incluye análisis de resultados?		
¿Incluye el desarrollo de su actividad?		
¿Incluye fotos de la realización de la práctica?		
¿Incluye video del funcionamiento del filtro?		

UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
FACULTAD DE ESTUDIOS SUPERIORES CUAUTITLÁN
LABORATORIO DE INVESTIGACIÓN EN ENERGÍAS RENOVABLES

PRACTICA N. 2

CONSTRUCCIÓN DE UN RELOJ SOLAR

CUESTIONARIO PREVIO

1. Explica que es un reloj de sol.
2. Describe las diferencias entre los tipos de relojes solares.
3. Determina la latitud de la FES Cuautitlán.

OBJETIVOS

I. Observar la trayectoria aparente del sol.
II. Determinar los ejes cardinales de la FES Cuautitlán.
III. Construir un reloj de sol para la FES Cuautitlán.

FUNDAMENTOS TEÓRICOS

Desde la antigüedad se han elaborado formas para seguir la trayectoria del sol a lo largo del día. El reloj de sol más simple consistía en colocar una vara e ir marcando la sombra que proyectaba cada hora, día y mes, para obtener el movimiento a lo largo del año. El reloj de sol más antiguo ha sido el de Egipto datado a más de 3500 años de antigüedad. Los antiguos babilonios, egipcios, griegos y mayas fueron algunas de las grandes civilizaciones que comprendieron que la posición del sol en el cielo y las sombras que proyecta podían ser utilizadas para hacer una estimación de la hora del día.

Figure 12 Example of practice and checklist
Source: Own elaboration

In the final project section, students are left with an integrative project, which considers that the student uses all the knowledge acquired during the semester to solve a problem related to the subject, for example in Ecological Engineering they are asked to solve a pollution or energy saving problem and in the case of Air Conditioning and Refrigeration, they are asked to come up with a proposal to solve the air conditioning of a space considering conventional equipment and passive techniques (reduction of the thermal load using thermal insulation, renewable energies and energy saving). Figure 13 shows an example of a project together with its evaluation rubric.

Results

There is a virtual classroom for each subject in which the didactic material generated is included, such as class videos, infographics, power point presentations, photos, mind maps, concept maps, timelines, exercises, etc., and for the evaluation of the subjects, exams, rubrics, questionnaires, integrating activities and problem-solving activities similar to real situations, which can be individual or in teams, were generated. In addition, the evaluation of some of the activities is contemplated to be carried out by the teacher and among students.

Asignatura: Ingeniería Ecológica.

Objetivo: Aplicar los conocimientos adquiridos durante el semestre.

Nombre del tema: Proyecto Final.

Actividad:
1.- Generar o construir un prototipo referente a los temas de la asignatura, el cual debe funcionar (no maqueta).
2.- Verificar mediante la rúbrica que contiene lo solicitado.

Pasos para su aplicación:
El asesor sube a Classroom la tarea solicitada.
El alumno consulta el documento y comienza a trabajar en su actividad.
El alumno sube a Classroom un documento en pdf con la información solicitada.

Instrumento de evaluación: Rúbrica.

Criterio\Porcentaje	100	75	50	25	0
Funcionamiento 2 puntos	El prototipo sirve y cumple con el objetivo del proyecto.	El prototipo no funciona y cumple con el objetivo del proyecto.	El prototipo funciona y no cumple con el objetivo del proyecto.	-	No incluye prototipo
Prototipo 3 punto	Incluye el diseño croquis o planos, memoria de cálculo de ser necesario, materiales de construcción y propuestas de mejora.	Incluye el diseño croquis o planos, memoria de cálculo de ser necesario y materiales de construcción.	Incluye el diseño croquis o planos, memoria de cálculo de ser necesario o materiales de construcción.	Incluye el diseño croquis o planos o materiales de construcción.	No incluye casi nada
Documento 3 puntos	Contiene resumen, justificación, planteamiento del problema, objetivos, marco teórico si se requiere, procedimiento, fotos de la elaboración del proyecto, fotos del funcionamiento de este, resultados y conclusiones.	Contiene resumen, justificación, planteamiento del problema, objetivos, marco teórico si se requiere, procedimiento, fotos de la elaboración del proyecto o del funcionamiento de este, resultados y conclusiones.	Contiene planteamiento del problema, objetivos, marco teórico si se requiere, procedimiento, fotos de la elaboración del proyecto y conclusiones.	Contiene planteamiento del problema u objetivos, procedimiento, fotos de la elaboración del proyecto.	No incluye casi nada
Memoria fotográfica 2 puntos	Incluye video y fotografías del funcionamiento del prototipo y del proceso de construcción donde se observa al alumno participar en la actividad.	Incluye fotografías del funcionamiento del prototipo y del proceso de construcción donde se observa al alumno participar en la actividad.	Incluye fotografías del funcionamiento del prototipo o del proceso de construcción donde se observa al alumno participar en la actividad.	Incluye fotografías del funcionamiento del prototipo o del proceso de construcción pero no se observa al alumno en ellas.	No incluye fotografías ni video

Figure 13 Final project of the subject Air conditioning and refrigeration
Source: Own elaboration

The virtual classroom as presented in this document was used by the students enrolled in semester 2022-2, who commented on the advantage of having the videos of the explanation of the subjects, the notes and the support material, since if they could not attend the zoom session because they were working, they could review the videos of the subject in their free time so as not to fall behind.

Conclusion

Today's communication technologies have given us the possibility to open up new avenues for students' academic development. In addition, we must continue to develop new tactics to encourage students to learn, taking advantage of what this pandemic has taught us.

Acknowledgements

We are grateful to the Programa de Apoyo a Proyectos para la Innovación y Mejoramiento de la Enseñanza (PAPIME-UNAM) for the support provided through project PE100222.

References

[1] CUAIEED, Aula Virtuales y Ambientes Educativos, Available in: https://aulas-virtuales.cuaieed.unam.mx/.

ISSN 2523-0360