

## Implementation of a greenhouse as a sustainability teaching strategy at university level

## Implementación de un invernadero como estrategia de enseñanza de la sustentabilidad a nivel universitario

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### Abstract

Considering the sustainable development model, it is necessary for universities to create strategies for teaching sustainability, especially those where Engineering is taught. In this work, a pilot test of a strategy for teaching sustainability integrated into two of the subjects of Biotechnology Engineering is presented. For this strategy, the subject syllabi were analyzed and the construction of a greenhouse with recyclable materials was proposed. The students planned a construction site within the university and proposed a design, considering the established guidelines. Once approved, it was built. The greenhouse was commissioned and currently houses a wide variety of plants belonging to various projects within the university. According to the surveys carried out, the students consider that thanks to the implementation of this strategy they were able to learn something new or reaffirm what they already knew. Therefore, it is necessary that universities develop strategies that help students better understand sustainable development.

**Sustainable development, Teaching strategy, University**

### Resumen

Tomando en cuenta el modelo de desarrollo sostenible es necesario que las universidades creen estrategias para la enseñanza de la sustentabilidad, especialmente aquellas en donde se imparten Ingenierías, en este trabajo se presenta una prueba piloto de una estrategia de enseñanza de la sustentabilidad integrado a los temas de dos de las materias de la Ingeniería en Biotecnología. Para esta estrategia, se analizaron los temarios de las materias y se planteó la construcción de un invernadero con materiales reciclables, los estudiantes platearon un sitio de construcción dentro de la universidad y propusieron un diseño, tomando en cuenta los lineamientos establecidos, una vez aprobado fue construido. El invernadero fue puesto en marcha y actualmente alberga una amplia variedad de plantas pertenecientes a diversos proyectos dentro de la universidad. De acuerdo con las encuestas realizadas los alumnos consideran que gracias a la implementación de esta estrategia pudieron aprender algo nuevo o reafirmar lo que ya sabían. Por lo anterior, es necesario que en las universidades se plateen estrategias que ayuden a los estudiantes a comprender de mejor manera el desarrollo sostenible.

**Desarrollo sostenible, Estrategia de enseñanza, Universidad**

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## 1. Introduction

The current state of deterioration of nature is forcing us to change the paradigms on which we have relied to educate new generations. This entails a change in the teaching strategies that are applied in educational institutions, that is, we must migrate to new teaching models based on sustainability.

The UN (2023) defines sustainability as the series of actions that allow humanity to “meet the needs of the present without compromising the ability of future generations to satisfy their own needs,” and it is the development model to which they aspire. migrate in the coming years, because of this the need arises to educate new generations under this new way of life.

Education helps us form a collective conscience about the needs of society and therefore is one of the most efficient instruments available for future generations to commit to sustainable development (Cantú-Martínez, 2014).

In this sense, Universities function as spaces whose function is to contribute to finding solutions to new global and local challenges through cooperation between universities or with industry to strengthen sustainable development through professional development by graduates, as well as the training of citizens committed to the three dimensions of sustainable development: economic, social, and environmental (Fernández Pérez, 2018).

That is, the University must commit to sustainable development, for which a review of graduation policies and profiles is necessary, modifying them to meet this objective (Buitrago *et. al.* 2020).

Some of the main problems to solve are:

- Protect nature
- Manage natural resources
- Solve environmental problems
- Analyze the links between economy, ecology, and society

For this, PBL-type teaching strategies are proposed, as well as case studies, if it is not possible to do field practices or stays.

One of the most important characteristics is that these projects must promote self-reflection and, in this case, promote sustainable development (Dieleman and Juárez-Nájera, 2008).

Various authors affirm that the curriculum and research in universities must be rethought since as progress in industries is led by engineers, a direct relationship can be established between sustainability and engineering (Buitrago *et. al.* 2020).

Thus, this work proposes a strategy for teaching sustainability through the implementation of a greenhouse, with students of the Biotechnology Engineering (IBT) degree, from the Polytechnic University of Cuautitlán Izcalli (UPCI), in the state of Mexico.

## 2. Methodology to be developed

### 2.1 Polytechnical University of Cuautitlán Izcalli (UPCI)

The UPCI is in the Lomas de Cuautitlán neighborhood in the municipality of Cuautitlán Izcalli, in the State of Mexico. It has bachelor's degrees in business and administration and engineering in Biotechnology, Biomedical and Energy. It belongs to the BIS system, which means that it is an institution that is governed by three characteristics: being Bilingual, International and Sustainable.

It has a type of clay soil that, due to the state of pollution, is difficult to cultivate, the climate is usually dry, and its type of vegetation is xeric scrub.

### 2.2 Population

The study group consists of 22 students with ages ranging between 21 and 25 years, belonging to Biotechnology Engineering and were studying the subjects of Environmental Biotechnology and Agricultural Biotechnology (Cuautitlán Izcalli, 2023).

## 2.3 Methodology

### 2.3.1 Analysis of the syllabi

The syllabi of the Environmental Biotechnology and Agricultural Biotechnology subjects were analyzed to propose a project that was transversal.

### 2.3.2 Project proposal

Once the syllabi had been analyzed, the students were proposed the project to follow, which consisted of the implementation of a greenhouse within the UPCI facilities. Monthly reviews of progress were made, which were evaluated through checklists.

Initially, students were asked to make a proposal, through bibliographic research and specialized software (Lab VIEW, for design and COCO Simulator, for calculations).

### 2.3.3 Construction

Once the proposal was reviewed, the students built the greenhouse prototype with the help of recycled materials.

### 2.3.4 Application of the survey

Once the greenhouse was built, the students were asked to answer a survey in electronic format, in which they were asked to answer 5 questions regarding their learning. This survey would have the format of a rating scale where the number 1 corresponded to “I did not learn anything new” and 5 to the option “I learned something new or reaffirmed the knowledge I already had.”

## 3. Results

### 3.1 Analysis of the syllabi

Once the syllabi were analyzed, it was determined that according to the specific knowledge required in each subject, the most pertinent proposal would be the construction of a greenhouse.

The proposal is that in this site the necessary conditions can be had to maintain the plants that are needed in the subject of Agricultural Biotechnology and the soil be restored according to some of the techniques seen in Environmental Biotechnology

### 3.2 Study subjects

This pilot test was applied to a group of 22 students, of which 15 were female and 7 were male, all Biotechnology Engineering students in the ninth and eighth semesters of the UPCI.

### 3.3 Selection of the area for establishing the greenhouse

A site within the university was selected to locate the greenhouse. The characteristic of this site was that it had little traffic and sufficient area available for the establishment of the plantations (Figure 1).



**Figure 1** Area for establishing the greenhouse within the UPCI

*Own Source, 2023*

### 3.4 Soil restoration

Due to the contamination of the soil, it was proposed to restore it using compost that was made with the waste from the institution's cafeteria. The soil was also leveled, cleaned and all weeds were removed (Figure 2).



**Figure 2** Soil restoration of the area selected for the greenhouse

*Own Source, 2023*

### 3.5 Greenhouse construction

Once the soil was nourished, the recycled wood posts were placed for the positioning of the shade mesh (Figure 3).



**Figure 3** Placement of the posts for positioning the shade mesh

*Own Source, 2023*

### 3.6 Establishment of the greenhouse

Once the greenhouse was established, various types of plants were grown (Figure 4).



**Figure 4** View of the greenhouse with some plant species

*Own Source, 2023*

### 3.7 Survey results

Once the survey was answered, the following results were obtained: 76% of the students considered that they had acquired or reinforced new knowledge that can help them pursue their career.

## 4. Conclusions

This work shows a strategy for teaching sustainability for university students, which is of utmost importance since it is the economic development model that will predominate globally in the following years.

According to the results of the survey, this strategy helps students have a better understanding about sustainability, as well as reinforces previously acquired knowledge and facilitates the acquisition of new knowledge.

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