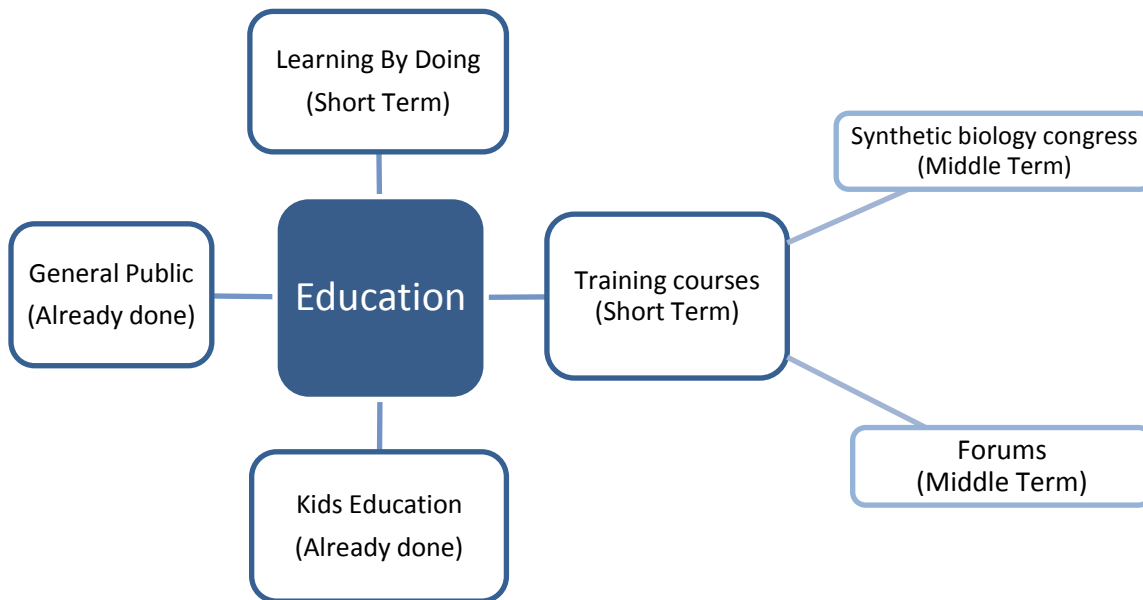


# Education Component

Ediner Fuentes Campos  
Fernando Vargas Arias  
Rene Chiguila Arevalo

In an effort to improve the public perception towards synthetic biology and to spread knowledge about it, the Zamorano Latinoamerica iGEM team created the education section of the project. The education section consist in a series of activities, some already performed and some due in a short and long term, that aim to teach people in the surrounding environment and neighbor countries about synthetic biology. The elements of the educational component are detailed below.

## Component activities



This graphic represents the four subsections of the education section.

## Biotechnology and introduction to synthetic biology work module

The “learning by doing” system has characterized Zamorano University in its 71 years of existence. It states that people learn better about something, if they do it themselves; hence the name. During their first three years of studies, students rotate between work modules, covering the whole value chain of the food and agriculture industry. During its fourth and last year of studies, students conduct a “Specialized Learning by Doing”. It provides students with the opportunity to organize and perform training courses and field activities for the younger year students, transmitting the knowledge acquired during their four years of study at the university. The unique philosophy of Zamorano provides the students with a learning process full of abilities and skills based on scientific, theoretical and practical knowledge; students are motivated to integrate what they have learned to solve professional modern real life problems in different kind of environments.

The work modules of the “learning by doing” system in Zamorano have been in a continuous improvement process during the seven decades of the institution’s existence. Nowadays Zamorano University has 13 businesses, possessing the equipment and adequate facilities for students to put in practice the knowledge achieved in the classroom. There are wide spaces for primary production, Agroindustrial processing plants, commercialization center and the support of modern analytic labs, research and new product development. Each one of it has an adequate guiding and supervising of qualified professors and instructors with experience on the specific topics. The learning by doing also helps the students to improve its performance for the time when they conduct their internship program in prestigious universities and companies.

The Zamorano Latinoamerica iGEM team, proposed the creation of a learning by doing work module for third year students. The proposition got accepted. This work module will bring students the opportunity to develop projects that may address this century’s challenges, using biologic technology based solutions. Using interactive conferences, lab practices and homework assignments, the students will learn the techniques and strategies and vocabulary of: bioremediation, biological systems engineering, genetic engineering, bioparts standardization and biological machinery.

This module will be two weeks long, and there will be a time of 3 months between the two weeks. The first week will be instructed introduction lectures, and then students will be assigned takes that students may comply in a three months period. After the three months the student will return to the module to perform laboratory practices.

## Module's description

- It is an advanced biotechnology module with emphasis on environmental science. It also includes applications to agriculture and agribusiness. It also integrates Synthetic Biology.
- The module emphasizes the study of the challenges that the planet faces for a sustainable development with economic, social and environmental dimensions, and creates opportunities for research and discussion of relevant issues to classical biotechnology and synthetic biology topics.
- The module seeks to respond to the demands of the competitive global society and the competitive workplace. It has been designed considering the latest technological developments in biosciences and related sciences.

## Objectives:

- To promote among students the assertive communication, critical thinking and teamwork.
- To teach the students about the basic principles of biological sensors.
- To promote in the students aseptic technique skills.
- To teach the students about the basic principles of synthetic biology.

## Teaching strategies to be used:

The learning by doing emphasizes a teaching and learning process in which students are the main responsible of its own formation. To achieve it, they will be assigned with a series of problems which will have to be resolved during the module. The self-administration of knowledge is an essential condition to keep updated during the professional life (Solzbacher, 2006). Referring to the importance of the learning by doing of Jean Piaget, Von Glasersfeld affirms the following: "The learning by doing aims for students to develop skills and abilities that may allow them to keep learning during their lives."

**Learning based on problems:** it is a method of teaching based on the principle that problems are a starting point in the acquisition and integration of new knowledge. The students will perform individual and team activities in which they will need to analyze and resolve highly difficult situations. The students will count with the guide and support of the module instructors, which will also be in charge of the class lectures.

**Laboratory practices:** The student will make didactive practices in the laboratory for a week. The purpose of the practices is for the student to obtain the experience and the knowledge; performing the assigned activities all by himself; learning by doing.

## Syllabus-Learning by doing program

<b>Module</b>	Biotechnology and synthetic biology introduction Sintética
<b>Department:</b>	Environmental and Development Engineerig
<b>Proffesors:</b>	Estela Aguilar Ms. C; Ludovic Bouilly Ph.D
<b>Number of weeks.</b>	1 week every 2 months
<b>Location:</b>	Microbiology Laboratory
<b>Benneficiries:</b>	Environmental and Development Engineering, Animal science, crop science and food technology.
<b>Topics:</b>	Practices
<b>Molecular biology</b>	Transfecction: Calcium Phosphate Transfection, Electroporation, Reporter Analysis, Stable Transfection
<b>Microbiology</b>	Antibiotics, Bacteria Assay, Bacteria Culture, Culture Media & Plates, Nucleic Acid Extraction
<b>Genetic engineering</b>	Biological systems construction
<b>Biochemistry</b>	Enzymes analysis
<b>Cellular biology</b>	Transfection, Nucleofection, Transduction of Stem Cells

## Training courses

Zamorano University will impart training courses for all people interested in learning about synthetic biology. Because of this, the courses are focused on a very heterogenic group of people; students and teachers from different ages, majors and universities. Due to the wide range of people, the courses available will be divided by the level of specificity. To classify the groups by levels of understanding will allow the information and basic knowledge about synthetic biology to be transmitted in an efficient way, so it is easier to understand.

We are providing information so the listeners and students could difference in a proper way the different topics related to genetic manipulation, also to support the process of developing their own capabilities (Margolis and Bell, 1986).

## Classification of training courses

**Classroom training:** Qualified professors will impart introduction and orientation classes about synthetic biology, its basis, and its applications. The classes will allow the student to maintain a close relationship to the specialist in the area. Zamorano, as it has already demonstrated through its learn by doing program, affirms the real learning experience becomes more important for the globalized world (Roca 2014).

**Laboratories:** This type of class will be held only at the laboratory. The basic asepsis techniques in a lab will be taught, along with daily procedures to work on it. What to do in case of an emergency will be explained. There will be DNA extraction practices and genetic modification of organisms so the students may understand the process.

**Synthetic Biology Academic Workshops:** These workshops are oriented to professors that will impart synthetic biology related classes. The target population for these workshops, the professors, should impart class in universities, public and private schools in Honduras. By informing professors, we are indirectly contributing to the spread of information about synthetic biology; because indirectly, it has a reach of hundreds of Honduran students. The team counts with the support of the Ministry of education and the Honduran government (which fully supports this student program). On top of this, Zamorano University it's placed at the heart of Central America, and because of the fact it holds students from more than 20 Latin American countries, it has been able to stablish alliances with almost all National universities represented and some international ones. Taking advantage from these alliances, there will be efforts towards working with nearby countries that do not have a synthetic biology programs such as: Nicaragua, El Salvador and Guatemala. The result will be a society aware of the benefits that synthetic biology represent.

The topics will be instructed for a basic synthetic biology program, by Doctors and specialist in biotechnology and synthetic biology, will be focused on 3 main areas. These are: Bioinformatics, Molecular biology and Microbiology, and genetics and biotechnology. The list of universities that Zamorano University may count with its participation can be found on the annexes.

**Congress:** Zamorano will organize the first Congress of Synthetic Biology of Honduras. The main mission of organizing it is to form a Latin American network of Synthetic Biology. Zamorano plans to be the meeting point in the coordination of this activity, which will provide universities and research institutes a space where scientific information can be exchanged freely. It is intended to invite all the schools listed in Annex 1. The creation of synthetic biology programs in invited universities will be promoted, so that through them a proposal directed to the formation of this regional network will be developed.

**Forums:** Zamorano will organize forums in related areas of synthetic biology, which will allow the general public to obtain a brief perspective on this area of research. These forums are an additional reinforcement for people who assist training and conferences. Some of the topics of significant value to the development of these forums include:

- Biosensors.
- Standardized Bioparts
- Biological Machines
- Biological Systems.
- Biosafety
- Bioethics
- Regulation of Synthetic Biology

***Online Training***

Because the transportation to Zamorano is an impediment to people living in other continents, training will be offered online. The scope that the internet has allow us to approach different people worldwide easily and very fast (Silvio, 1998). The online training will be created by the e-learning unit from Zamorano. The online training offered are:

**Graduates:** Zamorano will offer graduates that incorporate various applications in Agriculture and the Environment specifically aimed for teachers and students in areas related to biology. Through this degree we will reach hundreds of students and teachers of Latin American region and thus strengthen its bioscience base.

<b>Four-month Diploma course</b>	
<b>Duración:</b> 4 months	<b>Format:</b> Online; <b>Board:</b> E-Learning
<b>Topics</b>	
Synthetic biology present	Synthetic biology programs development
Synthetic biology remaining	Synthetic biology, Bio etic and bioterrorism

**Debates:** Zamorano will offer online spaces where participants can discuss synthetic biology. Participants will be divided into teams. The dynamics of this debate will work as follows: a moderator of our team of professionals will ask clear and precise questions on specific points in the regulation of synthetic biology. Teams will have enough time to prepare a response, and submit it. At the end of the week, the moderator will analyze the data collected and present it to all members of the discussion.

By doing this we ensure that everyone has a chance to share their opinion, and it to be respected. So that by the end of the third month, 15 different topics relating biotechnology and synthetic biology regulations will be discussed.

<b>Synthetic biology debates</b>	
<b>Duration:</b> 3 months	Online format in the Balckboard.
<b>Topics</b>	
Biodiversity syntetic biology impact	
Synthetic biology as the cure of diseases	
Bioetics	
Bioterrorism	
Synthetic biology and hunger assestment	
Synthetic biology regulation	
Cartagena Protocol. Biodiversirt biology and synthetic biology agreement	
Synthetic biology, the power to créate	
Synthetic biology moratorium	
Synthtic organisms assetment guide	
Synthetic biology risk analyssis	
Syntetic biology in Latin America	

## Education practices with elementary students

Performing laboratory practices with children familiarizes them with topics about synthetic biology from an early age. Children who become familiar with these issues at an early age increases the odds of them accepting this science when they grow up. For this, we have prepared small activities depending on the degree of schooling that arise. Children from last grade of elementary school were chosen, for the ease of interaction with them and because children around that age are more open to learn new lessons.

### Activities

**Games:** Children have the ability to enjoy and seize every activity performed (UNICEF, 2002). We used various games where their knowledge was put into practice. As resources for these activities, cardboard platforms, puzzles and dice were designed. Important issues, such as the composition of DNA, processes transcription, translation and DNA replication, and amino acid composition of proteins were taught in the simple way.

**Laboratories:** In the laboratory practices for children, we have implemented and developed easy to perform protocols. The team imparted several workshops for children aged 10 to 12 years. In addition, small laboratory practices are hoped to be developed, based on synthetic biology and related sciences, for elementary school teachers to implement in their institutions. One example of such practices is the extraction of DNA from a fruit.



## General public

Educational practices in the education section are not only limited to professionals or students; they also focus on an open and more diverse audience. Basic ways in which you can convey the development of synthetic biology, advances, applications and databases in public events were designed. This will keep informed a wider audience.

**Team exposition in fairs, festivals and special events:** Presentations and exhibitions at public events, inform the general public about the progress of synthetic biology. The team attended the tenth Panamerican Fair organized by Zamorano, which attracts the attention of Honduran, Salvadoran and Nicaraguan population. Thanks to the popularity of the fair, we reached over the 15,000 people who attended the event and actively participated in lectures, small laboratory practices and small conversations with team members and advisors. It is expected for us, the Zamorano team, to participate in cultural events and exhibitions, where we may be reach a wider audience.

**Interview with social media:** Along with the communication and marketing department of our institution, we have organized various ways to transmit information through several information channels; so that we can transmit the advances of the team.

**Social networks:** By having the opportunity to be on social networks, team progress, activities undertaken, progress of synthetic biology, relevant scientific research, applications and other information related to synthetic biology is transmitted.

- **Facebook:** The iGEM Zamorano team has its own Facebook account, which is updated daily with information relevant to synthetic biology, in order to get to our followers in an efficient way. 40% of our fans are youngsters and 96% are Hispanic. This allows the team to interact very personally with its fans, and thus know their tastes and how they learn. And so, publish interactive, relevant and quality information. It is intended for the team's reach to continue to grow; the team wants to have more followers to its activities in iGEM and in Zamorano so information about synthetic biology can reach more people.
- **YouTube:** The team's YouTube channel transmits through interactive videos synthetic biology advances, applications, and other relevant topics such as international competition and public iGEM events. The publications will be constant, depending on themes and activities the team does. Each of the videos will be revised by professionals so the information to be conveyed is of high quality and value; and to serve as an educational way and replication in different parts of the region.

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## Annexes

### Honduras:

- Universidad Autónoma de Honduras, Tegucigalpa, Honduras
- Universidad Jose Cecilio del Valle, Tegucigalpa, Honduras
- Universidad Católica de Honduras Tegucigalpa, Honduras
- UNITEC San Pedro Sula, Honduras
- Universidad Tecnológica de Honduras Tegucigalpa, Honduras

### Guatemala:

- Universidad San Carlos de Guatemala, Ciudad de Guatemala, Guatemala.
- Universidad del Vale, Ciudad de Guatemala, Guatemala
- Universidad Rafael Landívar, Ciudad de Guatemala, Guatemala
- Universidad Francisco Marroquín, Ciudad de Guatemala, Guatemala
- Universidad del Istmo, Ciudad de Guatemala, Guatemala
- Universidad Mariano Galvez, Ciudad de Guatemala, Guatemala
- Universidad Galileo, Ciudad de Guatemala, Guatemala
- Universidad Panamericana, Ciudad de Guatemala, Guatemala.

### El Salvador:

- Universidad Nacional de El Salvador (UES) San Salvador, El Salvador
- Universidad Dr. José Matías Delgado Santa Tecla, El Salvador
- Universidad Pedagógica de El Salvador San Salvador, El Salvador
- Universidad Don Bosco San Salvador, El Salvador

### Nicaragua

- Universidad Nacional Autónoma de Nicaragua (UNAN) Managua, Nicaragua
- Universidad Nacional de Ingeniería Managua, Nicaragua
- Universidad Nacional Agraria Managua, Nicaragua
- Tecnológico Nacional INATEC Managua, Nicaragua
- Instituto Latinoamericano de Computación Managua, Nicaragua
- Universidad Martín Lutero, Managua, Nicaragua
- Universidad Central de Nicaragua, Managua, Nicaragua
- Universidad Americana UAM, Managua, Nicaragua
- Ave María University, Carazo, Nicaragua
- Universidad Politécnica Nacional, Managua, Nicaragua
- Universidad Centroamericana, Managua, Nicaragua
- Universidad American College, Managua, Nicaragua
- Universidad Internacional para el Desarrollo Sostenible, Managua, Nicaragua
- Universidad Paulo Freire, Managua, Nicaragua
- Universidad Popular de Nicaragua, Managua, Nicaragua.