

## SPAIN

### BRITEC – Bringing Research Into the Classroom Learning Scenario 2

#### 1. Title

**Can we teach a computer to classify microscopy images of tumoral cells?**

##### Author(s)

Roger Pou (Ibercivis), Jesús Clemente-Gallardo (main researcher, University of Zaragoza and Ibercivis), Adrián Gollerizo (teacher) and Noelia Sánchez (teacher)

##### Area of research

Cellular Biology and Computer Science

##### Subject(s)

Biology

ICT

Maths

Physics

##### Topic

Cellular structure, Cellular death mechanisms, Machine learning

##### Age of students

14-18 years old

## 2. Introduction

### Contribution of the CS project to Science in general

The aim of the present project is to involve students in Citizen Science in and around the classroom to study effectiveness of using analysis of microscopy images of tumoral cells done by students, to train a machine learning platform to do the analysis autonomously.

In order to achieve this goal, students will do the following:

- Get information about cell structure and the different mechanisms of cellular death.
- Perform the analysis of a set of microscopy images in the platform cellspotting

<http://pybossa.socientize.eu/pybossa/app/cellspotting/>

- From the resulting database, ML platform will be trained.

### Aim of the activities plan and learning objectives

The aforementioned goals will be achieved through different subjects:

#### **BIOLOGY:**

The cell

- Cellular structure: the parts of the cell (complete)
- The cell life cycle. Cellular death (complete)
  - Apoptosis
  - Necrosis

#### **ICT:**

- Algorithms
  - Use of libraries in programming
  - Introduction to Machine Learning

**MATHS:** (to average the answers of different students on the same picture)

- Geometry and distance
- Statistics: averages

**PHYSICS:**(to estimate the error we can produce when selecting a wrong middle point for the cell)

Error analysis



### Summary of activities

Number of activity	Name of activity
1	Talk by an expert
2	Presentation by the teacher
3	Introduction to the platform
4	Analysis of the images
5	Evaluation
6	Talk by an expert



### 3. Detailed description of each activity (to be completed as many times as activities are implemented)

#### Activity 1: Talk by an expert

##### First Part: Aim of the activity

Main researchers of the project will give students a talk, explaining and describing the most important contents which will be addressed during the implementation of the pilot. During this session, concepts such as cytology and machine learning will be explained. Moreover, researchers will explain students which are the main goals of the project and which is their role in the process.

##### Second Part: Suggested procedure

Preparation time	2 hours
Teaching time	55 minutes (1 session)
Online teaching material	<a href="https://view.genial.ly/56c358f31561ec0fe052cd49/interactive-content-cells">https://view.genial.ly/56c358f31561ec0fe052cd49/interactive-content-cells</a>
Offline teaching material	The materials needed to make the plastic trap are: a one liter plastic bottle, a piece of plastic net, recycled fan of a desktop computer, two nylon flanges, power supply of a small home appliance such as a handheld vacuum or a printer, a piece of perforated pcb board, 2 pin plug-in screw terminal block connector, a white LED lamp, hot melt glue and a rope. The materials needed to make the mesh collection bag are: a piece of wire, adhesive tape, hot melt glue, a sheet of wedding veil, a rubber band.
Citizen science purpose of the activity (if any) *	To bring students closer to true scientific research and make them understand the purpose of the research project they are going to join
*Guidance for teachers	Teachers need to make sure students are acquainted with basic keywords: cell death; tumor; cancer; cell cycle; machine learning. It is a good idea to start reviewing cell theory, basic structures, ..





### Third Part: Advice on methodology

Try not to give a long talk to avoid students being distracted. In addition, this talk should include simple explanations of the technical concepts addressed, to assure younger students understand them.

### Fourth Part: Educational analysis

Visual Search & Learning: images and multimedia are more powerful than verbal stimuli.<sup>8</sup>

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<sup>8</sup> Pintó, R., Couso, D.; Hernández, M. I. (2010). An Inquiry-oriented approach for making the best use of ICT in the classroom. *eLearning Papers*, 20.

## Activity 2: Presentation by the teacher

### First Part: Aim of the activity

With regards to Biology lessons, this activity consists in introducing students to the concept of cellular death and the biological meaning of each cellular death type, thus their characteristics and differences will be explained. Consequently, this activity aims to provide the necessary background on the biological content for the students to be able to follow the experiment.

Concerning ICT lessons, in previous classes, students will be introduced to programming languages and they will learn basic concepts of Python programming. After that, they will be introduced to machine learning: what it is, what programming languages and what it is used for. The purpose of this introduction to programming and ML is to provide students with the background for understanding the implications of the experiment.

### Second Part: Suggested procedure

Preparation time	3 hours
Teaching time	55 minutes (1 session)
Online teaching material	Genial.ly presentation: <a href="https://view.genial.ly/5fa1be365ef4550d7bcc02cf">https://view.genial.ly/5fa1be365ef4550d7bcc02cf</a>
Offline teaching material	Same presentation
Citizen science purpose of the activity (if any) *	To understand apoptosis and necrosis processes. To associate apoptosis with cellular and tissular growth and renewal. To become aware of the main morphological features in both types of cellular death. To achieve a true meaningful learning.
*Guidance for teachers	Provide the necessary background on the biological content for the students to be able to follow the experiment.

### Third Part: Advice on methodology

Be visual, use different kinds of microscopy images for showing regular cells and their structures and main organelles. Diagrams and charts are ideal for explaining two types of death processes and their differences.

Regarding the basic programming and ML concepts, the main suggestion is to keep explanations clear and easy to understand. The goal of this introduction is that our students understand the basic structure of ML programs and what they are used for. We do not intend them to fully understand the ML platform lying beyond Cellspotting, just its basic working procedure.



### Fourth Part: Educational analysis

Visual Search & Learning: images and multimedia are more powerful than verbal stimuli.<sup>1</sup>

## Activity 3: Introduction to the platform

### First Part: Aim of the activity

In this activity the teacher will train students to perform the analysis of microscope images in the platform.

### Second Part: Suggested procedure

Preparation time	1 hour
Teaching time	30 minutes
Online teaching material	Cellspotting platform: <a href="http://pybossa.socientize.eu/pybossa/app/cellspotting/">http://pybossa.socientize.eu/pybossa/app/cellspotting/</a>
Offline teaching material	None
Citizen science purpose of the activity (if any) *	To discriminate between apoptotic and necrotic cells using fluorescent microscopy images. To connect theory topics with current research advances. To bring students closer to true scientific research. To achieve a true meaningful learning. To encourage scientific careers.
*Guidance for teachers	Show them how to manage the platform, basic areas and information to take into account.

### Third Part: Advice on methodology

Teachers should share first platform images (2-3 pics) and make students work all together with teachers guidance. First day, encourage students to share their questions and doubts. After 15 minutes let students work individually and ask questions one by one to point out possible mistakes and tricky images.



#### Fourth Part: Educational analysis

Visual Search & Learning<sup>1</sup>

STEM Learning<sup>9</sup>

Project-Based Learning

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<sup>9</sup> Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research on Science Teaching*, 34(4), 343-357



## Activity 4: Analysis of the images

### First Part: Aim of the activity

This activity consists of monitoring students' work on the platform. In this way, we will not only know which could be the possible difficulties students have to face, but also have the opportunity to solve any doubts about how the platform works so that they could continue later from home.

### Second Part: Suggested procedure

Preparation time	1 hour
Teaching time	4 and a half sessions
Online teaching material	Cellspotting platform: <a href="http://pybossa.socientize.eu/pybossa/app/cellspotting/">http://pybossa.socientize.eu/pybossa/app/cellspotting/</a>
Offline teaching material	None
Citizen science purpose of the activity (if any) *	Involve citizens in cancer research through analysing real microscopy images of cells treated with different drugs.
*Guidance for teachers	Let students work independently, be around in case they need your help.

### Third Part: Advice on methodology

Just make sure they don't have issues with the images and ask them questions from time to time.

### Fourth Part: Educational analysis

Visual Search & Learning: images and multimedia are more powerful than verbal stimuli<sup>1</sup>



## Activity 5<sup>10</sup> : Evaluation

### First Part: Aim of the activity

Students go to a survey for assessing the project and their self performance.

### Second Part: Suggested procedure

Preparation time	1 hour
Teaching time	15 minutes
Online teaching material	
Offline teaching material	Final questionnaire
Citizen science purpose of the activity (if any) *	
*Guidance for teachers	Assist students if they get stuck at any step.

### Third Part: Advice on methodology

Individual activity, it could be done in class or at home. Nonetheless, in all cases it was carried out in class.

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<sup>10</sup> Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers*. San Francisco: Jossey Bass.

## Activity 6: Talk by an expert

### First Part: Aim of the activity

The researcher will present the results from the machine learning platform, explaining it with graphical tools, as the set of evaluated pictures or the plots describing the increase of efficiency in recognition during the learning process.

### Second Part: Suggested procedure

Preparation time	1 hour
Teaching time	55 min
Online teaching material	Powerpoint presentation
Offline teaching material	None
Citizen science purpose of the activity (if any) *	To present students the result of the project and how their efforts have contributed to obtain a successful result. Also, the possible future extensions of the idea.
*Guidance for teachers	Encourage students to share their ideas, questions and suggestions.

### Third Part: Advice on methodology

Try not to give a long talk to avoid students being distracted. In addition, this talk should include simple explanations of the technical concepts addressed, to assure younger students understand them.

Involve students in the talk: ask them about their experience participating in the project and using the platform. Make them see the importance of their contribution not only to the project but also to science and society.

### Fourth Part: Educational analysis

Visual Search & Learning: images and multimedia are more powerful than verbal stimuli.<sup>1</sup>

## 4. Assessment after implementation of the activities plan

### Student's learning

The Activity 5 is the method used to assess the learning process of students after the implementation of this Learning Scenario. Students have to fill in a questionnaire (individually) about the contents addressed during the project in order to know what they have learnt and giving their opinion assessing the project itself.

### Citizen Science experience

The main challenge was to make students be constantly focused in a repetitive activity for a relatively long period of time without getting a mark. Students began to feel tired and not conscious of the relevance of the pilot project. Moreover, the implementation took part before Christmas, which was not an ideal time of the academic year to do it. Maybe these challenges could have been prevented if teachers have seen the platform before the implementation. Besides, a tutorial could have also been useful to avoid losing time in class finding out how the platform works. On top of that, the presentation given to younger students was very long, so it would be interesting to summarize it for them.

In addition, contact with other teachers could be beneficial as advantages, disadvantages, advices and doubts could have been shared during the implementation.





## 5. Bibliography

Angelo, T., & Cross, K. P. (1993). Classroom assessment techniques: A handbook for college teachers.

Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research on Science Teaching*, 34(4), 343-357.

Pintó, R., Couso, D., & Hernández, M. I. (2010). An Inquiry-oriented approach for making the best use of ICT in the classroom. *eLearning Papers* (20).



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## About the BRITEC project

BRITEC – Bringing Research into the Classroom project (<https://britec.igf.edu.pl/>) aims to introduce the Citizen Science (CS) approach in schools as a way of engaging pupils in research practices. This project has been funded with support from the European Commission within ERASMUS+ Programme and is coordinated by the Institute of Geophysics, Polish Academy of Sciences.