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**REDESIGNING SCIENCE CLASSES THROUGH THE E-CLASSES
PROJECT'S INITIATIVES**

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Abstract: *The article is a study based on the e-Classes project, a project funded by the European Commission (under the Erasmus+ programme) for the years 2017-2019 within an international partnership including institutions (schools, teacher training centres, non-governmental educational organisations and IT centres) from Bulgaria, Italy, Spain and Romania. The project aims to help both VET teachers to revise and strengthen their professional profile and young people to increase their motivation to study science and improve their academic performance. The project has created a collection of videos illustrating basic scientific concepts from science school subjects, on which the project's method relies. The method, the flipped classroom, highly encourages a student-centred learning environment, maximizing students' participation in online and offline activities. The paper presents the method, which uses the videos made by teachers as the main channel of content delivery, and discusses its benefits and challenges. The paper focuses on the findings of the flipped classroom experiment carried out with students studying at several vocational high schools in Iasi as well as the new roles that the participants, teachers, students and companies, may have in the educational process. It also gives details on how teachers can design their own flipped lessons, implement the flipped methodology and integrate ICT (Information and Communication Technology) and OER (Open Educational Resources) in traditional teaching.*

Keywords: *education; science; flipped classroom; motivation*

INTRODUCTION

Schools can benefit from the unprecedented advance of technology by integrating it into their classes, thus motivating students and making learning more effective by strengthening its connection with reality. The use of technology has the advantage of stimulating students to get involved in their learning process and in the creation of materials. One way of achieving this is through the flipped classroom method. The European E-Classes project, which promotes the flipped classroom methodology, aims at helping VET teachers to consolidate their professional skills and motivate their students, particularly those at risk of early school leaving and with low basic skills, by using ICT in schools.

I. THE ECLASSES PROJECT

1.1 The main objectives and target groups of the project

The main objectives of the project are:
-to improve and consolidate teachers' e-skills and collaborative learning skills;
-to create and manage multimedia educational resources;
-to stimulate students' active and creative role in the learning process through the use of ICT and OER.

The E-Classes project addresses the following target groups:
-direct target groups: VET students, VET teachers, VET schools, companies;
-indirect target groups: teachers and students (in general), schools, teachers' associations, students/ youth associations, parents, educational and training centers/ NGOs in the field of education, educational public authorities (teacher training Centers), public at large.

1.2 The project's methodology, the flipped classroom

The project's methodology, the flipped classroom, first provides students with new material, usually a video which they have to watch outside the class; then during class time students deepen what they have learned benefitting from their teacher's guidance, support and feedback in the classroom, in real class time. Outside the class students develop lower levels of cognitive work (gaining knowledge and comprehension) by watching videos while in-class they develop higher forms of cognitive work (application, analysis, synthesis, and/or evaluation) by solving problems, debating or discussing controversial issues where they have the support of their peers and teachers (Berrett, 2012).

It is very important that teachers explain to their students how the method works. Before the first in-class lesson teachers should first introduce their students to the topic and explain the learning process and its methodology, highlighting its benefits. Teachers should also present their expectations about students' participation. The first 10 minutes of the in-class should be spent on reviewing the pre-class activities; thus common questions or gaps can be easily identified (Fulton, 2012).

Teachers should carefully and rigorously plan the stages of the in-class by engaging students in active learning activities with a view to practising and improving what they started learning outside class. The class time relies on active participation through activities which are based on the video and are meant to stir students' interest in the topic, with the aim to deepen and apply the knowledge acquired. During classes students can use the internet, its online dictionaries and resources; they are encouraged to communicate with their peers and ask teachers for support and feedback (Hamdan et al., 2013).

II. THE ECLASSES PROJECT'S IMPLEMENTATION IN ROMANIA

2.1 The in-class activities

The activities organised by teachers, students' PPT presentations and discussions, case studies, micro lectures, creative scenarios and simulations, debates, group investigations enabled students to share, exchange and even create knowledge with their peers. They were able to work individually, in pairs or groups with the teacher circulating among them, monitoring them or providing help and feedback.

At the end of the first in-class activity teachers explained to students what they should do after the in-class activity to continue learning or link it to the next topic.

In all, a flipped classroom activity should include the following main elements:

The pre-class activities (videos, readings) carried out in advance of the first class.

During the pre-class activities students are asked to watch the video and do a task which usually focuses on the main new concepts to be learned (the maximum length of a video is 10-15 minutes).

For the first 10 minutes of the in-class time students review the pre-class activities to identify common questions or gaps.

Students are engaged in active learning activities during which they practise and improve what they started learning outside class.

Students continue learning (project work with peers) or link it to the next topic (Hamdan et al., 2013).

2.2 Videos and learning activities

The starting point has been the video or online PPT presentations, which definitely engages students much more than lectures in the learning process. Teachers can create their own videos or use selected online video resources. Videos should not be long if students are to watch them all.

The following in-class active learning activities have been mostly appreciated (Barkley, 2005): In the activity Think, Pair, Share, students reflect on a concept individually, then discuss it in pairs and finally with the entire class. This will engage students in a wider discussion demonstrating many different perspectives of the same concept. Quizzes are recommended to assess students' comprehension of the basic concepts. Brainstorming stimulates collaborative work with all members of the class. Students' PPT presentations and discussions are highly appreciated as students replicate conferences at a smaller scale when they have to present their findings and answer other students' questions about the material. Individual or paired quizzes encourage students to work in pairs and learn from one another. In Role Play students assume different roles and have to act out the parts ascribed to them, which generates discussions and research and develops students' critical thinking skills and empathy.

Critical Debates often stir very interesting discussions on the topic of the lesson. Students can be grouped according to their attitudes towards the topic (affirmative or negative side). Case studies make students relate what they learn to their familiar everyday world. Each group discusses how they would tackle the problem and what solution they would prepare; then each group can debrief with the rest of the class and present their solution. Group Investigation Students read an online article related to the topic of the video. In groups they discuss the article and prepare a PPT presentation of their findings for their peers. Think-Aloud Pair Problem Solving Students work in pairs to solve a problem. One student in the pair has to solve the problem and explain it to his/ her partner. The partner listens to the explanation and offers suggestions.

2.3 A flipped classroom lesson plan (a foreign language class)

The table below (Table 1) contains examples taken from a foreign language class where the teacher uses the flipped classroom method.

The teacher prepares the students for the class on Water pollution and water treatment by introducing the topic of the lesson (asking students where they get their water from at home). Then s/he explains that most water must go through a process that makes it potable, or safe for drinking. This process is called the water-treatment process, which they are going to learn about. Then students are asked to watch the video about the water-treatment process at home and answer the embedded quiz, which will be checked at school. The scenario of the video is simple and it is meant to engage students in the learning process. The complicated process through which water is treated and purified for drinking water production starts from the description of a common lake, Chirita Lake, which is part of the landscape for anyone living in Iasi, Romania. The explanatory video demonstrates how the Chirita Water Treatment Plant works, presenting the long journey of the water from the first stage when it enters the plant until it leaves the station to reach the population of the city (Table 1).

Table 1 In-class activities for flipped classes

Title of the lessons	Water pollution and water treatment
Units/key concepts covered	Coagulation (flocculation), sedimentation, filtration, disinfection, storage Water pollution, treatment, pollutant
Type of lesson	Foreign languages (introducing the process)
Students level	10 th grade (highschool)

Learning objectives	At the end of the lesson the students should be able to: - define the stages of the water treatment - store water vocabulary in long-term memory through cooperative learning - use the terminology describing the water-treatment process in their own sentences - speak about possible sources of watershed pollution in their community - speak about how to avoid water pollution
Skills to be developed in the students	Reading skills: skimming, reading for gist Speaking skills Public speaking skills

Description of the method/tool (s) being used	Timing: 2 hours
Steps: a. Check the quiz (a Kahoot quiz to check the video info). b. Mind map: focus on vocabulary (key concepts). Ask students what words they associate with water and help them create a mind map (potable water/water treatment/ fresh water/) c. Brainstorm meanings of water-treatment process terminology: coagulation, sedimentation, filtration, disinfection and storage. d. Body sculptures: Set students into six groups; five groups have to create body sculptures representing the five concepts associated with the water-treatment process while the sixth group is the group of experts who will evaluate their performance. e. Reading text -Students are asked to draw a three-section chart: “Know, Want to Know, Learned”. Before beginning the lesson allow students to fill	Group size: 24
	Materials needed (optional) Handout (Water pollution and its treatment)

in the first two columns of the chart: they write what they already know about the topic in the “Know” column, they record questions they would like to answer or things they would like to learn through their studies in the “Want to Know” column.

-How much do you know about the water-treatment process? Read the following statements and decide whether they are true or false.

1. Water covers over 60% of the Earth’s surface. True/False
2. Our body uses water to help regulate its temperature. True/False

True/False

3. Pollutants are particles, chemicals or substances that make water contaminated. True/False

4. Water pollution affects only individual living species. True/False

5. Fresh water is directly sent to our home. True/False

6. Only governments and local councils can solve water pollution. True/False

-Now read the text on water pollution and the water-treatment process. Are the previous sentences related to the text true or false?

-Read the text about the water-treatment process and write the paragraph headings (1–5) in the correct spaces (a–e). Use of padlet.com

-Find the words in the text about the water-treatment process that mean:

Drinkable water-

Water that is not safe to drink-
contaminated –

Substances that make water contaminated –
microorganism, especially one that produces disease in
animals or plants –

An ecological community together with its environment,
functioning as a unit-

The grouping together of small particles in a solution into
larger particles-

f. *Presentations:* Write each of the steps in large print on cards. Set students into groups, give each group a card and ask them to prepare a presentation of their step (describing what happens in that step in their own words). Ask the spokesperson from each group to present it in front of the class. Encourage suggestions and questions from the audience.

g. *Brainstorm why different orders of the steps in the water-treatment process wouldn’t work.*

Ask five student volunteers to organize into the following order: coagulation, disinfection, sedimentation, and filtration. Think, pair, share: Ask all students whether this order would make water potable. Then discuss *why* the steps have to occur in a certain order (introducing water pollution).

h. *Playing the detective: Brainstorm:* What are some possible sources of watershed pollution in your community? Set students into groups and ask them to identify sources of ground water contamination.

Homework/follow-up activities

Project work on water pollution: Group work following the

<p>structure: What is water pollution?/ What are the main types of water pollution?/ What are the causes of water pollution?/ What are the effects of water pollution?/ How can we stop water pollution?</p> <p>-Cultural issues: Research: Encourage students to think about how water is, or is not, treated in other places around the world. Ask: <i>How do people in certain locations or societies bring water to their homes? Do they treat this water to make it safe for drinking? If not, why not? Does everyone in this society or area of the world have access to this treatment process? Why or why not?</i></p> <p>- Debate on having a chemical plant built near a river (Debate and instructions).</p>	
<p>Feedback from students At the debriefing stage students return to the K-W-L chart and fill in the Learned section.</p>	

2.4 Teachers and students' roles; challenges of the approach

A teacher's role in a flipped classroom is important although the teacher no longer delivers direct instruction through lectures; teachers become facilitators of learning, who make sure that students are getting what they need. Their focus is on providing an active learning environment and organising engaging activities where students can make sense of the world around them and connect ideas. Teachers' main roles in the in-class activities are to monitor, guide, facilitate and support the learning process. Students may have varied levels of understanding and comprehension after having completed the out-of-class task. The teacher may organise the in-class activities in two distinct ways: individual or group-based activities. Group activities prevail in the flipped classroom: each student contributes to the content of the lesson, as they draw on each other's knowledge and understanding of the material to have a better picture of the lesson (Colibaba, A. et al, 2015).

In flipped learning, a teacher's job is complex: planning is as important as finding or creating appropriate and effective videos that students have to watch. In addition the teacher is responsible for creating engaging and powerful activities to practice the concepts that students have learned outside the class. It is important that teachers create learning opportunities for their students that encourage collaborative learning and problem solving. The teacher's time is spent helping students, facilitating discussions, giving feedback.

Students become active learners instead of sitting passively listening or not to the lecturer as the disseminator of knowledge. Flipped classrooms make use of learning technologies, which turn students into active participants. Students can work at their own pace, engage with their peers and learn in a meaningful way. In flipped classrooms, students are asked to take responsibility for their learning first outside their classroom then in class by participating actively.

On the other hand, the flipped classroom method requires a lot of time and effort as the teacher must know how to design it well to make sure that his / her objectives are met. They have to create the learning environment and activities which will stimulate students to participate actively. The role of teachers has changed: teachers no longer are the only knowledgeable authority; they are facilitators of learning, guides and feedback providers; the focus is on students, who are the centre of learning. Some students may be resistant to this approach as it is much more comfortable to passively listen to the teacher's lecture and take notes. Careful preparation is necessary to raise students' awareness about the benefits of the method (Colibaba, A. et al, 2018).

III CONCLUSIONS

On the whole the students and teachers who have been involved in the implementation of the project's method have appreciated it. The project's implementation is not completed yet and we expect to collect new findings from participants. The students have highlighted the active role they had during the classes; they also enjoyed being allowed a personal learning pace, working in pairs or groups and having a voice. "I liked it that we watched the video explaining the concept at home; I was able to watch it until I understood it and then we worked on it in class"- FM, student. "I liked it because when we worked in pairs or in groups the teacher was always there helping us"- DD, student. "I liked it when I asked questions if I hadn't understood something. I got answers from my colleagues and teacher "- FR, student. "I liked it when I got feedback from my peers or teacher; this helped me a lot to finish my work" – RS, student. "I liked it because we had to interact with each other and work together" - VA, student.

The teachers' feedback focuses on the students' better performance and results or the quality of the new method: "Some students that had lower grades are better now because they work more in class"- LM, teacher. "I am happy my students have become very active during my classes now" – MC, teacher. "The flipped classroom stirs students' interest in a topic; it encourages students to reflect on the topic or concept; they have to think of the questions they can ask their peers or the teacher in class; **lessons and content are more accessible**. Students who are absent from school can catch up with their peers faster with the flipped classroom method"- CS, teacher.

Acknowledgements

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