Microlearning to study bioeconomy and circular economy in agri-food systems

Microaprendizaje para estudiar bioeconomía y economía circular en sistemas agroalimentarios

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Abstract- The bioeconomy and the circular economy are novel aspects that are attracting growing interest. However, despite this, there are few teaching materials related to these concepts, especially in the agri-food sector. The BIOCIR project (Active learning in bioeconomy and circular economy in agri-food systems) aims to fill this gap by creating audiovisual content using microlearning techniques. The project involves Bachelor and Master students of 9 subjects of the School of Agricultural, Food and Biosystems Engineering (ETSIAAB) in the development of short videos (2-5 minutes) on agricultural bioeconomy and circular economy with the aim of consolidating a new source of updated, attractive, and transversal didactic material. Surveys of students and teachers are used to evaluate the skills acquired and the usefulness of the teaching material created.

Keywords: Circular bioeconomy, microlearning, videos.

Resumen- La bioeconomía y la economía circular son aspectos novedosos que están despertando un creciente interés. A pesar de ello, existen escasos materiales didácticos relacionados con estos conceptos, especialmente en el ámbito agroalimentario. El proyecto BIOCIR (Aprendizaje activo en bioeconomía y economía circular en sistemas agroalimentarios) pretende suplir esa carencia creando contenido audiovisual mediante técnicas microlearning. El proyecto involucra a alumnos de Grado y Máster de 9 asignaturas de la Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas (ETSIAAB) en la elaboración vídeos cortos (2-5 minutos) sobre bioeconomía agraria y economía circular con el objetivo de consolidar una nueva fuente de material didáctico atractivo y transversal. Mediante encuestas a alumnos y profesores se evalúan las competencias adquiridas y la utilidad del material didáctico creado.

Palabras clave: Bioeconomía circular, microaprendizaje, vídeos.

1. INTRODUCTION

Over the last decade, the bioeconomy and the circular economy have received growing attention as they have been integrated into sustainable development agendas. These concepts offer a unique opportunity to address societal challenges such as ensuring food security, managing natural resources sustainably, reducing dependence on non-renewable resources, mitigating and adapting to climate change, and creating jobs.

Paradoxically, and despite the growing interest in the bioeconomy and circular economy, there is little scientific production and a lack of teaching materials related to these concepts, especially in the agri-food sector.

In this context arises the BIOCIR project (Active learning in bioeconomy and circular economy in agri-food systems), which is the one presented in this paper. BIOCIR is an Educational Innovation project promoted by the Educational Innovation Group AgroEcoS (Agroeconomy, Agri-food, Agroecosystems) of the Universidad Politécnica de Madrid (UPM). The objective of the BIOCIR project is to create audiovisual microcontents on circular economy and bioeconomy, based on nine courses of four undergraduate degrees and a master's degree of the ETSIAAB (UPM). The final aim is to consolidate a new source of attractive, updated, and transversal didactic material.

This type of learning, called 'microlearning', presents information in small content pills that, when linked together, create a more complete and deeper knowledge (Taylor & Hung, 2022). Microlearning is applied in many disciplines and is gaining prominence in companies and universities due to its effectiveness and efficiency. Its use in bioeconomy and circular economy would improve the teaching-learning of these novel concepts.

2. CONTEXT & DESCRIPTION

Microlearning has experienced a significant boom in the last decade, driven by hyperconnectivity and changes in the way information is acquired and consumed (Wang et al., 2020). This new educational strategy is presented as an alternative to

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conventional learning methods (macro-learning), offering short didactic contents with more flexible formats adapted to the needs of the students (Sankaranarayanan et al., 2023).

Recent studies indicate that microlearning has a positive impact on academic performance and student learning, due to its versatility and high student acceptance (Taylor & Hung, 2022). It presents content in easy and accessible formats anytime, anywhere. It saves time and allows to quickly assimilate important basic concepts, speeding up the learning of the rest of the subject. In addition, it facilitates autonomous learning, and increases student participation and motivation. Finally, it allows the development of soft skills such as creativity, communication, the use of ICTs (Information and Communication Technologies), planning and organization of tasks, etc. (Nowak et al., 2023).

However, this method of learning also has its limitations. Some studies suggest that the content may be too brief and superficial (Taylor & Hung, 2022). In addition, the necessary means must be available to access these contents (cell phones, computers, etc.) and interaction with other users may be limited, making some users feel isolated (Demmans Epp & Phirangee, 2019). Therefore, it is important to carefully consider the content and context before implementing microlearning and, in any case, to use it as a complementary support material. Students who base their learning entirely on these microcontents may not achieve the knowledge necessary to pass the exams (Demmans Epp & Phirangee, 2019).

Microlearning training activities have different formats and durations depending on the learning objective. The BIOCIR project has opted for the "Short Lesson" method, the most common method applied in microlearning studies (Taylor & Hung, 2022). This method consists of fragmenting and digitizing a selected topic into microcontents equivalent to 2-5 minutes of training. In addition, the 'video' format was chosen because short, impactful videos tend to help students understand topics better compared to written materials.

The project consists of 4 phases (Fig. 1).

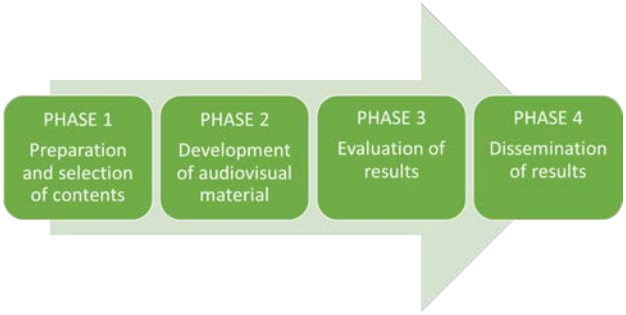

Figure 1. Steps of the project.

- Phase 1: Preparation and selection of contents. In this stage the activity is coordinated and prepared. Teachers select the topics to be covered and divide them into micro-units (1 micro-unit = 1 video). Then, they explain to the students the activity and how they will be evaluated.
- Phase 2. Development of audiovisual material. In this stage the students work autonomously in the creation of the videos. The students receive a basic guide on the development of didactic videos and make the videos under the supervision of the teachers.
- Phase 3. Evaluation of results. In this stage, the activity is evaluated. Students are surveyed to find out their degree of satisfaction with the proposed activity, the skills acquired or improved during the activity, and the usefulness of the developed didactic material. Similarly, surveys are conducted with teachers to determine their degree of satisfaction with the proposed activity and the impact on students' performance.
- Phase 4. Dissemination of results. This stage consists of disseminating the experience and the results of the project. All videos are included in the Moodle platform of each course so that students can study and analyze them independently. In addition, the best videos are broadcasted (prior authorization) on other channels and websites (e.g. the UPM You Tube channel and the EELISA European University channel).

The phases of the project are sequential and are developed in parallel in all project-related courses. Specifically, they are carried out in 9 courses (8 undergraduate and 1 postgraduate) of the ETSIAAB, which reflect the transversal nature of the bioeconomy and circular economy concepts (see Table 1).

Table 1. Courses linked to the BIOCIR project.

Degree	Courses	Degree year/ Semester	ECTS
Agri-environmental Engineering	Hydraulics and environmental hydrology	3/1	6
	Wastewater management in agriculture	4/2	6
Food Engineering	General economics	1/2	4
	Waste management and utilization	4/2	4
Agricultural Sciences and Bioeconomy	Principles of economics and bioeconomy	2/1	6
	Bioeconomy policy and regulation	2/2	4
	Bioeconomic analysis techniques I	3/2	4
Biotechnology	Business economics and management	2/1	6
Master in Agricultural Economics	Environmental economics and policy	4/1	4

The project involves 400 students, 15 teachers and 1 doctoral student. The teachers are linked to 4 Departments (Agricultural Economics, Statistics and Business Management; Food Chemistry and Technology; Agroforestry Engineering; and Agricultural Production) and 4 Educational Innovation Groups (AgroEcoS-Agroeconomy, Agri-Food, Agroecosystems; Chemistry and Agricultural Analysis; Food Engineering Applied to Health; and Agricultural Systems Group) of the UPM. In addition, the project is part of the EELISA Green Planet community (https://blogs.upm.es/eelisa-greenplanet/).

3. RESULTS

This section presents the results obtained in the first half of the project (February-May 2023), corresponding to 5 courses of the second semester of the 2022-2023 academic year (Table 2).

Tabla 2. Digital microcontents.

Courses	Selected topics	Nº of videos	Nº of students	Weight on final grades
Wastewater management in agriculture	Necessity and regulations Wastewater treatments	2	5	10%
General economics	Externalities and public goods in agriculture	10	56	10%
Waste management and utilization	Experimentation in waste valorization to create bioplastics	10	49	1.5%
Bioeconomy policy and regulation	Short marketing circuits Rural Pact & Green Deal Environmental regulations Circular Economy	7	27	15%
Bioeconomic analysis techniques I	Material flow analysis Agri-food market models System dynamics models	5	22	10%

During the second semester of the 2022-2023 academic year, 35 short videos on a wide variety of topics were developed. Most of the videos cover theoretical aspects (regulations and policy strategies, market failures, etc.), although videos with a more practical approach (application of models and experiments) have also been developed.

In the course 'Bioeconomy policy and regulation', the topic of study was chosen by the students. In the rest of the courses, teachers chosen the topic to be covered based on its relevance to the study of the bioeconomy and circular economy, the scarcity of teaching material and its suitability for the digital microcontent format.

A total of 159 students participated in the activity. In all courses, the videos were made in groups of 3-6 students. Most of the students recorded the videos with Smartphones (82%). The software used to edit them has been very varied, the most used being Canvas (30% of the students), Filmforth (12%) and Filmora (5%). Other well-known software, such as Camtasia, Camstudio, Capcut, Edpuzle, DaVinci, were also used, but to a lesser extent. Most of the students (72%) had no problems creating the videos. However, some students reported difficulties in adjusting to the length of the video, gathering and organizing the necessary information, and editing the videos (putting shots together, etc.)

In most of the courses, the videos have been designed as a complement to the traditional training. In addition, in many cases, students were required to prepare a written assignment to supplement the videos, which may have increased the student's workload. The weight of the videos in the final grade varies significantly, from 1.5% in Waste Management and Utilization to 15% in Bioeconomy policy and regulation. In this sense, the surveys reveal that low scores, of less than 10%, are not well received by the students, as they consider that the effort and time spent in the development of the videos is not reflected in the final grade.

The evaluation survey was answered by 44 students. The results reveal that the evaluation of the videos was good or very good, with similar scores for format and content (Fig. 2).

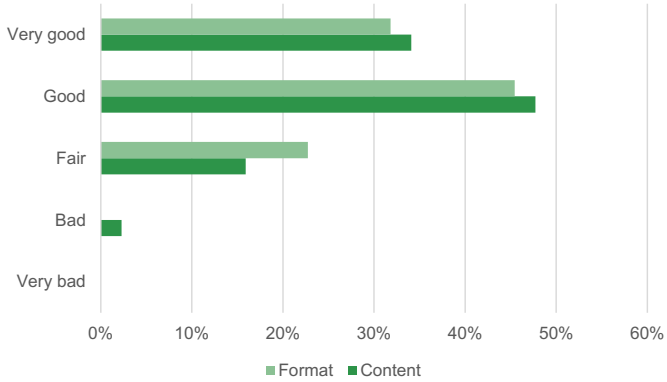

Figure 2. Quality of the videos.

In addition, a very high percentage of students (80%) believe that the videos developed can be useful to other students. However, 45% of students indicate that they would not use them to prepare for exams. This can be explained by the fact that the exams still have a traditional format (written and based on macro-contents) and students perceive that microlearning does not fit with the training required for the final exams.

Students were also asked about the usefulness of the activity in terms of acquiring new concepts, improving understanding of concepts, retaining information, fostering interest/motivation, saving time in learning, and flexibility/adaptability of learning.

Students indicated that the activity had enabled them to acquire new knowledge and improve their understanding 'a lot' (30%) and 'quite a lot' (32%). They also said that it has contributed to retain information better (16% 'a lot' and 45% 'quite a lot') and, to a lesser extent, increase their motivation and make learning more flexible (20%-16% 'a lot' and 30%-34% 'quite a lot'). The worst rated was the time savings (25% 'very little' and 16% 'little'). This may be because the students had to spend a lot of time preparing the videos and, therefore, do not consider that the activity has saved them time in learning.

The activity was also highly valued in terms of soft skills acquisition (Fig. 3).

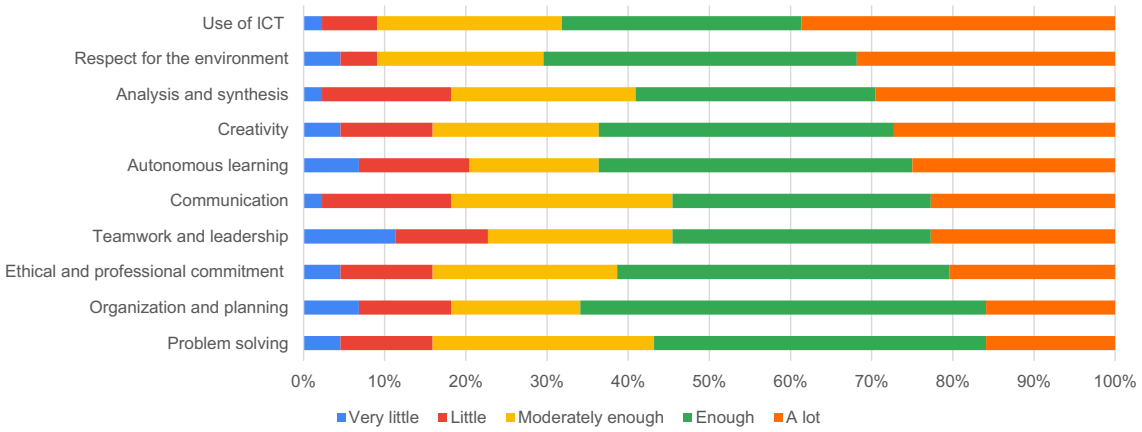

Figure 3. Acquisition of soft skills.

The students report that the activity has enabled them to acquire 'a lot' of soft skills, especially the use of ICTs, respect for the environment, capacity for analysis and synthesis, creativity, and autonomous learning. Also, students feel that they have been able to acquire 'enough' soft skills, such as organizational and planning skills, problem solving, and professional ethics and responsibility. The lowest rated skills were teamwork and leadership, and communication. Even though in all the subjects the videos have been made in groups, this has not served to work sufficiently on this competence. The students indicate that the work groups should be smaller and that spaces should be provided for group work.

Finally, 46% of the students generally rate the activity as 'good' and 21% as 'very good'. In addition, most respondents (46%) would be willing to do this activity again in other courses.

Teacher evaluation surveys will be conducted in the coming months. The activity is still ongoing and pending grading.

4. Conclusions

This project has served to generate attractive educational material, so far scarce and fragmented, on agri-food bioeconomy and circular economy. Thus, it contributes to address a challenge with a high social impact, that of the development of the bioeconomy and circular economy as key instruments to achieve a more modern and innovative economy, which reconciles the demands of sustainable agricultural production and low-carbon economy with the challenges of food security and sustainable use of renewable resources.

In addition, the chosen format (micro-videos) has improved the teaching-learning of these concepts, optimizing the comprehension and retention of information and the acquisition of soft skills (use of ICTs, respect for the environment, etc.).

bioeconomy and circular economy, the videos generated may be used in future years in other undergraduate and Master's degree courses and potentially in continuing education programs (LifeLong Learning) of other students inside and outside the UPM. Also, the best videos will be disseminated through institutional channels, promoting the dissemination and internationalization of the experience.

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