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Applying Challenge Based Learning to Teach Mass Transfer*

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In order to enhance undergraduates' understanding of mass transfer unit operations, Challenge-Based Learning (CBL) was applied in two courses on Transport Phenomena in the Food Industry. The courses are part of Agrifood Engineering Degree program at the Universitat Politècnica de València (UPV). After the lecturers explained the topic to the fourth-year students, they were given the challenge of preparing and solving cases of mass transport phenomena dealing with solid-liquid extraction and food drying. Students were divided into six groups of three or four students; each group chose a product to work with, and each group designed a flowchart with the main stages of the process based on the information gathered from varied bibliographical sources. The corresponding mathematical models were applied to characterize the flow and estimate the performance and efficiency. After that, students wrote short reports of the main steps followed to complete the task. The reports were presented to a panel of expert lecturers to provide feedback and recommendations. Specifically designed rubrics were employed by the panel to assess the impact of the methodology on students' subject-specific skills in addition to collaborative work, problem solving, time management and oral presentation skills.

Keywords: challenge-based learning; mass transfer operation; flowchart; oral presentation; recording; panel of experts; rubrics

1. Introduction

Learning experiences are a challenge for Higher Education professionals and their institutions since they are responsible for the academic and professional development of students so that they can effectively address contemporary problems [1]. The expectations and needs for future graduates go way beyond the purely technical skills and demand innovation competences [2]. Thus, despite the efforts made so far, it is necessary to continue planning, developing and sharing teaching experiences that clearly contribute to the development and evaluation of soft skills and professional competences, which are transferable, allowing other lecturers to implement similar actions adapted to other contexts. In this sense, the development and assessment of competences throughout university education, especially soft skills, has become a challenge for faculty [3]. Making an explicit statement of what it means to be competent at different levels means requires the ability to specify the learning outcomes associated with that competence at each level (Education and Training 2020 Work program. European Commission) [4]. In technological universities students use, sequence, and align different resources in order to study mathematics and apply them to their engineering-related projects. Knowledge on how students use resources and how they develop their *Actual Student Study Paths* (ASSPs) in challenge-based (CB) projects could help university tutors and lecturers to guide students effectively to progress their learning and projects [5].

Challenge-Based Learning (CBL) is a collaborative learning experience and a multidisciplinary approach in which teachers, students and sometimes societal stakeholders work together to learn about pressing issues, propose solutions to real problems and take action for sustainable development [6]. This approach forces students to reflect on their learning and the impact of their actions and publish their solutions to a global audience [7]. In this scenario, CBL is presented as a meaningful learning approach that involves the mastery of various cross-cutting and professional competences such as critical thinking, teamwork, problem solving and decision-making. According to Gaskins et al., (2015) and Membrillo-Hernandez & García-García, (2020), CBL is a structured model for course content based on problem-based learning (PBL). Both approaches engage students in real-world problems and involve them in the development of specific solutions [9]. In the case of CBL, the aim is not only to solve the problem itself, but to also use it for learning development and competence acquisition [10]. CBL offers general concepts from which students derive the challenges they will address. In this line, it is remarkable the processes involved in the adoption of CBL methodology to

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identify challenges and how academia can link with industry in solving real-life problems, such as those related with the electrical sector in Tanzania [11].

In higher education, an increasing number of educators have been shifting from traditional classrooms towards a more flexible, effective, and interactive online learning environment, increasing the implementation flipped learning [12]. Especially in engineering courses, using computer tools in the resolution of simulated cases greatly facilitates progress in the establishment of knowledge and provides it with a real practical sense. Moreover, in the current scenario of teleworking, triggered by the Covid-19 pandemic, has propitiated the mastery in the usage of technological software skills which are mandatory for future workers. Furthermore, searching for information in different online databases provides the students with data to design processes in a short period of time that are quite close to the real ones. Distinguishing reliable and unreliable sources of information and selecting only the data needed for their final goals could also be promoted through this activity. Working in groups to develop all the steps necessary to achieve a specific objective is also an opportunity to learn from their peers accordingly under the supervision of their lecturer through tutoring sessions and simulating the day-to-day life in a real project office. So, if students prepare an oral presentation explaining the idea to their peers and to a panel of experts, how they developed it, what the main results are after mathematical models and finally their main conclusions, they can get feedback from them and improve their solution. Undoubtedly, proper and accurate usage of technological tools such as REMIND, ZOOM or CANVAS, among other platforms, is necessary to increase efficiency in the development of a CBL experience with a training partner [10].

Considering the above, it is crucial to know the best assessment tools that best suit the needs of the different CBL activities, being the assessment by rubrics and checklists the ones that had the highest objectivity [9]. However, other authors have reported the use of deliverables, such as written reports, peer reviews or skills tests [10].

In this context, the objective of this paper is to share the CBL experiences carried out in the courses of Transport Phenomena in the Food Industry I and II of the Agrifood Engineering Degree at the UPV in which students were challenged to fully describe and design a food process that includes both solid-liquid extraction and the operation of a hot air-drying unit according to sustainability and energy efficiency criteria. The assessment of their contribution to the students' mastery of matter was also analysed.

2. Materials and Methodology

The following is a description of the CBL process in the context of two core courses of the 4th year of the Degree in Agrifood Engineering (intensification in agri-food industries) belonging to the School of Agricultural Engineering and Environment (Universitat Politècnica de València). It should be noted that the courses of Transport Phenomena in the Food Industry I and II (TP1 and TP2, respectively) are taught consecutively during the first semester and that 92% of the students enrolled in both subjects were the same (25 and 23 students for TP1 and TP2, respectively). Prior knowledge in solving mass and energy balances is assumed. In addition, of the three properties that can be transferred in a food system (mass, heat and momentum), the challenge-based learning aimed to deepen the understanding of two unit operations involving mass transport: solid-liquid extraction and hot air drying.

2.1 Description of the Challenge

The challenge given to the students on the first day of class was to fully describe a new food process or improve an existing one involving a solid-liquid extraction operation (for the course TP1) and a hot air-drying step (for the course TP2). Simulating the real activity of the Process Engineering Department of an Agri-Food Company, the students were asked to work for 7 weeks in groups of 3 to 4 people under the supervision on-demand of the lecturers, mainly outside class hours and online due to the health alert situation caused by the COVID-19 pandemic. Feedback of the deliverables was sent to the students within 24–48 hours. As for the tasks to be carried out by the students, they became more complex as the course content progressed. Attendance to the basic principles of the design of a sustainable industrial process was positively valued.

2.2 Students' Tasks

During the first two weeks of the course, the students received the appropriate instructions on the development of CBL and were asked to form the groups and define the food process to be designed. They could choose one of the processes proposed by the lecturers (obtaining vegetable oils from seeds, nuts or olive pomace, making *horchata* and other vegetable beverages, making tea or soluble coffee, etc.) or a completely different one.

In the following two weeks of the course, the students had to draw the complete flow diagram of the process (deliverable 1) and define both the flow rates and compositions of the main flows, as well as the conditions (type and amount of solvent, counter-current or fresh solvent in each extraction step, drying air conditions, continuous or intermittent dryer, etc.) to carry out the process (deliverable 2). For this, the students should have searched for information in specialized databases and websites. Decision-making should have been based on sustainable practices, promoted the rational use of natural resources and minimized waste generation without reducing the efficiency of the process.

In weeks 5 and 6 the students were required to design and solve mass balances to calculate the flow rate and composition of all the streams involved in the process. They should have also applied the graphical methods taught in class in order to estimate the number of stages involved in the solid-liquid extraction process or the composition of the air as it passes through the drying unit. Finally, students had to apply certain equations to calculate both the yield and the efficiency of the process. For the completion of these tasks the students had the lecturers' feedback on the previous deliverables together with the class notes. The results obtained were collected in an orderly manner and delivered in a spreadsheet (deliverable 3).

In the last week of the course, the students had to record a 3 to 4 minutes presentation where each member of the team explained one of the different tasks performed (deliverable 4). The video was screened in the last session of the course in front of a panel of experts consisting of 3 lecturers/researchers with experience in designing unit operations for the food industry.

As part of the aim of this particular CBL, it is intended through these tasks that the students will acquire certain soft skills, such as analysis and problem solving, effective communication, critical and creative thinking or planning and time management. The specific skills of the Degree on Agrifood Engineering will also be worked on, especially the ability to use the basic principles of food engineering and the ability to consolidate, expand and integrate the knowledge.

2.3 Grading of the Assignments

Deliverables 3 and 4 were graded according to the criteria listed in the corresponding rubric (Tables A1 and A2 in the Appendix section). These rubrics were specifically designed for the challenge based on the PoliformaT-UPV rubrics gallery [13]. No more than seven items were assessed in each rubric and each item was graded according to four levels. The expected academic skills were mainly assessed with the rubric for deliverable 3, whereas soft skills were assessed with both rubrics. Deliverable 3 was graded solely by the lecturer of the course, while deliverable 4 was graded individually by the three members of the expert panel. The final grade was obtained from the average of the grades obtained in each of the two deliverables. With a few exceptions, all team members received exactly the same grade. The rubrics were made available to the students at the beginning of the activity.

3. Results and Discussion

The information in this section has been organised in two parts. Firstly, the topic selected by the students to fulfil the challenge and the guidance they were given are presented. In addition to showing some examples of the best-scored flowcharts, the grades obtained by the students according to the rubrics are analysed. Finally, the impact of the challenge on the exam score is evaluated.

3.1 Topics and Examples of Flow-Charts

Table 1 shows the case studies chosen by the students. To approach the study of both the solid-liquid extraction and the hot-air drying unit opera-

Table 1. Practical cases addressed in the context of CBL applied in subjects Transport Phenomena in the Food Industry 1 and 2 (TP1 and TP2) of the Agrifood Engineering Degree at UPV

Challenge	Manufactured Product	Solid-liquid extraction	Hot air-drying operation
Ch1	Horchata	Soluble solids extraction with water from dried and crushed tigernuts.	Convective drying of whole tigernuts to produce tigernut flour.
Ch2	Sunflower oil	Fat fraction extraction with hexane from dried and crushed sunflower seeds.	Convective drying of sunflower seeds as a pre-extraction treatment.
Ch3	Almond oil	Fat fraction extraction with hexane from dried and crushed almonds.	Convective drying of whole almonds as a pre-extraction treatment.
Ch4 (TP1)	Olive pomace oil	Fat fraction extraction with hexane from olive orujo.	
Ch4 (TP2)	Dehydrated onion for seasoning		Convective drying of sliced onions.
Ch5 (TP1)	Cod liver oil	Fat fraction extraction with ether from cod liver.	
Ch5 (TP2)	Dried apple slices		Convective drying of apple slices.
Ch6	Soluble chicory	Soluble solids extraction with water from dried and crushed chicory.	Convective drying of chopped chicory

tions, several learning objects (following the rules of Online Teaching from UPV) in format of articles [14–16] and short videos [17,18], along with the class notes and the recommended bibliography [19, 20] were provided to the students together with the lecturer's guidance.

Figs. 1 and 2 show the flowcharts of two of the processes designed by the students: fat extraction with ether from cod liver (Ch5 in subject TP1) and the convective drying of sunflower seeds as a pre-extraction treatment (Ch3 in subject TP2). As can be seen, all unit operations involved in the whole process were identified, but only solid-liquid extraction (for subject TP1) and hot-air drying (for subject TP2) were analysed in depth.

In the case of solid-liquid extraction, there were several possibilities depending on the management of the solvent and the number of stages in order to achieve a given yield in this operation [20]. Thus, if more than one stage were needed, there were two

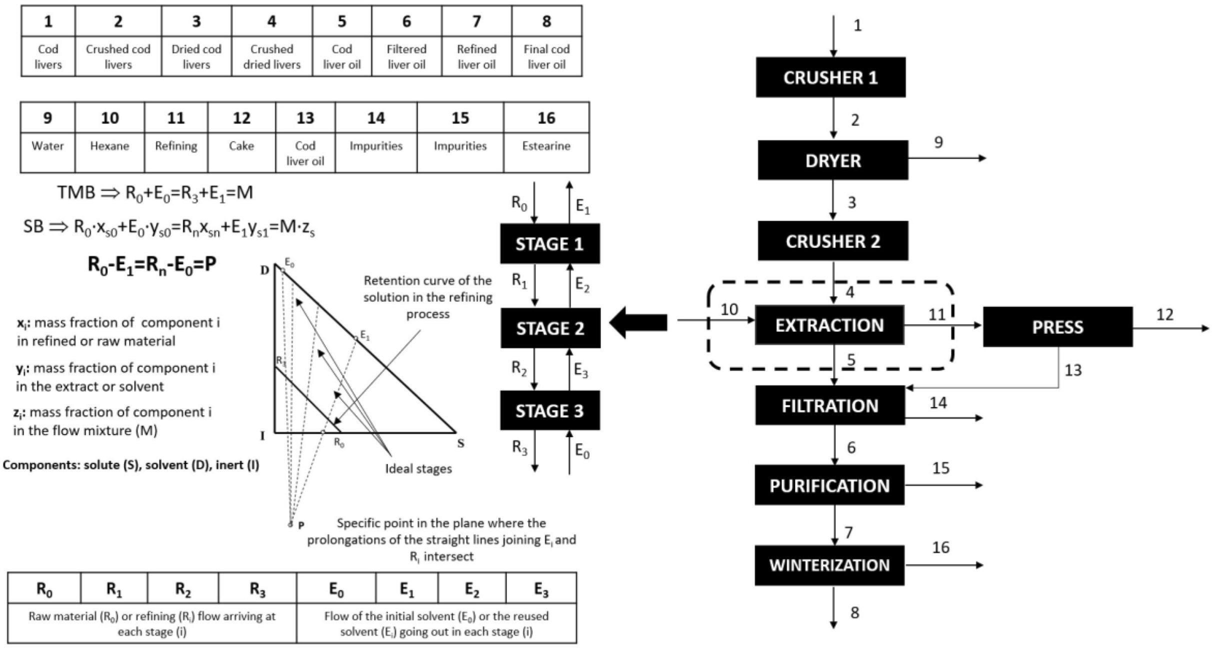


Fig. 1. Flowchart corresponding to the cod liver oil extraction process (Ch5 in subject TP1).

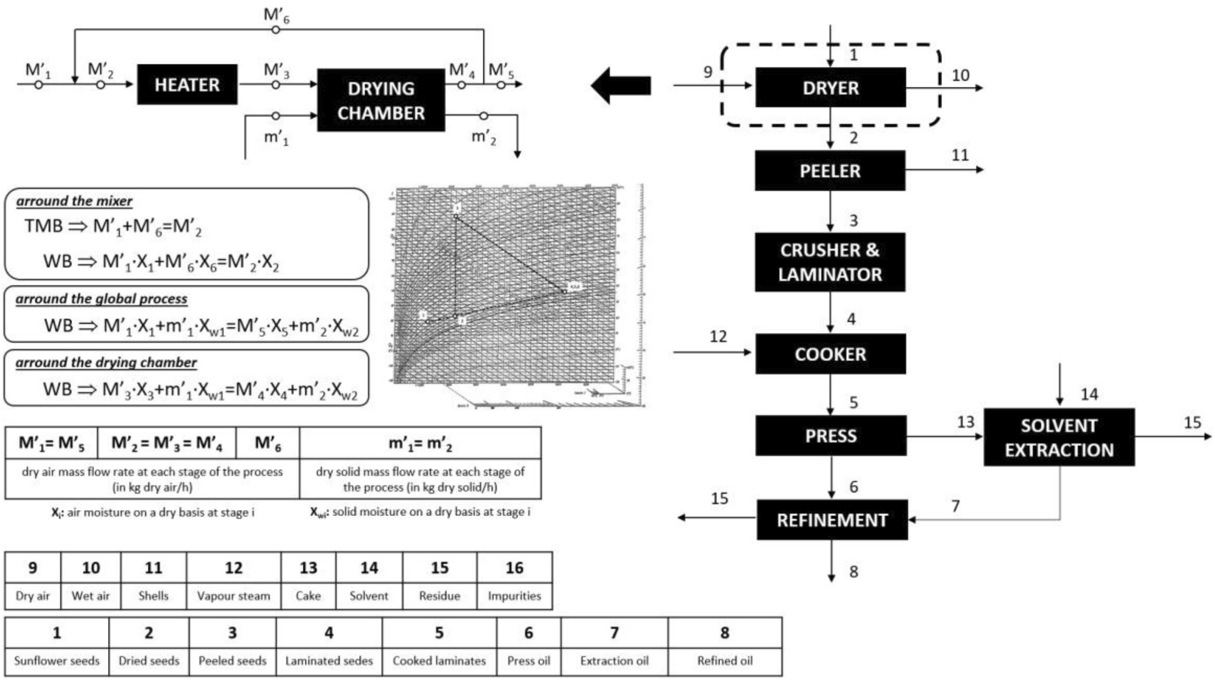


Fig. 2. Flowchart corresponding to the drying process of sunflower seeds (Ch3 in subject TP2).

other possibilities. In the first one, it was possible to have new solvent in each stage, obtaining a different extraction flow in each stage. In the second one, the solvent was reused in the successive stages and a single final extraction flow was obtained. To meet the challenge depicted in Fig. 1, students opted for a 3-stage counter-current extraction with hexane.

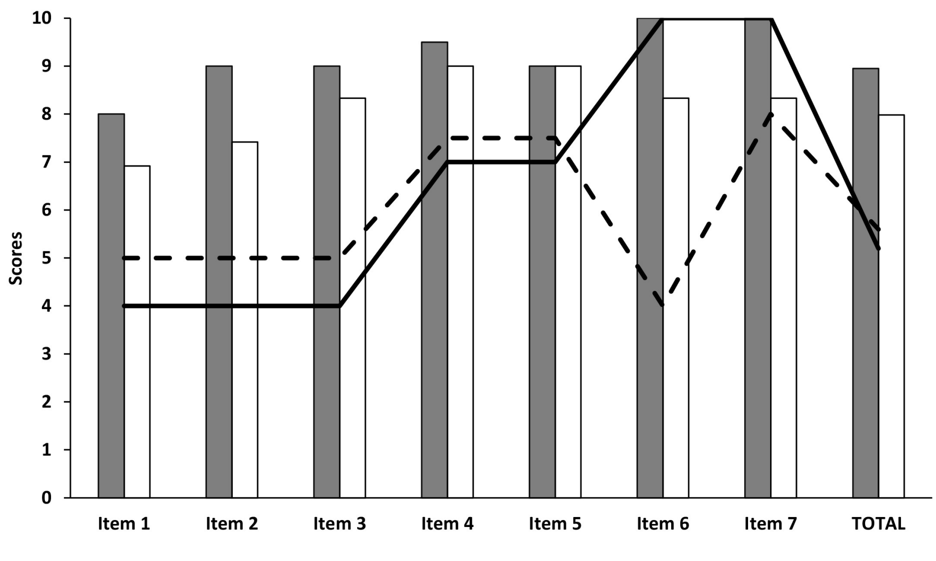
The alternatives that arose in the design of the hot-air drying step were the type of dryer (continuous or discontinuous) and the possibility of recirculating part of the air coming out of the dryer. For drying of the sunflower seeds prior to oil extraction, the students opted for a batch test dryer and decided to recirculate 20% of the dry air that came out of the dryer and reintroduced it before the heat generator (Fig. 2). In this way, a considerable reduction of the energy supplied by the heater would be achieved, contributing to sustainable development goals.

3.2 Lecturer's Assessment of Calculations

Fig. 3 shows, for each of the items defined in the corresponding rubric (Table A1), the average of the scores given by the lecturer to each of the challenges together with the average overall score. As can be seen, most of the items were scored between 7 and 9. Teamwork and timeliness of delivery (both soft skills) were the highest rated items in the challenges related to solid-liquid extraction. On the other hand, the presentation of the results in the Excel sheet and the proper use of the nomenclature and units (both academic competences) were the highest rated items in the challenges related to hot-air drying. It should be noted that, although not significantly, the scores for each of the items, as well as the overall scores, were higher for the challenges addressed in the course TP1 than for the same addressed in the course TP2. Given that the students involved in both subjects were basically the same, the differences found in the scores between subjects could be attributed to the different level of demand of each lecturer or to the different degree of complexity of the specific calculations of each unit operation. It is also possible that the students were more tired or overloaded with other assignments and tests from other courses since TP1 and TP2 were taught one after the other.

3.3 Experts' Assessment of the Presentations

Table 2 shows, for each of the items defined in the rubric for the oral presentation (Table A2), the average of the scores assigned by the three experts to each one of the challenges. The challenges rated highest by the experts were those numbered 2 and 3, for TP1, and those numbered 3, 5 and 6, for TP2. It follows that, except for the team facing challenge 3 in both courses, there was no relationship between



Items	Description
1	Information search and selection of process conditions following sustainability and energy efficiency criteria
2	Elaboration of flowcharts (main unit operations and flows)
3	Calculation of the flow rate and the composition of the different flows following the specific methodology
4	Organization of the information in an Excel file
5	Proper use of the units and the terminology
6	Working time
7	On-time deliverables

Fig. 3. Students' scores of deliverable 3 according to the rubric shown in Table A1. Grey bars and white bars referred to challenges addressed in subjects TP1 and TP2, respectively. Minimum values for each item are represented in lines (continuous for TP1 and dashed for TP2).

Table 2. Scores of the assessment of the oral presentations with the rubric for all challenges in TP1 and TP2 subjects. Values in brackets are the standard deviation of the scores given by the three experts, equivalent to discrepancies among experts

Subject	Item	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6
TP1	Content selection	6 (2)	8 (3)	10 (0)	6 (2)	7 (0)	7 (0)
	Explanation	7 (0)	10 (0)	9 (2)	8 (2)	9 (2)	7 (3)
	Graphical elements	9 (2)	10 (0)	10 (0)	6 (2)	9 (2)	7 (0)
	Oral Language	8 (2)	10 (0)	9 (2)	7 (0)	7 (4)	9 (2)
	Teamwork	9 (2)	10 (0)	10 (0)	10 (0)	9 (2)	7 (0)
	Time control	10 (0)	10 (0)	10 (0)	6 (2)	6 (2)	8 (2)
	TOTAL	**8.0 (0.3)**	**9.6 (0.7)**	**9.7 (0.6)**	**6.9 (0.8)**	**7.3 (1.5)**	**7.4 (0.5)**
Subject	**Item**	**Ch1**	**Ch2**	**Ch3**	**Ch4**	**Ch5**	**Ch6**
TP2	Content selection	8.0 (1.7)	7 (0)	10 (0)	8.0 (1.7)	10 (0)	10 (0)
	Explanation	7 (0)	7.5 (0.9)	10 (0)	7 (3)	10 (0)	10 (0)
	Graphical elements	8.5 (1.5)	7.5 (0.9)	10 (0)	8 (2)	10 (0)	10 (0)
	Oral Language	9.0 (1.7)	8.0 (1.7)	10 (0)	7 (3)	10 (0)	10 (0)
	Teamwork	9 (1.7)	10 (0)	10 (0)	7 (0)	10 (0)	10 (0)
	Time control	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)
	TOTAL	**8.6 (1.0)**	**7.92 (0.03)**	**10 (0)**	**7.9 (1.2)**	**10 (0)**	**10 (0)**

the scores given and the composition of the team. Challenges numbered 2 and 3 were the highest scored in TP1 as a consequence of getting the highest marks in the items content selection, explanation, graphical elements, oral language and time control. However, challenges 3, 5 and 6 in TP2 achieved the highest scores on all items. In such cases, the experts' responses were unanimous, so the standard deviation of the experts' responses was nil. In contrast, the discrepancies between the ratings of the different members of the panel of experts were most pronounced for the items with the lowest ratings.

Fig. 4 shows the average of the resulting standard deviations for each of the items evaluated during the oral presentations. Major discrepancies among the experts' assignments occurred, regardless of the subject matter, in oral language, the explanation, the content selection and the use of graphical elements. It is also noteworthy that, in TP2, no differences were found in the scores given by the experts to time control. This fact gives evidence that after presenting the challenge related to the solid-liquid extraction, students were able to improve the management of this item which also achieved the highest score.

3.4 *Impact of CHL on Students' Learning Outcomes*

In order to have an objective assessment of the impact of the challenge on the students' learning, the ratio between their score in the exam and the challenge score was obtained. The results were classified into three different levels of this ratio (above 1, between 0.5 and 1 and below 0.5) (Fig. 5). In TP1, the percentage of students with a higher exam score than the challenge score (47.6%) was significantly higher than in TP2 (11.8%), whereas the percentage of students with a very low exam mark in comparison with the challenge

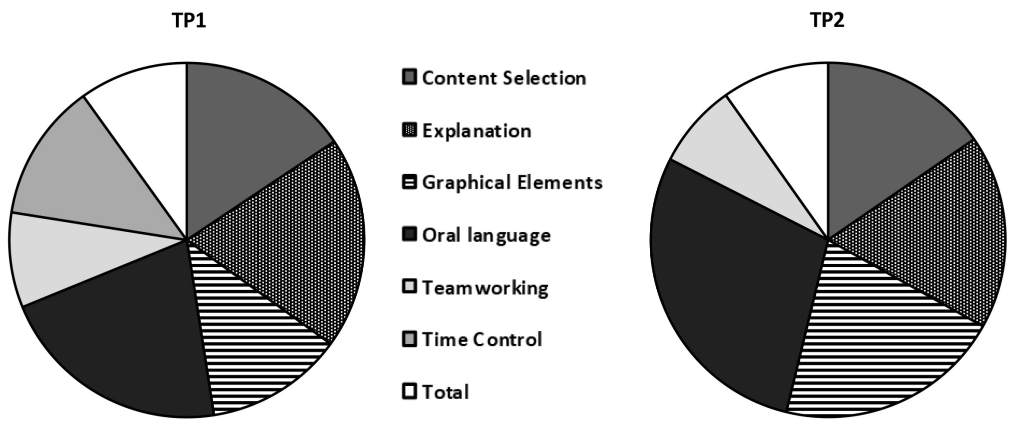


Fig. 4. Average of the standard deviation of each item assessed with the rubric for oral presentation against a panel of experts in both subjects.

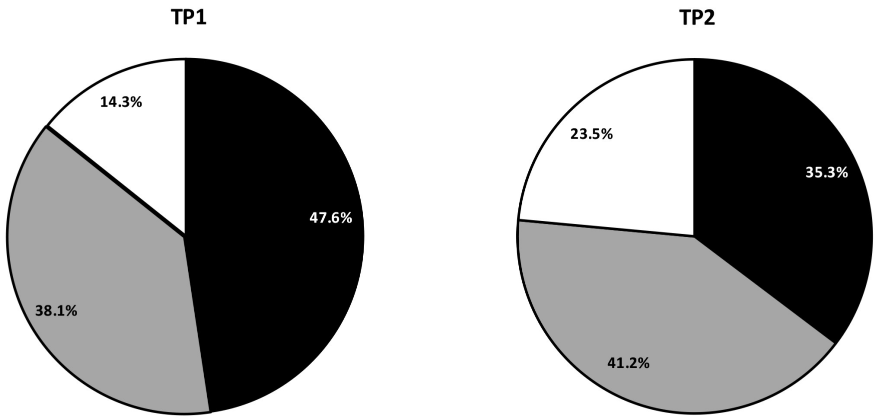


Fig. 5. Levels of the quotient score in the exam/score in the challenge classified in three levels: higher than 1 (black), between 0.5 and 1 (grey) and lower than 0.5 (white).

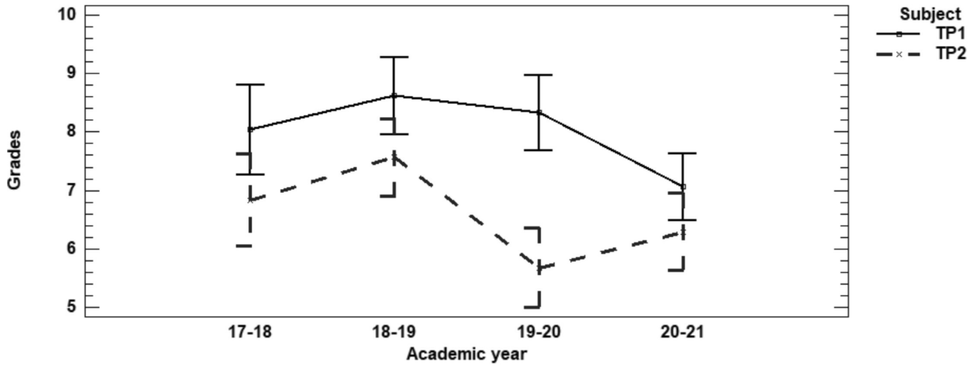


Fig. 6. Average values and 95% LSD intervals for grades in the last four academic years in subjects TP1 and TP2.

score was less than 15% regardless of the subject. This would support that the challenge may contribute to success in understanding the procedure in both courses, but mainly in TP1. It also follows that not all team members worked equally well on the challenge in the context of TP2, coupled with the fact that perhaps the assessment test was more complex in that case.

To better show the possible improvement in the students' grades as a result of the challenge, Fig. 6 shows, for each of the two subjects, the average of the marks of all the students enrolled in the last four academic years.

As can be observed, the scores achieved by students in TP1 were slightly higher than those achieved by the same students in TP2. It can also be seen that, for a similar level of demand, the average mark of all the students enrolled in TP2 are very different. Regarding the completion of the challenge, the average mark in TP2 slightly increased but that in TP1 slightly decreased in comparison with that of the immediately preceding academic year. It could be stated that the grades of the students who completed the challenge during the academic year 2020–2021 were of the same order as those of the students in the academic years 2017–2020, who did not complete the challenge. It would not be fair to say that completing the challenge was not useful for learning the content since this depends very much on the students' profile and there is only one year of experience. In fact, after completing the challenge, a percentage of students with a grade higher than 9 in TP2 (Fig. 7) showed up as a fact which had not existed in previous years.

4. Conclusions

The CBL based on the design of a process involving a solid-liquid extraction and a hot-air drying step was applied to enhance understanding of these unit operations. Due to the Covid-19 pandemic, this methodology has been applied in a blended learning context (online and face-to-face), thus also favouring the mastery of ICTs by both students and lecturers. However, this situation has made the assessment of the team work difficult. The document tells the experience and also provides useful rubrics for the evaluation of the appropriate use of engineering tools and commu-

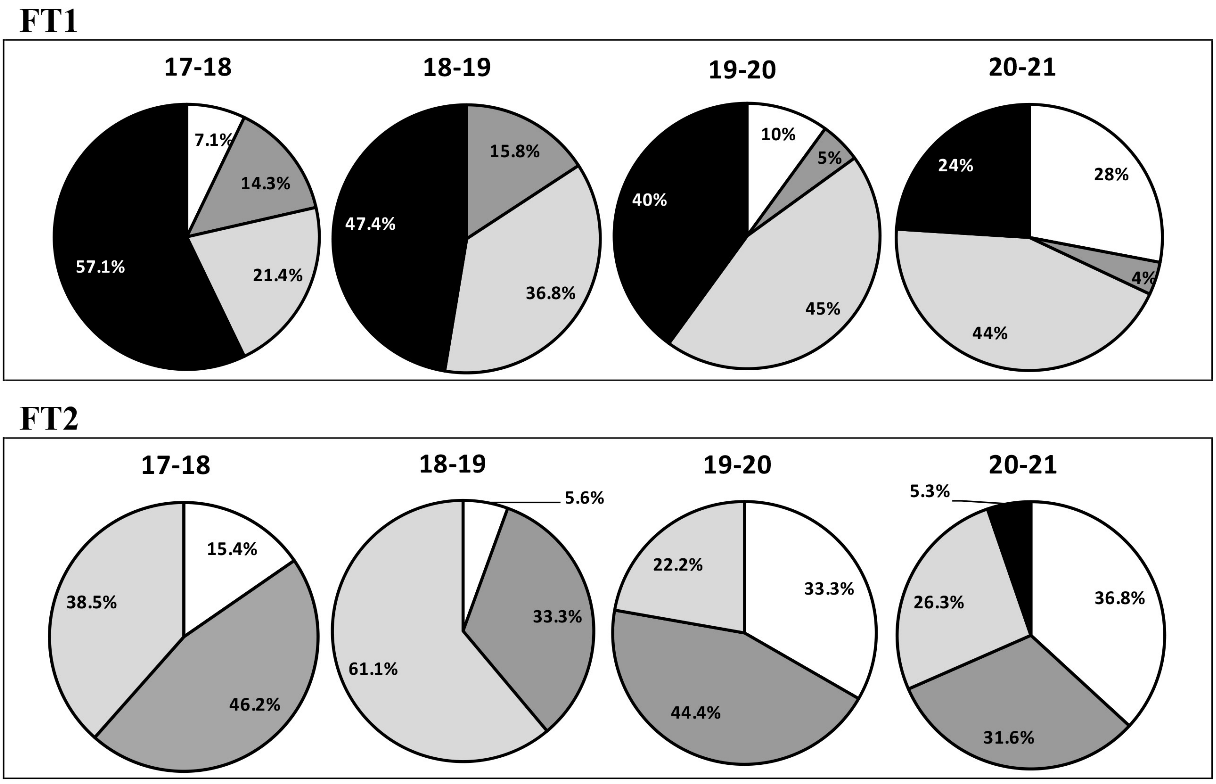


Fig. 7. Percentages of the score-groups (black: higher than 9, light grey: between 7 and 9, dark grey: between 5 and 7 and white: lower than 5) in the last four academic years in subjects TP1 and TP2.

nication skills in front of a panel of experts. Regarding the effect on the students learning, since they were assumed to have similar previous knowledge in solving mass and energy balances, and due to the lack of a control group not following the CBL, no significant improvement in the final marks were observed in the context of Transport Phenomena courses at the Agrifood Degree of the UPV. However, the challenge was expected to provide them with more means to succeed in their professional careers. Solving these limitations and including opinion surveys when further applying this methodology will afford to have more information about its impact in learning mass transfer unit operations.

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Appendices on following page.

Table A1. Rubric to assess deliverable 3

Item	Rate	Excellent 10–9	Good 8–7	Acceptable 6–5	Not achieved 4–0
1. Information search and selection of process conditions according to sustainability and energy efficiency criteria.	20%	A good search has been carried out (on manufacturers' websites, on product labels, in scientific databases...) and the process conditions have been selected according to sustainability criteria. Furthermore, the sources consulted have been correctly referenced.	In general, an effort has been made to search for information in different sources (on manufacturers' websites, on product labels, in scientific databases...) and the process conditions have been selected according to sustainability criteria, but the sources have not been cited.	Not enough sources have been consulted to establish the most appropriate process conditions based on sustainable development criteria.	No sources of information have been consulted to define the conditions of the process.
2. Elaboration of flowcharts (main unit operations and flows).	20%	All the unit operations involved in the process are identified, as well as the input and output flows in each of them. The graphic representation is clear and facilitates the understanding of the process, detailing the most relevant components for each flow.	All the unit operations involved in the process are identified, as well as the input and output flows in each one of them, but the graphic representation is confusing and makes it difficult to interpret the process.	Some unit operations are missing or not all the components of interest are defined for each of the flows involved in the process.	Flowchart not provided
3. Calculation of the flow rate and the composition of the different flows according to the specific process design methodology.	30%	All the equations and other mathematical tools have been properly selected and applied and the results obtained are correct.	All the equations and other mathematical tools have been properly selected and applied but some of the results obtained are incorrect.	Equations and other mathematical tools have not been properly selected or applied in all cases and, consequently, some of the results are incorrect.	Not all the equations and/or mathematical tools required to obtain the final result have been applied.
4. Organization of the information in an Excel file.	10%	Each value is correctly defined. The equations used are indicated and the meaning of each term is explained. Text boxes or similar detail the calculation path taken.	Each value is correctly defined. The equations used are indicated but the meaning of each term is not explained. Furthermore, the calculation path carried out is not sufficiently detailed.	The results are shown but the equations used are not indicated or the calculation path is not sufficiently detailed.	The results are shown but neither the equations used nor the calculation path are indicated.
5. Proper use of the units and the terminology.	10%	Proper use of the nomenclature and the units in all quantities involved in the process.	Proper use of the nomenclature and the units in most of the quantities involved in the process.	Incorrect use of the nomenclature or the units in most of the quantities involved in the process.	Incorrect use of the nomenclature and the units in most of the quantities involved in the process.
6. Working time.	5%	All members contribute to the performance of the work in the same proportion.	Almost all members contribute to the work in the same proportion.	There is a significant disproportion in the contribution of each member of the group to the work, but all members contribute to the completion of the work.	There is a significant disproportion in the contribution of each member of the group to the work, and some of them have not contributed at all to the completion of the work.
7. On-time deliverables.	5%	All deliverables on time.	All deliverables, except one, on time.	Only two deliverables on time.	Less than two deliverables on time.

Table A2. Rubric to assess deliverable 4

Item	Rate	Excellent 10–9	Good 8–7	Acceptable 6–5	Not reached 4–0
1. Content selection	20%	The content has been well selected, so that the most relevant information is included in each of the sections of the work: information search, flowchart, calculations and results.	The content of each of the sections of the work (information search, flowchart, calculations and results) is included, but some relevant information is missing.	The content has not been well selected, so relevant information is missing in some of the sections of the work (information search, flowchart, calculations and results).	The content has not been well selected, so relevant information is missing in most sections of the work (information search, flowchart, calculations and results).
Explanation	15%	Proper use in all cases of the terminology and technical language in the explanation of the tools and the calculation path.	Proper use in most cases of the terminology and the technical language in the explanation of the tools and the calculation path.	Proper use in some cases of the terminology and the technical language in the explanation of the tools and the calculation path.	Inadequate use of the terminology and the technical language in the explanation of the tools and the calculation path.
Graphic elements	15%	The explanation is supported by a slide presentation that has an appropriate font size and amount of text, and that includes images and other graphic elements that facilitate the understanding of the speech.	The explanation is supported by a slide presentation that, although it has not an appropriate font size or amount of text, it includes images and other graphic elements that facilitate the understanding of the speech.	The explanation is supported by a slide presentation that has not an appropriate font size or amount of text, in addition to including images or other graphic elements that do not facilitate the understanding of the speech.	The explanation is supported by a slide presentation that has not an appropriate font size or amount of text, in addition to not including images or other graphic elements that facilitate the understanding of the speech.
Oral language	20%	Students answer all questions clearly and concisely, , demonstrating mastery of the subject matter.	The students answer all the questions well, but there are certain deficiencies in the domain of the subject.	In general, the students are able to answer the questions, but in some cases they deviate from the purpose of the question.	The students do not answer or answer something that does not correspond to what they were asked.
Teamwork	10%	Proper use of formal language, with a non-monotonous tone of voice and arousing the interest of the audience.	Proper use of formal language, but with some deficiencies in verbal fluency.	Proper use of formal language, but the tone of voice is monotonous and does not arouse the interest of the audience.	The students abuse colloquial, boring language, do not arouse interest and/or show deficiencies in their oral expression.
Duration	20%	Each team member contributes equally in presentation time and in the amount of content presented.	Most team members contribute equally in presentation time n and in the amount of content presented.	Most team members do not contribute equally in presentation time or in the amount of content presented.	Some team members do not intervene in the presentation of the results.