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Version: Accepted manuscript

## HOW TO CITE

Feijoo, G., Crujeiras, R.M. and Moreira, M.T. (2018). Gamestorming for the conceptual design of products and processes in the context of Engineering Education. *Education for Chemical Engineers*, 22, 44-52.

## FUNDING

Research has been funded by project INNPAR2D (reference code MTM2016-76969-P), from the Ministry of Economy and Competitiveness and the European Regional Development Fund (ERDF).

# **Gamestorming for the Conceptual Design of Products and Processes in the context of Engineering Education**

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1       **Abstract**

2       Creating an ideal environment to develop creativity and innovation in engineering education is a  
3       real challenge. One alternative approach can be based in the application of Gamestorming  
4       methodology that considers the use of games in the process of brainstorming. Presenting the  
5       problem in a game format eludes the conventional lecturing and frees the participants to think  
6       creatively to solve problems. In this contribution, the adaptation of the Gamestorming  
7       methodology was applied in different Bachelor and Master courses of Chemical Engineering and  
8       Environmental Engineering in the University of Santiago de Compostela (Spain). The aim of this  
9       initiative was to develop students' creativity and teamwork, where the class divided in working  
10      groups propose and assess alternatives in the Conceptual Design of Products and Processes.  
11      Specifically, two examples of the application of the methodology are provided: (i) a wood box  
12      for wine storage was remodeled according to a number of requisites: functionality, savings of  
13      energy consumption and reduction of environmental impact; (ii) the conceptual design of a  
14      treatment system for the removal of pollutants present in a gaseous stream to accomplish the  
15      targets of wide applicability and efficiency as well as reduced cost and environmental impact. A  
16      total of 129 students from 4 different academic years participated and the survey performed after  
17      completing the activity rated this methodology as a mechanism to foster their creativity in the  
18      progress of teamwork toward decision making process.

19  
20      **Keywords**

21      Gamestorming. Creativity. Innovation. Employability Skills. Teamwork. Conceptual design  
22

## 1. Skills to be developed under the Gamestorming approach

Engineering education must strengthen students' capabilities in the decision making process in the design and operation of engineering processes, offer more and better instruction in oral and written communication, and provide training in teamwork skills, critical thinking and problem-solving methods (Shook and Kinckrehm, 2017). After the completion of the studies, students must have acquired the so-called business or employability skills (Fletcher et al. 2016; Grant and Dickson, 2006). Therefore, the curriculum of engineering students must include activities that enhance their initiative and versatility and, in this context, the different courses should address simple strategies and practices that allow the development of transversal competencies.

Creating an ideal environment to develop creativity and innovation in engineering teaching is a real challenge. Beyond the traditional lecturing approach for the presentation of principles and concepts, critical thinking must be fostered through specifically designed methodologies. This goal is very important in Product-service systems, motivated to fulfill customers' needs, considered as good strategies to face today's competitive business environment (Vasantha et al., 2012). There are different strategies based on the classic methodology of brainstorming that aim to standardize this process of creation. The Design Thinking process developed by Stanford University is one of the most developed options (Plattner et al., 2011).

The term gamestorming is linked to the process of brainstorming under the perspective of games (Gray et al., 2010). Introducing game dynamics in the teaching practice is nothing new, but many times we find cases of failure where the sessions of "games" are not productive and these dynamics are discarded because the participants have the feeling that it is a loss of time.

Gamestorming applies the theory of games to develop the potential of students in the field of creativity and other general skills. The development of the teaching process starts with the creation of teams, where all participants in a team are aligned towards a goal, everyone

1 understand what they are doing and their way of working as a team is active and dynamic. They  
2 solve problems through games and interactive discussion, avoiding the use of presentations  
3 where a single voice monopolizes the presentation of results. This teaching activity also provides  
4 information about the skills developed by the students from previous courses but it aims to foster  
5 creativity and critical analysis (Bruning et al., 1999). The concepts of teamwork (particularly  
6 how to promote creative participation and interaction with fellow group members), critical  
7 analysis, time management, and communication skills are also competences to be acquired.  
8 Although its application can consider different learning environments, few references are  
9 available on the concept of Gamestorming such as its application in a workshop on Data Mining  
10 using vision sensors (Kushiro et al., 2017) or the conceptual design of industrial product-service  
11 systems (Meuris et al., 2013).

## 12 **2. Gamestorming methodology**

13 The gamestorming methodology starts with the division of the class into groups of three or four.  
14 It is essential that at the beginning of every session all participants of the gamestorming session  
15 should be aware of the preliminary statements and principles and the final goal to accomplish.  
16 The participation of the different members of the group will also integrate methods of  
17 cooperative learning, as one of the most commonly used instructional method used for team  
18 work (Johnson et al., 1999; Millis and Cottell, 1998).

19 There are three main stages in the process: opening, exploration and closure (Gray et al., 2010).  
20 The opening consists of bringing together in the same workspace different interest groups to let  
21 ideas come up and information flow. In this stage, the different groups should generate as many  
22 examples as they can think of in a brief period of time in a brainstorming process, considered as  
23 explosion of ideas and opportunities when all ideas are written down. The more ideas generated  
24 in this phase, the more efficient the work will be in the next phase. The teacher should give the

1 groups a fixed allotted time (it can be slightly increased depending on the group dynamics),  
2 afterwards, it is time to collect ideas and list them without criticism.

3 During the exploration phase, participants seek to sift through the ideas described in the opening,  
4 so that unexpected and surprising elements emerge. Yang (2009) found statistically significant  
5 correlations between the quantity of brainstormed ideas and the design outcomes. At this stage,  
6 patterns and analogies should be investigated, initial premises and problems must be evaluated in  
7 a different way so ideas can be built and tested. In addition to contributing their own ideas,  
8 participants can suggest improvements in others' ideas, which can be as a stimulus for  
9 improvement. Sometimes, changing just one aspect of an impractical solution can make it a great  
10 solution.

11 Closure is the last step that allows us to move towards conclusions and actions from a more  
12 critical and realistic point of view, channeling the energy of the organization towards the most  
13 promising elements. It is the time to conclude, to make decisions, to define the actions to be  
14 carried out, to converge to the final solution. These three stages constitute the basic structure of a  
15 session of gamestorming, that can be used sequentially, making that the conclusion of a session  
16 of gamestorming is the initial condition of the following one.

17 This methodology has been implemented in three courses at the University of Santiago de  
18 Compostela (Spain): Project Design in the Bachelor of Chemical Engineering and two courses in  
19 the Masters in Chemical Engineering and Environmental Engineering: Life Cycle Assessment &  
20 Ecological design of products and processes. To be admitted for enrollment in the different  
21 courses, the students must have completed a number of basic fundamental topics such as material  
22 and energy balances, process analysis and unit operations. Lectures and group problems are also  
23 teaching activities developed in the three courses. In the course of Project Design, lectures are  
24 dedicated to specific topics on conceptual design of design projects, including mass and energy

1 balances, but also equipment dimensioning, engineering ethics, financial planning and market  
2 study. Students can complete an in-class problem at the end of every lecture to immediately  
3 apply the concepts learned. The problems are primarily completed in teams that will also work  
4 together in the gamestorming activity. Regarding the Master courses, the fundamentals of Life  
5 Cycle & Ecodesign will be presented in a number of examples. Now, it follows a description of  
6 the methodological approach, including the analysis of student perception, based on four years of  
7 experience.

8 Among the different games, we selected an opening game named as "The Publication" (Staker,  
9 1997), where from a simple element such as adhesive notes, a set of ideas are obtained, classified  
10 and reorganized as function of the objectives sought. There are a number of requisites to be  
11 predefined: Common space (the classroom), Time restriction (to be defined in the different stages  
12 of the process, a maximum period of 2 h is recommended for the whole session) and Material  
13 (internet access, laptops and ordinary classroom materials: papers, colored markers and post-it®).

14 In this framework, this type of activity can be afforded within the context of a regular class.

15 Additionally, a number of informal rules are recommended to define the dynamics of the whole  
16 session to accomplish the different stages: One conversation at a time, Stay focused on the task,  
17 Encourage wild ideas, Go for quantity, Be visual, Defer judgment and Build on the ideas of  
18 others (Kelley and Littman, 2001).

### 19 *2.1. Statement of the problem (up to 10 min)*

20 The teacher defines the problem to be solved, establishing the characteristics of the  
21 product/process and the targets for improvement: efficiency, yield, environmental impact, etc.  
22 (Figure 1). Regardless we focus on product development or process design, the system is  
23 subdivided into its main characteristic subsystems and on which the different improvement  
24 strategies will be proposed.

1 With this methodology, the teacher changes the role as lecturer role by a supervisor role, with the  
2 objectives of managing the evolution of the learning process and guaranteeing that the  
3 interactions among students and students-instructor are productive. It is very important that all  
4 team members participate in the development of the bullet points as the proof of the potentiality  
5 of the team work.

6 When designing a session of gamestorming, a balance between creativity, reflection and decision  
7 making must be established. There is no standard protocol and depending on the work team, the  
8 instructor will have to define the session ad-hoc, handling the group features under the  
9 framework of gamestorming. Each team is a world, there are working groups that flow very fast  
10 and others that need more time for reflection.

11 **>Figure 1<**

12 *2.2. Brainstorming (30-45 min)*

13 Brainstorming is a tool for creative problem solving, wherein a group of people come together to  
14 contribute ideas spontaneously. It is particularly useful when one wants to break out of out-of-  
15 date patterns of thinking, so that new ways of looking at things are developed. When an  
16 interdisciplinary team aims to accomplish the same goal under diverse perspectives, the  
17 acceptance of the final solution is easier to achieve (Kelley and Littman, 2001).

18 The definition and presentation of ideas will be placed in a mural in the class. The steps to follow  
19 are:

- 20 a. Each student should write in a post-it® an idea about each stage/section after a reflection  
21 (in silence) of 5 min
- 22 b. The ideas are published, which gives name to the game: The Publication
- 23 c. The same procedure is repeated for each of the stages or sections in which the product or  
24 process is subdivided.





1 The proposed new "uses" to extend the life cycle of the product were developed from two  
2 perspectives:

- 3 a) Oriented to the implication of the consumer. Use the product as storage box of  
4 common materials in the home: sewing elements, tools, games, etc.
- 5 b) Oriented to take actions by the seller/retailer. The proposal of option (a) has a  
6 limit of reuse of the boxes by each individual consumer; so, in the medium term,  
7 the surplus number of boxes would turn into a waste. Therefore, it is necessary to  
8 consider options that assume the availability of the boxes in large quantity. The  
9 proposals were characterized by the use of the box as raw material for the  
10 manufacture of furniture (shelves) or use it directly as shelter of animals in nature  
11 due to its biodegradable features.

#### 12 *3.4. Decision making*

13 A priority was given to the various options for improvement, resulting in new products where the  
14 proposed prototypes should maintain the following guidelines:

- 15 (i) To develop multi-functionality, using the function of basic storage for chess pieces,  
16 socks, underwear, etc. or others such as a pot for home-grown agriculture or as an anthill.
- 17 (ii) Single material. Use the wood of a single tree species as the only constructive element  
18 (main body, cover and joints), which facilitates their final recycling.
- 19 (iii) Renewable. The concept of the "total" renewable product is pursued, by making use of  
20 only renewable material (wood) and renewable energy (the company should choose to  
21 install wind and solar energy systems in its facilities).

22 In all cases, the final ideas were compared with the prototypes that an eco-design team carried  
23 out for a timber enterprise (González-García et al., 2011), so that students can compare their  
24 proposal and evaluate them under the light of the real prototype (Figure 4).

1 >Figure 4<

2 **4.- Case study II: Process Design**

3 This case study was developed in one course of the Bachelor in Chemical Engineering (Project  
4 Design as mandatory subject).

5 *4.1. Statement of the problem*

6 Conventional end-of-the-pipe technologies for air pollution control are based on the transfer of  
7 pollutants from the gas stream to a solid or liquid phase through adsorption or absorption  
8 processes, followed by a chemical or biological oxidation of the target compounds (Estrada et  
9 al., 2011; Schlegelmilch et al., 2005). The challenge is the consideration of reliable alternatives  
10 for the mitigation of odour nuisance associated to the presence of certain pollutants.

11 *4.2. Brainstorming*

12 The students performed the evaluation of a range of technologies, specifically designed and  
13 applicable for the treatment of pollutants present in gaseous streams. For this purpose, the  
14 concepts developed in previous courses on mass and energy balances and unit operations would  
15 be the basis for the calculations for equipment sizing. In this case, the representation of the idea  
16 in the post-it® was modified to include a brief summary and description of the process. The  
17 proposed alternatives were the following: chemical scrubber, incineration, adsorption system  
18 with artificial (ie activated carbon) or natural packing support (ie tree bark), biofilter and  
19 biotrickling filter (Figure 5).

20 >Figure 5<

21 *4.3. Classification of ideas*

22 When assessing and determining the potential viability of the different strategies, the analysis  
23 mural was divided in 4 quadrants according to the following targets: application, efficiency, cost

1 and operational requirements (Table II). The valuation of each technology was qualitatively  
2 performed according to a traffic-lights code.

3 **>Table II<**

#### 4 *4.4. Decision making*

5 In this phase, the students investigated the technology that would allow guaranteeing the  
6 achievement of all the criteria defined in the previous stage. Assuming that there is no single  
7 technology that satisfies all the restrictions imposed, a first line of discussion was focused on the  
8 prioritization of the criteria and, therefore, skipping some requirements for the sake of  
9 practicality. In this way, they were able to proceed with the process design. A second line of  
10 discussion (which might be encouraged by the teacher, but not always necessary) is established  
11 when considering the possible integration of alternatives. In this stage, the advantages and  
12 disadvantages of each technology are confronted to select a process that accomplishes a balance  
13 of the requirements (Alfonsin et al., 2015).

14 The final choice depends on each class and the creativity in the combination of process units.  
15 Normally, they opt for a combination of biotechnological processes and physical-chemical ones,  
16 seeking maximum removal yield of the target pollutants at lower cost (Figure 6).

17 **>Figure 6<**

#### 18 **5.- Assessment of activity**

19 In order to analyze the results of the activity, a survey was developed to rank several items  
20 grouped in three blocks: (A) scope of the competences; (B) qualification of the activity and (C)  
21 overall satisfaction with the activity. A detailed analysis of the results obtained in the different  
22 blocks will be included in the subsequent sections, analyzing the survey responses from an item  
23 and a cohort perspective.

## 1 *5.1 Scope of the competences*

2 Table III shows the results for block A, where the students evaluate the achievement of various  
3 competences associated to the implementation of Gamestorming. The scores considered run from  
4 1 (strongly disagree) to 4 (strongly agree). As it can be seen in Table III, for all items, the highest  
5 proportions correspond to score 4.

### 6 **>Table III<**

7 An equality test for proportions has been run using function `prop.test` from statistical computing  
8 developed as R software (more details in [www.R-project.org](http://www.R-project.org)). The equality test for proportions  
9 of “strongly agree” for each item reveals a maintained trend, with no significant increasing or  
10 decreasing patterns. The high proportions for score 4 translates into average values higher than  
11 3.5 and mostly over 4, for all items and all years (Figure 7). It is worth highlighting the excellent  
12 working atmosphere in the classroom, as well as the identification of the students with the  
13 common challenge to propose actions to bring the product or process to the real world.

14 For each year, it has been also checked if all items were equally highly valued or if there were  
15 significant differences between them. This feature was observed for all the groups except for the  
16 2015 cohort. Specifically, it should be noted that the largest differences (comparing proportions  
17 of “strongly agree” by items) involve item 4 (the teamwork spirit has been strengthened), which  
18 usually gives the lowest (although high) rate.

### 19 **>Figure 7<**

## 20 *5.2 Qualification of the activity*

21 The second block corresponded to the self-evaluation of the activity by the students, defining the  
22 grade (between 1 and 4) that the class should have. This grade would represent 25% of the final  
23 grade of the subject. The evaluation criteria to be taken into account were: the development of the  
24 activity and the characteristics of the prototype. The concept of "development" implied

1 evaluating the performance of the class as a "unit" or "team", constructively supporting the search  
2 for the best solution. The evaluation of the final solution obtained after completing the  
3 gamestorming process consisted in comparing the "driving-force" ideas that its conceptual design  
4 had with the one that finally was put into practice.

5 The grades are in line with the assessments of the competencies analyzed in the first block of the  
6 survey (Table IV and Figure 8). There are no significant differences in the grades given by the  
7 different groups. Regardless of the students cohort considered, the activity allowed teamwork to  
8 be strengthened, and the comparison with the "real" prototypes promoted the positive  
9 endorsement of the professional capacities and competences of the students, which finally  
10 implied a very positive self-evaluation of the work done.

11 **>Table IV<**

12 **>Figure 8<**

### 13 *5.3 Overall satisfaction*

14 The last block of the survey contains a single item: "Indicate the degree of overall satisfaction  
15 with the activity", where students score between 1 (very unsatisfied) and 4 (very satisfied).  
16 Results are reported in Table V and Figure 9. The students clearly showed a remarkable  
17 satisfaction with the implementation of Gamestorming as part of the teaching activity of the  
18 subject, and this behavior has been maintained along the years, with no significant differences.  
19 As a global result, 23% of the students were "somewhat satisfied" and 70% "very satisfied",  
20 being this pattern observed for all the years (Figures 9 and 10).

21 **>Table V<**

22 **>Figure 9<**

23 **>Figure 10<**

## 6.- Conclusions

Gamestorming can be a working methodology for several reasons: easy to implement, team oriented, inspire commitment and encourage creativity. This teaching methodology emphasizes free discussion and expressions of student opinions, with minimal teacher-centered information.

The major goals of the Gamestorming activity are the development of critical thinking and creative problem-solving skills, reinforcement of the students' self-confidence and teamwork in pursuit of a common goal.

Moreover, the nature and quality of interactions between the students and the professor and among the students had a positive effect on the quality of learning and the motivation and attitudes of students toward the course. The students' perception considered this methodology as a mechanism to foster their creativity in the progress of teamwork toward decision making process.

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21

1       **Caption to Figures.**

2       **Figure 1.** Definition of the framework for a "new" product or process.

3       **Figure 2.** Classification of the options of improvement in driving force ideas or lines of action.

4       **Figure 3.** Stage of brainstorming: reflection and publication

5       **Figure 4.** Comparison between the actual prototypes considered by the company and those  
6       defined by the class in the case study of a wine storage box.

7       **Figure 5.** Selection of the technologies for the abatement of pollutants from gaseous streams.

8       **Figure 6.** Combined approach of technologies for the abatement of pollutants from gaseous  
9       streams.

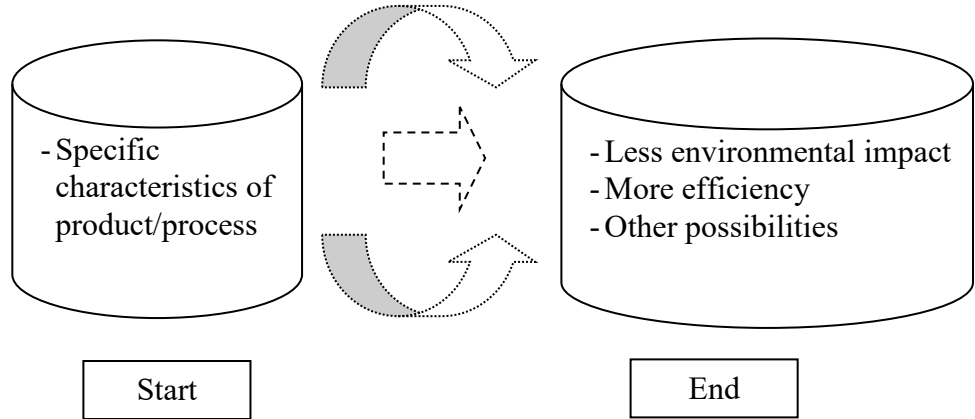
10      **Figure 7.** Results for block A: scope of competences. Bar plots for each item and year with the  
11      following legend: strongly disagree in yellow, disagree in red, agree in green and strongly agree  
12      in blue. Line plot for average trends, from 2013 to 2016. Note that axis has been reduced to 3-4.

13      **Figure 8.** Results for block B: qualification of the activity. Bar plots for each item and year with  
14      the following legend: strongly disagree in yellow, disagree in red, agree in green and strongly  
15      agree in blue.

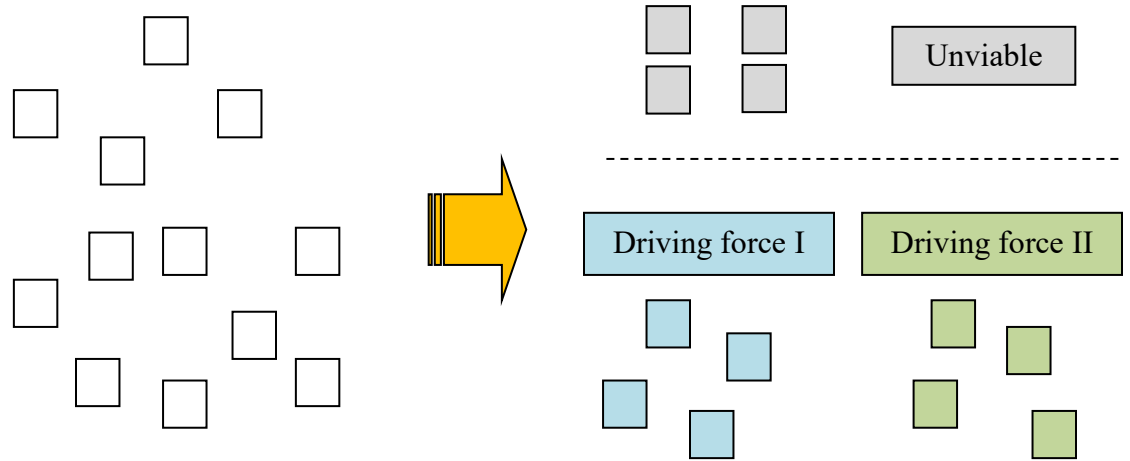
16      **Figure 9.** Results for block C: overall satisfaction with the activity. Bar plots for each item and  
17      year with the following legend: strongly disagree in yellow, disagree in red, agree in green and  
18      strongly agree in blue.

19      **Figure 10.** Trend lines for average values ( $\pm$  standard deviation) for block B (qualification of the  
20      activity, red) and block C (global satisfaction, blue).

21



**Figure 1**

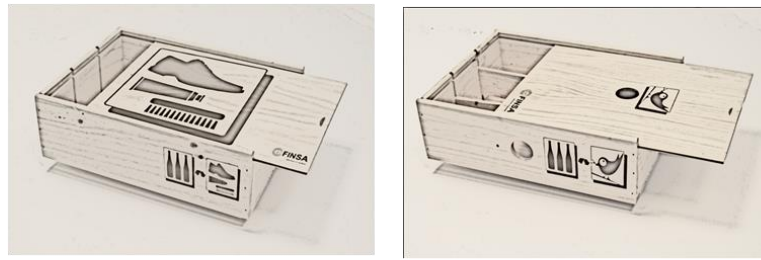


**Figure 2**

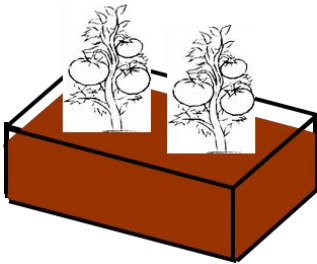


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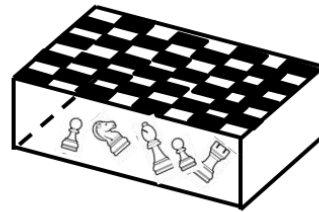
**PROTOTYPES CONSIDERED BY THE COMPANY**



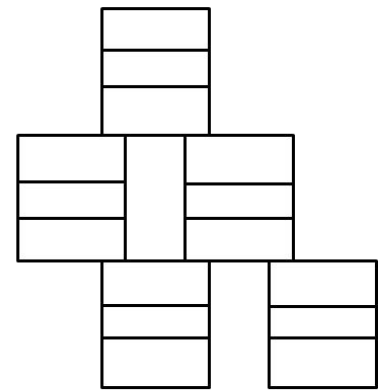
**PROTOTYPES PROPOSED BY STUDENTS**



**FLOWER POT**



**CHESS**



**SHELVES**

**Figure 4**

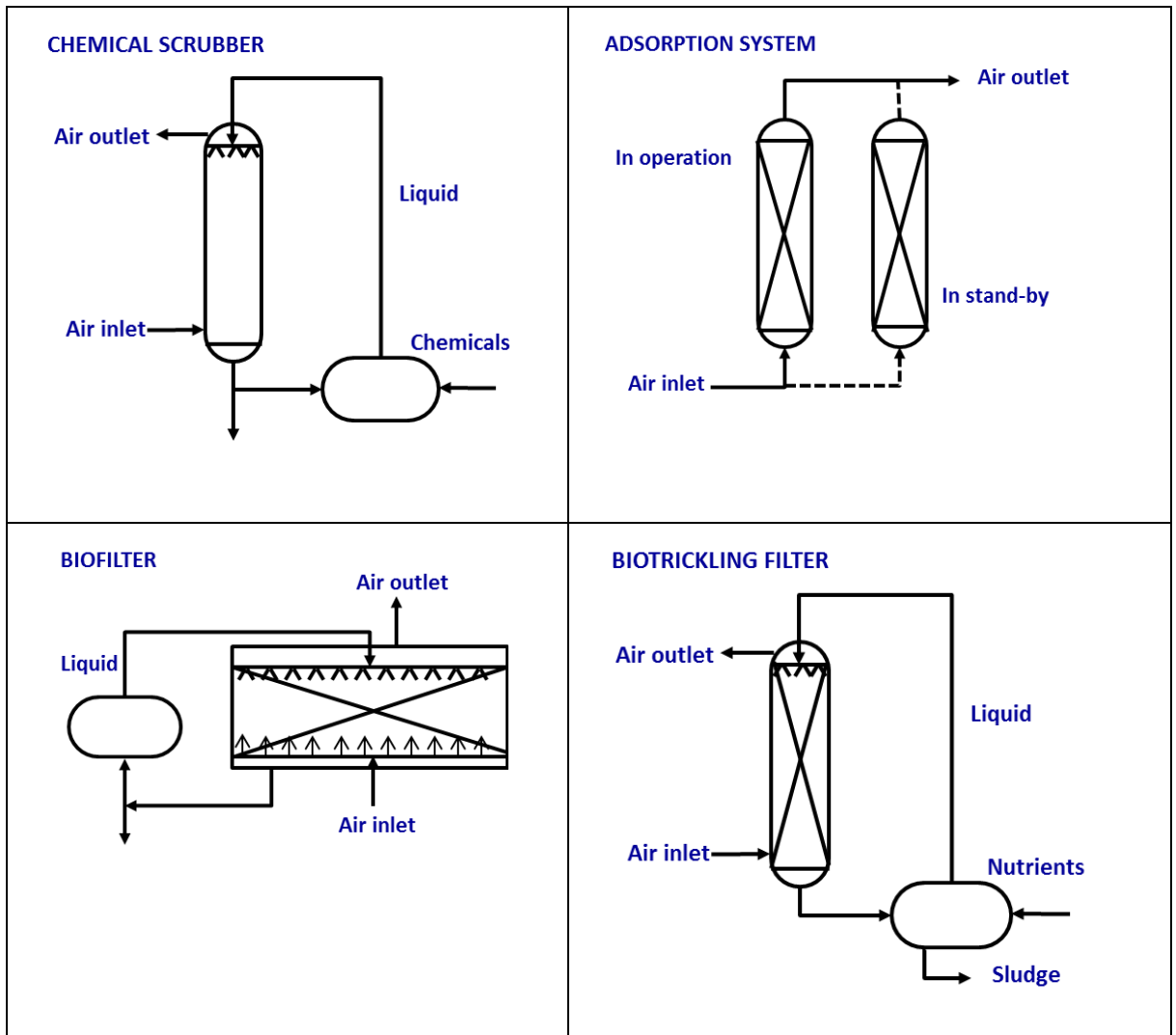


Figure 5

ADSORPTION SYSTEM

BIOTRICKLING FILTER

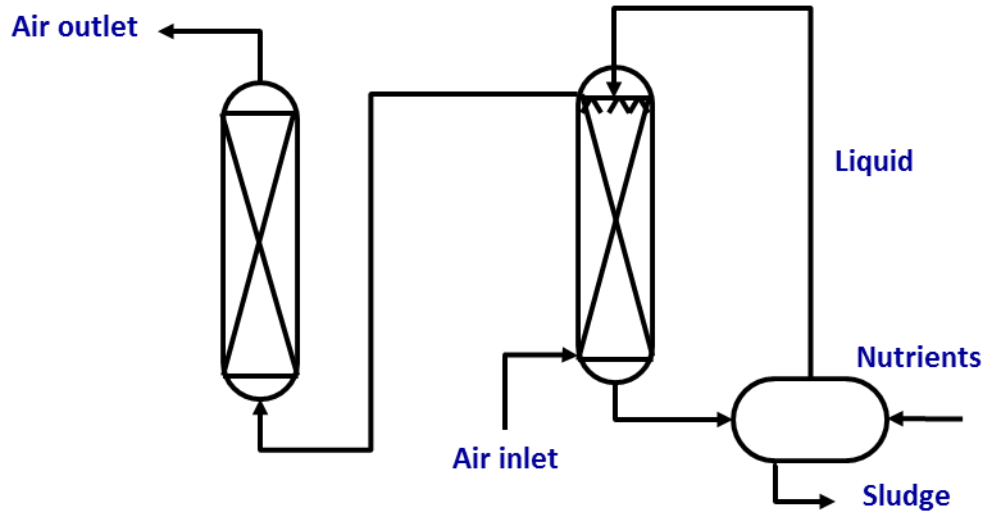
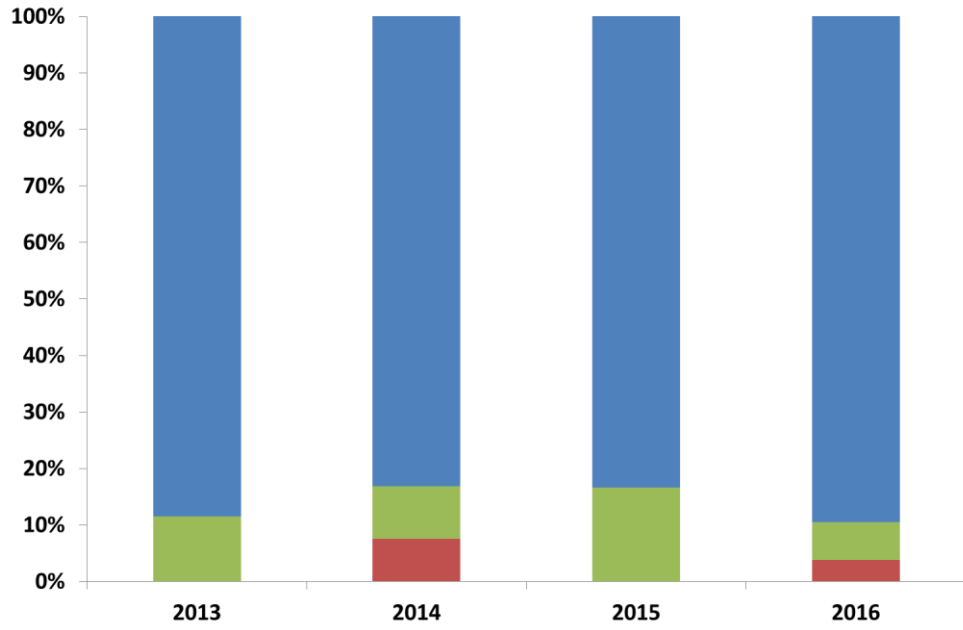


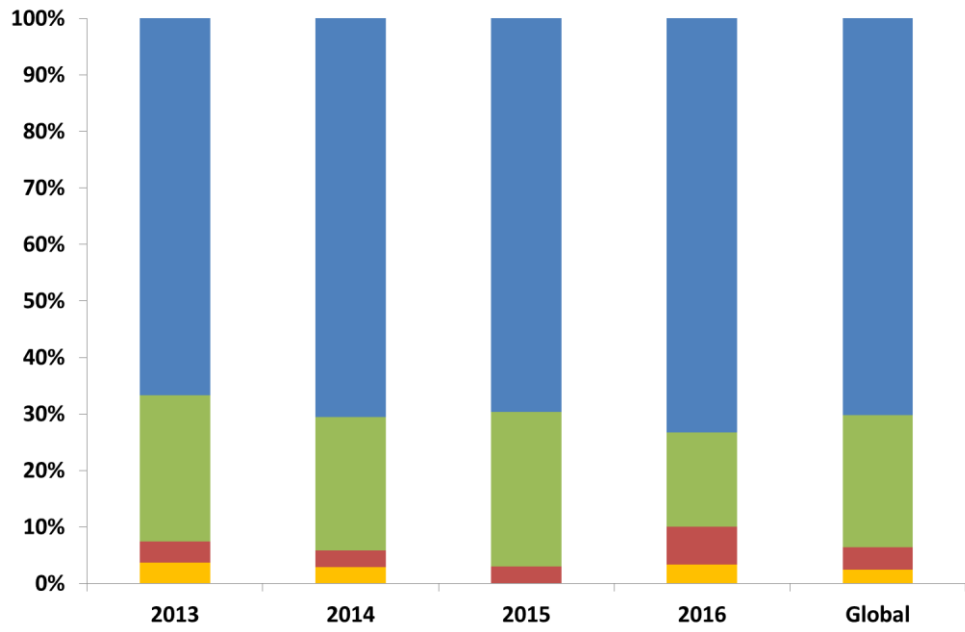
Figure 6



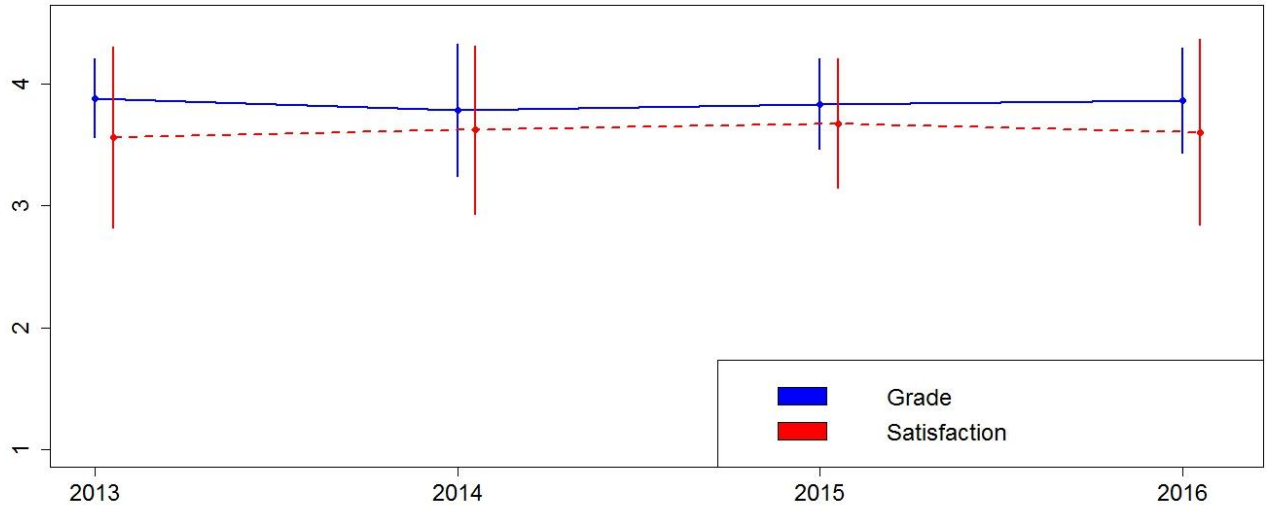
Figure 7



**Figure 8**



**Figure 9**



**Figure 10**

**Table I.** Main driving force ideas derived from the phase of brainstorming and subsequent analysis for the wood box.

<b>Concept</b>	<b>Materials</b>	<b>Production</b>	<b>Distribution</b>	<b>End of life</b>
Multi-functionality from a seller/retail perspective	Reduce	Reduction of process steps	IKEA model: "detachable"	Enhancing energy recovery
Minimalist design	Change	Renewable energy	Packing material	Extend the end of life with other uses: related to concept
	Remove		Green logistics	

**Table II.** Classification of the different process diagrams according to selected criteria

<p><b>1. Applicability</b>  Range of applicability, considering both the type of the pollutants (more or less recalcitrant) and their concentration in the gas stream:</p> <ul style="list-style-type: none"> <li>●: wide range of compounds and concentrations (VI+)</li> <li>●: limited range of compounds or concentrations (VI)</li> <li>●: limited range of compounds and concentrations (IV)</li> </ul>	<p><b>2. Efficiency</b>  Operation versatility that fulfills diverse regulatory standards:</p> <ul style="list-style-type: none"> <li>●: The efficiency removal can be extrapolated to other conditions beyond those representative of the system (VI+)</li> <li>●: Meets the efficiency removal required by current legislation (VI)</li> <li>●: Does not achieve the required efficiency removal (IV)</li> </ul>
<p><b>3. Cost</b>  Estimation of costs for infrastructure and operation:</p> <ul style="list-style-type: none"> <li>●: Affordable cost of equipment and operation (VI+)</li> <li>●: High cost of equipment or operation (VI)</li> <li>●: Very high cost of equipment and operation (IV)</li> </ul>	<p><b>4. Operational requirements</b>  Reduced chemicals and energy consumption:</p> <ul style="list-style-type: none"> <li>●: No need for chemicals or limited energy consumption (VI+)</li> <li>●: Requirement of chemicals or high energy consumption (VI)</li> <li>●: Large consumption of chemicals and energy (IV)</li> </ul>

**Table III.** Evaluation of the skills developed in the Gamestorming activity.

A. On the scope of competences	Year	Total (NR/NK)*	Strongly disagree	Disagree	Agree	Strongly agree	Average (StD)**
The objective of the activity has been clearly defined.	2013	29	0.00%	6.90%	13.79%	79.31%	3.72 (0.58)
	2014	35	0.00%	2.86%	11.43%	85.71%	3.83 (0.45)
	2015	35	0.00%	0.00%	11.76%	88.24%	3.88 (0.32)
	2016	31 (1)	0.00%	0.00%	10.00%	90.00%	3.90 (0.30)
You have felt involved in the activity.	2013	29 (2)	0.00%	0.00%	3.70%	96.30%	3.96 (0.19)
	2014	35 (1)	2.94%	2.94%	5.88%	88.24%	3.79 (0.63)
	2015	34 (1)	0.00%	3.03%	9.09%	87.88%	3.85 (0.43)
	2016	31 (1)	0.00%	0.00%	6.67%	93.33%	3.93 (0.25)
You have detected that the class has acted as a team.	2013	29 (2)	3.70%	0.00%	14.81%	81.48%	3.74 (0.64)
	2014	35 (1)	0.00%	8.82%	11.76%	79.41%	3.71 (0.62)
	2015	34 (0)	0.00%	2.94%	8.82%	88.24%	3.85 (0.43)
	2016	31 (1)	0.00%	6.67%	23.33%	70.00%	3.63 (0.60)
The teamwork spirit has been strengthened	2013	29 (1)	3.57%	3.57%	28.57%	64.29%	3.54 (0.73)
	2014	35 (0)	0.00%	5.71%	17.14%	77.14%	3.71 (0.56)
	2015	34 (1)	0.00%	9.09%	15.15%	75.76%	3.67 (0.64)
	2016	31 (1)	0.00%	10.00%	33.33%	56.67%	3.47 (0.67)
The activity is related to the content and competences of the course.	2013	29 (0)	0.00%	0.00%	0.00%	100.00%	4.00 (0.00)
	2014	35 (0)	0.00%	0.00%	5.71%	94.29%	3.94 (0.23)
	2015	34 (0)	0.00%	0.00%	8.82%	91.18%	3.91 (0.28)
	2016	31 (1)	0.00%	0.00%	3.33%	96.67%	3.97 (0.18)
The activity encourages the development of creativity.	2013	29 (0)	0.00%	0.00%	10.34%	89.66%	3.90 (0.30)
	2014	35 (1)	0.00%	0.00%	2.94%	97.06%	3.97 (0.17)
	2015	34 (0)	0.00%	0.00%	5.88%	94.12%	3.94 (0.24)
	2016	31 (1)	0.00%	0.00%	6.67%	93.33%	3.93 (0.25)
Critical analysis has been strengthened.	2013	29 (0)	0.00%	6.90%	10.34%	82.76%	3.76 (0.57)
	2014	35 (1)	0.00%	0.00%	2.94%	97.06%	3.97 (0.17)
	2015	34 (2)	0.00%	0.00%	12.50%	87.50%	3.88 (0.33)
	2016	31 (1)	3.33%	3.33%	13.33%	80.00%	3.70 (0.69)

\*NR/DK: No Response/Don't Know

\*\*StD: Standard deviation

**Table IV.** Marks from the self-evaluation of the activity by the students

<b>B. Grading of the activity</b>	<b>Year</b>	<b>Total (NR/DK)*</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Average (StD)**</b>
Rate the grade that the class deserves considering the development of the activity and the proposal of the prototype	2013	29 (3)	0.00%	6.90%	13.79%	79.31%	3.72 (0.32)
	2014	35 (3)	0.00%	2.86%	11.43%	85.71%	3.83 (0.54)
	2015	34 (4)	0.00%	0.00%	11.76%	88.24%	3.88 (0.37)
	2016	31 (2)	0.00%	0.00%	10.00%	90.00%	3.90 (0.43)

\*NR/DK: No Response/Don't Know

\*\*StD: Standard deviation

**Table V.** Overview of global satisfaction by the students

<b>C. Overall satisfaction</b>	<b>Year</b>	<b>Total (NR/DK)*</b>	<b>Very unsatisfied</b>	<b>Somewhat unsatisfied</b>	<b>Somewhat satisfied</b>	<b>Very satisfied</b>	<b>Average (StD)**</b>
Global satisfaction	2013	29 (2)	3.70%	3.70%	25.93%	66.67%	3.56 (0.74)
	2014	35 (1)	2.94%	2.94%	23.53%	70.59%	3.62 (0.69)
	2015	34 (1)	0.00%	3.03%	27.27%	69.70%	3.67 (0.53)
	2016	31 (1)	3.33%	6.67%	16.67%	73.33%	3.60 (0.76)
	Global	129 (5)	2.42%	4.03%	23.39%	70.16%	3.61 (0.68)

\*NR/DK: No Response/Don't Know

\*\*StD: Standard deviation