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THE USE OF RUBRICS TO EVALUATE THE CONSTRUCTION OF SCALE MODELS IN THE UNIVERSITY TEACHING OF INDUSTRIAL DESIGN

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Abstract

The use of rubrics can be beneficial in guiding students through the learning process. Well-designed, the rubrics are versatile tools that make it possible to evaluate both individual work and teamwork, while promoting self-learning. This paper presents a set of rubrics designed for the subject 'Model making workshop' of the Bachelor's Degree in Industrial Design and Product Development Engineering. The subject aims on the one hand that students understand the importance of models as vehicles for presenting ideas about new products, and secondly, to acquire the skills needed to build them properly. The intention when applying the rubrics is twofold: on the one hand, it is intended that students acquire skills to objectively assess their work and that of others, and on the other, offer clear criteria that serve as a guide for the correct development of various models, setting some specific objectives in each case, such as knowing how to work the different materials and the formal design concepts inherent in each work. The rubrics have been applied during the current academic year and the results are commented.

Keywords: Industrial design, rubrics, self-evaluation, model making.

1 INTRODUCTION

The compulsory subject 'Model making workshop' is taught in the second year of the Bachelor's Degree in Industrial Design and Product Development Engineering. The subject aims on the one hand that students understand the importance of scale models as vehicles for the presentation of ideas about new products, and on the other hand, that acquire the necessary skills to build them correctly. Different aspects of the subject were improved over the past years [1] [2] [3] [4], but for several courses we have detected that students still have problems in understanding the correct way to work with different materials, what are the objectives of the models in each case and how to assess that the necessary skills have been achieved to develop them. We detect, therefore, that students lack a guide that helps them to know what specific aspects should be taken into account to correctly develop the work.

The use of rubrics can be beneficial to guide the students during the learning process. Well designed, the rubrics represent versatile tools that allow to evaluate teamwork [5] as well as to favor self-learning [6] or to evaluate the work carried out in a non-face-to-face way [7].

This paper presents the design of a series of rubrics for the subject 'Model making workshop'. The intention is to offer clear criteria that guide students towards the correct development of various exercises, setting specific objectives in each case, such as knowing the correct way to work the different materials and the formal design concepts inherent to each exercise. The use of rubrics was previously introduced in the subject 'Product design prototyping workshop', obtaining positive results [8]. Due to its development and similar contents, it is believed that the application of other similar rubrics adapted to this subject can also be beneficial.

2 EXERCISES DEVELOPED DURING THE COURSE

The exercises to be developed by the students were the following:

2.1 Exercise 0: Introduction to techniques

Emulate the shape, scale, proportions and disposition of the elements that make up each of the 4 reference models available in the classroom. It involves taking metric data from the pieces of each reference model and constructing an equivalent one with corrugated cardboard, plastic, wood and metal, depending on the case.

2.2 Exercise 1: The plane as shape configurator

1A. Design and build a three-set furniture for the habitat through direct experimentation with cardboard through folding, cuts and incisions. From these experiences, design and shape a product of domestic furniture with a thin sheet of aluminum.

1B. Design and build a monochrome hat from the plane as a structuring element. The object must be conceived from an architectural composition with geometric shapes by means of enveloping or crisscrossed planes. The surface can be intervened by incisions, folds, grooves or perforations. It is essential that it has certain symmetry and that it be stable in the head. Material: poster board.

2.3 Exercise 2: The line as shape configurator

2A. Design and construct an object related to furniture or lighting for the domestic habitat or for public spaces. Imagine new design alternatives using straight, curved or zigzag rods that are articulated in space by fixed or mobile connections, knots, interlacing or intersections. Geometric resources of seriation, symmetries or intersections can be used to generate visual sensations depending on the determined object. Material: wooden or metal rods.

2B. Interpretation of the volume of any animate or inanimate object through the line as a means of formal definition. The line can be structured geometrically using meshes. The interpretation must result in an object that is recognizable even if it does not have an enveloping surface. Material: wire.

2.4 Exercise 3: Geometric volumes, composition and design

Design and construct an object related to furniture or lighting for the domestic habitat or for public spaces whose general form is composed of strictly geometric volumes. It is a question of combining geometric three-dimensional shapes in a balanced way without necessarily resorting to symmetry, although to harmony and stable compositional structure. Materials: wood, plastic and metal.

2.5 Exercise 4: Multi-purpose furniture

Develop a product design related to furniture or lighting that combines two or more different functions. Consider the double or triple functionality of the same object without losing formal coherence, through three different modes of expression: through integration, through transformation or articulation, or through a change of position.

2.6 Exercise 5: Polyhedral volumetric model: synthesis of an object

Starting from the analysis of the volume and general structure of a human head, model a universal head schematizing the volumetric shape by planes and edges, always considering the axial symmetry of the head. Material: play-dough.

2.7 Exercise 6: Organic volumetric model: child seat

Design a child's seat in one piece based on the volumetric concept of organic surfaces. Material: polyurethane foam.

2.8 Exercise 7: Synthetic volumetric model: mascot

Design a three-dimensional mascot that represents the image of an event or the brand of a specific product. Material: play-dough.

3 RUBRIC TO ASSESS THE CORRECT WAY OF WORKING THE DIFFERENT MATERIALS USED IN THE EXERCISES

A total of seven rubrics were designed, some of them common to different exercises, in order to offer an objective tool to the students to assess the way of working the materials:

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|----------------------|--|---|---|--|---|---|--|---|--|---|----|
| Cutting | The cut is quite inaccurate | | | The cut is somewhat inaccurate | | | The cut is fairly accurate | | The cut is very accurate | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Bending | Many edges are bent inaccurately and you can see wrinkles clearly | | | Some edges are bent somewhat inaccurately and there are wrinkles | | | The edges are bent in a fairly accurate way and there are almost no wrinkles | | The edges are bent very precisely and there are no wrinkles. | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Adhesive application | The adhesive overflows and is clearly seen in many places, and has become detached from others | | | The adhesive overflows at some points, but it keeps the model attached | | | The adhesive barely overflows at any point, and keeps the model well attached and stable | | The adhesive does not overflow at any point, and keeps the model very well attached and stable | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Cleanliness | There are at a glance many stains on the material and pencil lines or similar | | | There are at a glance some stains or lines of pencil in the material | | | There are a few small stains or line of pencil, although they are difficult to see | | There is no stain or pencil mark on the material | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 1. Rubric to assess different aspects of cardboard or poster board.

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|----------------------------------|--|---|---|--|---|---|--|---|--|---|----|
| Shape precision and finish | The shape is quite inaccurate, the measurements fail and is not filed at the edges | | | The shape is somewhat imprecise and at some point is not well filed | | | The shape is fairly accurate, and the terminations are correctly filed | | The shape is very accurate, and the finishes are perfectly filed | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Bending | Many pieces or rods are bent inaccurately | | | Some pieces or rods are bent somewhat inaccurately | | | Some pieces or rods are bent somewhat accurately | | Some pieces or rods are bent very inaccurately | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Welding or bonding with adhesive | In many joints the solder or the adhesive overflows and is excessive | | | In some joints the solder or the adhesive overflows | | | The solder or adhesive barely overflows at some point | | The welding does not overflow at all and keeps the pieces very well joined | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Cleanliness | There are at a glance many stains on the material and pencil lines or similar | | | There are at a glance some stains or lines of pencil in the material | | | There are a few small stains or line of pencil, although they are difficult to see | | There is no stain or pencil mark on the material | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 2. Rubric to assess different aspects of metal work.

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|---------------|--|---|---|--|---|---|--|---|--|---|----|
| Cutting | The cut is quite inaccurate | | | The cut is somewhat inaccurate | | | The cut is fairly accurate | | The cut is very accurate | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Adhesive | The adhesive overflows and is clearly seen in many places, and has become detached from others | | | The adhesive overflows at some points, but it keeps the model attached | | | The adhesive barely overflows at any point, and keeps the model well attached and stable | | The adhesive does not overflow at any point, and keeps the model very well attached and stable | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Cleanliness | There are at a glance many stains on the material and pencil lines or similar | | | There are at a glance some stains or lines of pencil in the material | | | There are a few small stains or line of pencil, although they are difficult to see | | There is no stain or pencil mark on the material | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 3. Rubric to assess different aspects of wood work.

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | | |
|----------------------|--|---|---|--|---|---|--|--|--|--|----|----|
| PLASTIC | Cutting | Cuts and sanding are quite inaccurate. | | | Cuts and sanding are somewhat inaccurate. | | | Cuts and sanding are fairly accurate. | | Cuts and sanding are very accurate. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Bent and curved | The bending is very misshapen and imperfect | | | The bending is somewhat inaccurate | | | The bending is fairly accurate and homogeneous | | The bending is very accurate and homogeneous | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Adhesive application | The adhesive overflows and is clearly seen in many places, and has become detached from others | | | The adhesive overflows at some points, but it keeps the model attached | | | The adhesive barely overflows at any point, and keeps the model well attached and stable | | The adhesive does not overflow at any point, and keeps the model very well attached and stable | | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Cleanliness | There are at a glance many stains on the material and pencil lines or similar | | | There are at a glance some stains or lines of pencil in the material | | | There are a few small stains or line of pencil, although they are difficult to see | | There is no stain or pencil mark on the material | | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

Figure 4. Rubric to assess different aspects of plastic work.

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | | |
|---------------|---|---|---|---|---|---|---|---|--------------------------------|--|----|----|
| PLAY DOUGH | Surface finish | Surfaces have many obvious unevenness | | | Surfaces have some obvious unevenness | | | The surfaces present some slight unevenness | | The surfaces do not present any unevenness | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Edges and corners | Many edges and corners are damaged or are very inaccurate | | | Some edges and corners are damaged or are somewhat inaccurate | | | Many edges and corners are in good condition and are quite accurate | | All or almost all the edges and corners are in very good condition and are very accurate | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Cleanliness | There is a lot of dirt on the whole surface of the play dough | | | There dirt on the surface of the play dough | | | The surface presents some dirt, but it is difficult to see. | | No dirt on the surface | | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |

Figure 5. Rubric to assess different aspects of play dough work.

| Criteria ▼ | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | | |
|---------------|---------------------------------|------------------------------------|---|----------------------------|------------------------------------|---|----------------------------|---|--------------------------------|--|---|----|
| POLYURETHANE | Surface finish | The surface has many imperfections | | | The surface has some imperfections | | | The surface is fairly homogeneous and continuous, although it can be improved | | The surface is totally homogeneous and continuous, and very smooth | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 6. Rubric to assess the handling and working of polyurethane foam.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|---------------|----------------|--|---|---|--|---|---|---|---|---|---|----|
| PAINT | Painted finish | The finish of the piece is quite inaccurate, and has many flaws in the painting or the combination of colors is not right. | | | The finish of the piece is somewhat imprecise, and has flaws in the paint or the combination of colors is not right. | | | The finish of the piece is fairly accurate, and is painted well with an appropriate combination of colors | | The finish of the piece is very precise, and is very well painted and coordinated in colors | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 7. Rubric to assess the paint application on the models.

4 RUBRICS TO ASSESS FORMAL DESIGN CONCEPTS IN EACH EXERCISE

In some exercises, in addition to assessing the use of the corresponding material, it was necessary for students to apply certain formal design concepts to their work. Below are the rubrics designed to assess these concepts:

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|---------------|---------------------------------|---|---|---|--|---|---|---|---|---|---|----|
| DESIGN | Functional and ergonomic design | The model is too big or too small for a human head, and it does not fit or go very loose | | | The model is too tight or too loose | | | The model fits moderately well, but fits something tight or something loose | | The model fits very well to a human head, does not fall and does not tighten | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| DESIGN | Use of the plane | Uses very little variety of enveloping, crisscrossed, serialized, or traversed planes, and/or are poorly combined | | | Use a small variety of planes and in an unbalanced or little harmonic way, poorly combined | | | Use some enveloping, crisscrossed, serialized or crossed planes, in a reasonably balanced or harmonic way, combined in an acceptable way. | | Use a variety of enveloping, crisscrossed, serialized or crossed planes, in a well-balanced or harmonious way, very well combined in a suitable and very attractive composition | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 8. Rubric to assess formal concepts of design of exercise 1B.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|---------------|---------------------------------|---|---|---|---|---|---|---|---|---|---|----|
| DESIGN | Functional and ergonomic design | The model is not functional at all, and its life-size version would not be ergonomic at all. | | | The model is not very functional, and its full-size version would present some ergonomic defects | | | The model is functional, and its full-size version would work quite well at the ergonomic level. | | The model is very functional, and its full-size version would work perfectly at the ergonomic level. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| DESIGN | Use of the line | The use of the line in the work is not recognized, and it does not use lines that intersect or move parallel to generate planes | | | The use of the line at work is barely recognized, and it barely uses lines that intersect or move parallel to generate planes | | | The use of the line in the work is recognized and uses lines that intersect or move parallel to generate planes | | The use of the line at work is recognized successfully, and uses lines that intersect or move parallel to generate planes, creating an attractive design. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 9. Rubric to assess formal concepts of design of exercise 2A.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|------------|-----------------------|--|---|---|--|---|---|---|---|---|---|----|
| DESIGN | Object representation | The structure is quite inaccurate and does not maintain proportions with the photographed object represented | | | The structure is somewhat inaccurate, and represents little the outer surface of the photographed object | | | The structure is moderately accurate and represents acceptably the outer surface of the photographed object | | The object is perfectly recognized, and its structure perfectly represents the outer surface of the photographed object | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| DESIGN | Use of the line | The line does not outline the volume of the object in the air | | | The line barely outlines the volume of the object in the air | | | The line outlines the volume of the object in the air | | The line outlines very well the volume of the object in the air | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 10. Rubric to assess formal concepts of design of exercise 2B.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|------------|---------------------------------|---|---|---|---|---|---|---|---|---|---|----|
| DESIGN | Functional and ergonomic design | The model is not functional at all, and its life-size version would not be ergonomic at all. | | | The model is not very functional, and its full-size version would present some ergonomic defects | | | The model is functional, and its full-size version would work quite well at the ergonomic level. | | The model is very functional, and its full-size version would work perfectly at the ergonomic level. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| DESIGN | Use of geometric volumes | The use of basic geometric volumes is not recognized and does not use these volumes in a balanced or harmonic way | | | Few recognizable basic geometric volumes are used, and although these volumes are used in a balanced or harmonic way, they are not well combined. | | | The use of basic geometric volumes is successful, and uses these volumes in a balanced and harmonious way in a suitable composition | | The use of basic geometric volumes is very successful, and uses these volumes in a very balanced and harmonious way in a suitable and very attractive composition | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 11. Rubric to assess formal concepts of design of exercise 3.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|------------|--------------------------|--|---|---|--|---|---|--|---|--|---|----|
| DESIGN | Ergonomic design | The life-size version would not be ergonomic at all. | | | The full-size version would present some ergonomic defects | | | The full-size version would work quite well at the ergonomic level. | | The full-size version would work perfectly at the ergonomic level. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| DESIGN | Double function approach | The double function does not make sense, or is not suitable for this type of furniture | | | The double function makes some sense, but is not suitable for this type of furniture | | | The double function makes quite sense, and is somewhat useful for this type of furniture | | The double function makes a lot of sense and is very useful for this type of furniture | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 12. Rubric to assess formal concepts of design of exercise 4.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|------------|---------------------------------|--|---|---|--|---|---|--|---|--|---|----|
| DESIGN | Functional and ergonomic design | The model is not functional at all, and its life-size version would not be ergonomic at all. | | | The model is not very functional, and its full-size version would present some ergonomic defects | | | The model is functional, and its full-size version would work quite well at the ergonomic level. | | The model is very functional, and its full-size version would work perfectly at the ergonomic level. | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 13. Rubric to assess formal concepts of design of exercise 6.

| Criteria ▼ | | VERY POOR (0, 1 or 2 points) | | | POOR (3, 4 or 5 points) | | | AVERAGE (6 or 7 points) | | CORRECT (8, 9 or 10 points) | | |
|---------------|---------------|---|---|---|--|---|---|---|---|---|---|----|
| DESIGN | Formal design | The mascot has a non-coherent shape, and is very badly related to the brand or event it represents and its target | | | The mascot has a somewhat coherent shape, but is poorly related to the brand or event it represents and its target | | | The mascot has a coherent shape, and is somewhat related to the brand or event it represents and its target | | The mascot has a very coherent shape, and is very well related to the brand or event it represents and its target | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Figure 14. Rubric to assess formal concepts of design of exercise 7.

5 RESULTS

All the rubrics were applied during the course to assess the different exercises proposed in the subject. The students used them to self-assess their work, obtaining a final mark in each exercise. Later, the teachers also assessed the works using the same criteria established in the rubrics. It was possible to confirm that the mark obtained in both cases applying the same rubrics were very similar, from which it is possible to conclude that both the students and the teachers agreed when interpreting the ratings of each rubric.

6 CONCLUSIONS

The rubrics presented in this paper have been effective and could be applied in similar subjects related to industrial design. Rubrics have helped students know how they are developing their learning and know what aspects have to keep improving in each case. In addition, it is possible to deduce that students acquired skills to objectively assess their work and that of others, given that their assessments coincided quite closely with those of the teachers.

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REFERENCES

- [1] S. Martín Martín, F. Felip Miralles, J.L. Navarro Lizandra, "Web 2.0 tools for technical teaching of industrial design. The blog as a resource for learning, critical thinking and dissemination of results", *ICERI2012 Proceedings*, pp. 3628-3635, 2012.
- [2] F. Felip Miralles, S. Martín Martín, J.L. Navarro Lizandra, "Recursos de la web 2.0 para la mejora del razonamiento crítico y la difusión de proyectos en la enseñanza universitaria del diseño industrial", *International Conference on Innovation, Documentation and Teaching Technologies*, pp. 365-370, 2013.
- [3] S. Martín Martín, M.L. García Martínez, J.L. Navarro Lizandra, F. Felip Miralles, "Modelmaking in university learning of industrial design. Changes in teaching methodologies to improve students' handling skills using tools and materials", *EDULEARN13 Proceedings*, pp. 177-183, 2013.
- [4] S. Martín Martín, M.L. García Martínez, J.L. Navarro Lizandra, F. Felip Miralles, "Using collaborative tools for improving the academic performance in the degree in industrial design and product development", *EDULEARN13 Proceedings*, pp. 218-223, 2013.
- [5] N. Castilla, J. D. Segrelles, A. Martinez, "Assessment of teamwork competence through an evaluation rubric", *EDULEARN16 Proceedings*, pp. 4939-4945, 2016.
- [6] M.E. Arce-Fariña, J.L. Miguez, E. Granada, C. Miguez-Alvarez, "Tools for self-directed learning: learning pills and rubric", *ICERI2013 Proceedings*, pp. 6817-6822, 2013.
- [7] R. Soler, J. Cano, "A proposal for a rubric for the assessment of online learning through virtual forums in universities", *EDULEARN11 Proceedings*, pp. 6170-6177, 2011.

- [8] F. Felip, J.L. Navarro, S. Martín, M.L. García, "Adaptation of the subject 'Product design prototyping workshop' to the European Higher Education Area. Analysis, evaluation and discussion of new approaches", *INTED2014 Proceedings*, pp. 6672-6681, 2014.