

# Development and implantation of a Thesaurus of Manufacturing Engineering terms

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## ABSTRACT

Present work shows the teaching-learning experience developed in the Department of Manufacturing Engineering of the University of Malaga. This experience is based on the need to generate a specific glossary of manufacturing engineering terms to be used as a study guide by the students. Eventually, it was decided to make a Thesaurus that would be aimed at a teaching activity. Also, it would take part in the educational innovation project PIE 13-025 of the University of Malaga, within the biennium 2013/2015. The first step consisted of the design of Thesaurus pattern, taking into account the kind of information that it was necessary include in it. Afterward, this pattern would be place on the *Virtual Campus* and the student would have to complete the information required. Finally, the results obtained in the different applications of this activity would be analyzed and evaluated.

**Keywords:** Thesaurus; Technical terms; Manufacturing Engineering; Teaching

## 1. Introduction

One of the most important supports in the current educational system in Spain, the European Higher Education Area (EHEA), are the information and communications technologies (ICT) [1-3] which provide the necessary platform to develop many of the different teaching-learning activities considered in the subjects guidelines. Likewise, these ICT's are strengthened thanks to the availability of the *Virtual Campus*, a space where teachers can organize and develop their subjects by using of many varied activities. This whole situation makes much easier the interaction between students and teacher and, in the end, an improved academic performance.

In this context, the Department of Manufacturing Engineering of the University of Malaga (UMA) conceived an activity based on the generation on a wide and completed glossary of technical terms related to the manufacturing engineering. This decision was based on the difficulty that students manifested in their learning processes because of the large number of specific terms and the lack of a detailed meaning about them. In the future, this useful database would take part of the documentary sources provided students. Also, this activity would be integrated in the Innovate Educational Project PIE 13-025 of the University of Malaga: "Strategies for promoting the use of ICT tools by means of Virtual Campus in the Manufacturing Engineering subjects in the UMA and Andalusia Tech" [4].

## 2. Design and Implantation

### 2.1 Design

Once the different possibilities were studied the group decided the realization of a *Thesaurus* [5-7]. Because of the fact that Virtual Campus did not have so specific activity it would be necessary design a structure, thinking of the kind of information we considered relevant about the diverse denominations. After a period of work, a zero version of the thesaurus structure was presented and approved by the group. In the next step, it should be chosen the subject that would be put into practice. Eventually, due the possibilities offered, the subject *Manufacturing Engineering* (also called *Manufacturing Technologies* in one degree) was selected, Table 1. This subject is strongly technological and is taught in the second course, aimed at students from many different degrees. In this way, the potential universe of application was wide enough, with 700 estimated students involved in each year (1400 in total), 12 groups of teaching five

degrees, three schools and two universities, so the conclusions drawn can be generalized and verify the viability of this project. In addition, all of them have the same number of ECTS (European Credit Transfer and Accumulation System) credits (specifically 6 ECTS).

**Table 1.** Subjects object of the project

Degree	Faculty	Subject	Grade	Groups theory
Mechanical Engineering (GIM)	EPS	Manufacturing Engineering	2 <sup>nd</sup>	4
Electrical Engineering (GIE)	EPS	Manufacturing Engineering	2 <sup>nd</sup>	1
Industrial Electronical Engineering (GIEI)	EPS	Manufacturing Engineering	2 <sup>nd</sup>	1
Industrial Technologies Engineering (GITI)	ETSII	Manufacturing Engineering	2 <sup>nd</sup>	4
Industrial Organization Engineering (GIOI) (Andalucía Tech)	ETSII	Manufacturing Tecnologies	3 <sup>th</sup>	2

Later, the group met several times and zero version was revised, adding, modifying or eliminating some of the fields of that; in the end, the new working version, version 1, was configured. Finally, a list of terms, classified by the topics of the subject we generated, Table 2, and the structure designed was adapted to the specific working format of virtual campus. Some of the sections contemplated are:

- Integrated definition
- Equivalence in English
- Example from the source document (context and page)
- Brief comment about the term
- Illustrative image

**Table 2.** Classification of terms by topics

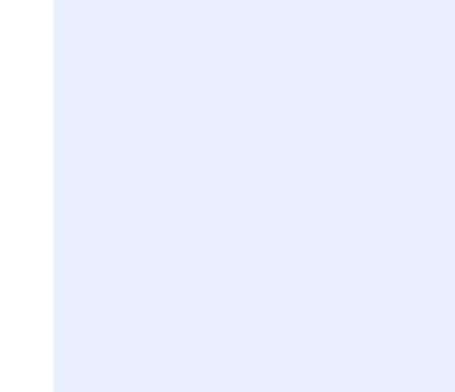
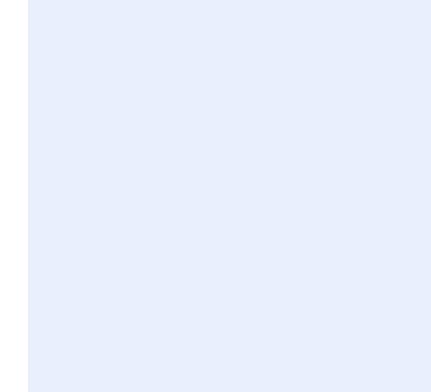
<b>Topic I. Introduction and Materials Selection</b>				#
Automatización	Ciclo de producción	...	Vida en Servicio	46
<b>Topic II. Moulding</b>				
Arena de moldeo	Arena de relleno	...	Zamak	71
<b>Topic III. Pulvimetalurgy</b>				
Atomización	compactación con matriz flotante	...	Sinterizado en fase sólida	34
...				
<b>Topic XI. Manufacturing Systems</b>				
Alineación de las operaciones	AMFE	...	Valor añadido	69
<b>Topic XII. Manufacturing Quality</b>				
Acción correctiva	Acción preventiva	...	trazabilidad	32
<b>Topic XIII. Environment and Manufacturing</b>				
Análisis ambiental	Auditoría ambiental	...	Vertidos	32
<b>Total</b>				<b>585</b>

## 2.2 Pilot Implantation

Once the new format was definitely configured, it was proceeded to the pilot implementation of the experience. This pilot experience would be developed in the subject of an only degree and the results obtained would allow the group to achieve the required improvements for the following applications. It would be repeated in the three next semesters of two courses and the previous glossaries could be used as learning tools through the virtual platform for next students.

Next stage consisted in creating a learning activity for students, who, until that moment, had not taken part in this project. They had to make groups of two or three students and the teacher gave each group several terms to complete. To make sure of students understood the information to consider in each field of the Thesaurus, students were given a template of the kind of information to include in each section Table 3.

**Table 3.** Template of Thesaurus terms

<b>TÉRMINO</b>	TÉRMINO TEAURO			
<b>DEFINICIÓN</b>	Definición integrada y propuesta por el alumno			
<b>ETIMOLOGÍA</b>	Origen del término			
<b>TRADUCCIÓN AL INGLÉS</b>	Termino en inglés			
<b>DEFINICIÓN EN FUENTES</b>	<b>DRAE</b>	Definición del Diccionario de la Real Academia de la Lengua Española		
	<b>DE</b>	Definición del Diccionario Esencial de la Lengua Española		
	<b>OTROS</b>	Nombre de otro Diccionario		
		Definición según el diccionario propuesto		
	<b>WIKIPEDIA</b>	SI <input type="checkbox"/>	Definición del término según Wikipedia	
		NO <input type="checkbox"/>	url	
	<b>NORMATIVA</b>	Elija un elemento.	Identificación de la norma	
			Definición según la norma seleccionada	
Elija un elemento.		Identificación de la reglamentación		
		Definición según la reglamentación seleccionada		
<b>ORGANISMO</b>	Nombre del organismo	Identificación del documento publicado por el organismo		
		Definición según organismo		
<b>REFERENCIA EN TEXTO REAL Y FUENTE</b>	Frase o texto en el que aparezca el término tesauro y Fuente de la que se ha extraído dicho texto.			
<b>COMENTARIO CRÍTICO</b>	En este apartado el alumno debe reflejar el debate planteado junto con el resto de alumnos de su grupo para decidir la definición propuesta.			
<b>TRAZABILIDAD (FAMILIAS)</b>	Elija un elemento.	Selección de la familia o bloque (de la asignatura de Ingeniería de Fabricación) a la que pertenece el término		
<b>TÉRMINOS RELACIONADOS</b>	Enumeración de otros términos relacionados (propuestos en la actividad Tesauro o no)			
<b>IMAGEN ILUSTRATIVA</b>				
	Fuente de la imagen (url, libro, propia, etc.)		Fuente de la imagen (url, libro, propia, etc.)	

Previous table shows the format in which would be structured the information about a term. However, it was necessary adapted this structure to the electronic version of *Virtual Campus*. Through this module students filled the information related to the terms selected.

Finally, the information would be showed in this platform, according the format of Figure 1.

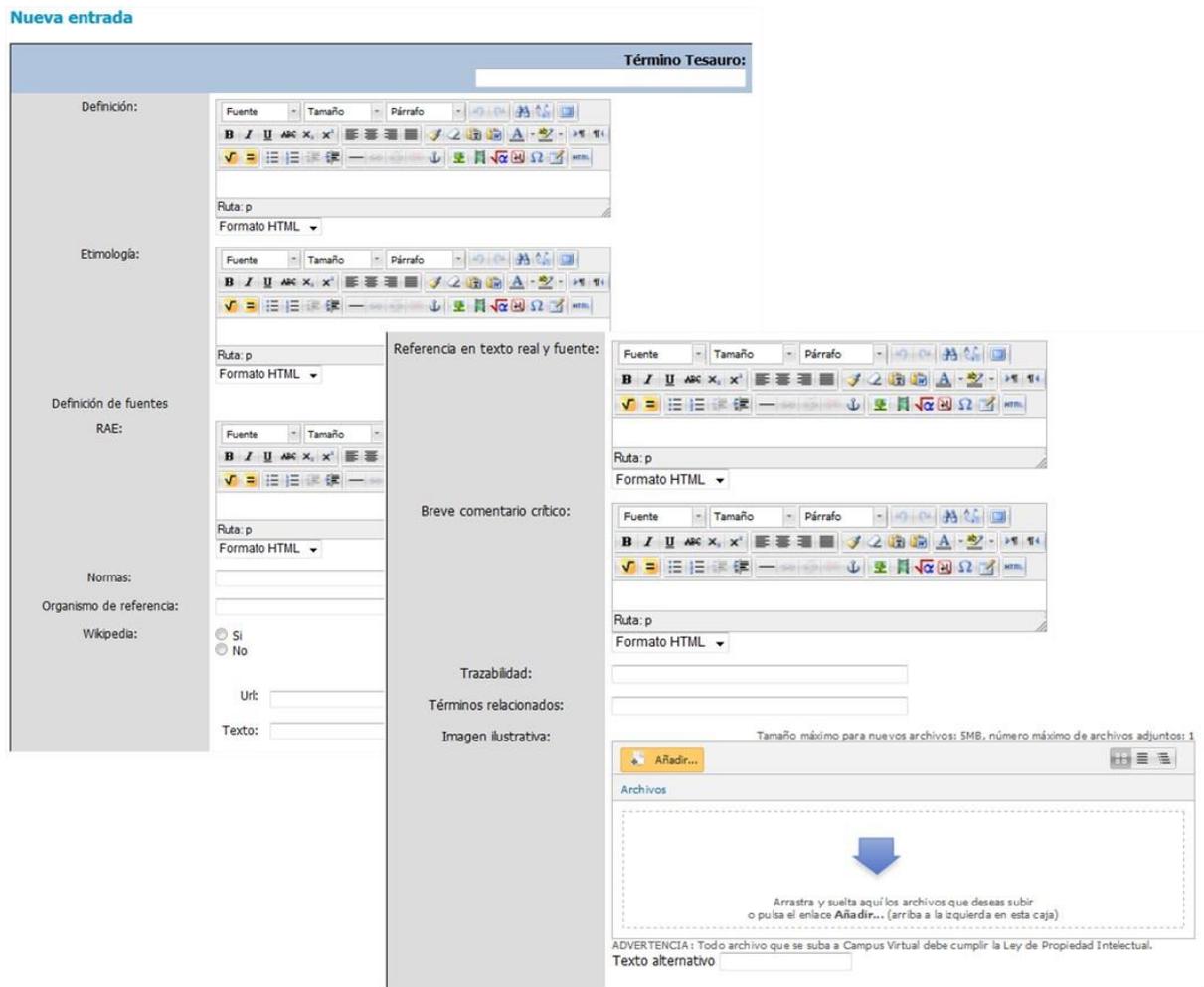


Figure 1. Fragment of the Virtual Campus module

At the end of that semester, each group was evaluated by their lecturer and subsequently the complete working group participated in a general meeting where the results were presented and it was made an assessment on the application of the teaching experience. Some of the principal conclusion drawn were: most of students did not understand what exactly they had to include in some of the sections, mainly those one related to the documentary reference or relevant organizations; some denominations could not be completed because of the lack of information about them; many student neither did an adequate integrated definition of the term nor an critical analysis of it.

From these conclusions, before the beginning of the next course, the group carried out a series of improvements on the format and structure of the Thesaurus. Likewise, the best compositions were included as a model for next students and terms that did not reach a minimum level were rejected and proposed again.

### 2.3 Global Implantation

The new implantation was applied to the whole degrees and subjects considered in the project. According to the improvements planned previously, students received several documents that contents detailed information about each section of the Thesaurus, especially on that field which had been more difficult for them. Also, they were given some instructions about how to work in group, even some indications about how not to consider certain sections.

The working groups would be integrated by four students and this work would be configured as an extra activity whose mark would mean a 1 score of 10. **¡Error! No se encuentra el origen de la referencia.** shows a short extract of the list of terms on which worked in the new phase of the project, numbered, classified by topics and assigned to groups.

**Table 4.** Extract of terms list assigned

#	Term	Topic	Group
542	Soldador	Soldadura	
543	Soldadura	Soldadura	NIC-A
544	Soldeo	Soldadura	
545	Solidificación	Fundición	ELE-A
546	Soplado	Polímeros	NIC-A
547	Stock	Sistemas de Fabricación	ELE-A
548	Takt Time	Sistemas de Fabricación	GITI-C
549	Taladrinas	Mecanizado	NIC-A
550	Taller convencional	Automatización	
551	Técnica	Introducción y selección de materiales	
552	Tecnología	Introducción y selección de materiales	NIC-A
553	Tecnologías de fabricación	Introducción y selección de materiales	GITI-C
554	Termoconformado a presión	Polímeros	NIC-A
555	Termoconformado a vacío	Polímeros	NIC-A
556	Termoconformado mecánico	Polímeros	NIC-A
557	Tiempo Normal	Sistemas de Fabricación	
558	Tornillo recíprocante	Polímeros	ELE-A
559	Torno	Mecanizado	NIC-A
560	Torreta portaherramientas	Control numérico	ELE-A
561	TPM	Sistemas de Fabricación	ELE-A
562	Transferencia	Compuestos	

<b>Término TESAURO: Acreditación</b>	
Definición propuesta por el alumno:	Proceso mediante el cual un organismo autorizado, le otorga a una persona/entidad mediante un documento oficial, la capacidad de inspeccionar/certificar cualquier actividad que le haya sido encomendada.
Etimología:	Proviene de acreditar, con prefijo a (ad en latín) y crédito que viene del vocablo latino creditum.
Traducción al Inglés:	Accreditation
<b>Fuentes</b>	
Definición según DRAE:	1. Acción y efecto de acreditar. 2. Documento que acredita la condición de una persona y su facultad para desempeñar determinada actividad o cargo.
Definición según DE:	1. Certificación, mediante un documento, de que una persona posee las facultades necesarias para desempeñar un cometido.
Otros:	Diccionario: Enciclopedia Salvat Universal. Edición 1999. Definición: f. Acto por el cual el Gobierno de una potencia confirma al de otra la autenticidad de los poderes que dio a su representante.
Wikipedia:	Si Definición: Proceso voluntario capaz de medir la calidad de sus productos, y el rendimiento de los mismos frente a estándares reconocidos a nivel nacional o internacional.
web:	<a href="http://es.wikipedia.org/wiki/Acreditacion">http://es.wikipedia.org/wiki/Acreditacion</a>
<b>Normativa</b>	
Normativa:	Norma UNE-En ISO 9001:2000 Procedimiento mediante el cual un organismo autorizado da reconocimiento formal que una organización o individuo es competente para llevar a término tareas específicas.
Reglamentación:	LEY DE INDUSTRIA VIGENTE DESDE 12/08/1992 A 24/12/2014. Acreditación: Declaración por un organismo de acreditación de que un organismo de evaluación de la conformidad cumple los requisitos fijados con arreglo a normas armonizadas, y cuando proceda, otros requisitos adicionales, incluidos los establecidos en los esquemas sectoriales pertinentes, para ejercer actividades específicas de evaluación de la conformidad.
Otros organismos que definen:	Organismo: ENAC Fuente: <a href="http://www.enac.es/web/enac/acreditacion">http://www.enac.es/web/enac/acreditacion</a> Definición: La acreditación es la herramienta establecida a escala internacional para generar confianza sobre la actuación de un tipo de organizaciones muy determinado que se denominan de manera general Organismo de Evaluación de la Conformidad y que abarca a los Laboratorios de ensayo, Laboratorios de Calibración, Entidades de Inspección, Entidades de certificación y Verificadores Ambientales.
Referencia en texto real y fuente:	Lleva acreditación el periodista. Diccionario de la lengua española © 2005 Espasa Calpe. Una vez conseguida la acreditación podrían abandonar la norma. perso.wanadoo.es

Figure 2. Example of a Thesaurus term

**Comentario Crítico**

Como se puede observar, he podido encontrar muchos significados de la palabra acreditación. He buscado en muchas páginas, la mayoría me llevaban a organizaciones, como ENAC, AEC, IAF, etc... He podido encontrar en todas la definición de acreditación. La definición de la norma ISO de acreditación la pude localizar en la 9001. La definición de Salvat Universal (1999) me llevó a un significado totalmente distinto al actual. La definición del diccionario español, me llamo mucho la atención porque la define como certificación, lo cual lleva a confusión, porque no es una certificación, sino acreditación a entidad/organismo capaz de certificar, eso me llevo a no fijarme mucho en esta definición de diccionario. Para mi definición, me di cuenta de que todas las definiciones de la organización, reglamentos y diccionarios, me llevaban a lo mismo. En la que más me fije fueron, ley de industria, ISO y CEM, porque son las que más se parecen y definen mejor la palabra. La ley de industria, pude encontrar la vigente del 24/12/2014, la cual actualiza la definición de los apuntes definida en el tema de calidad.

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**Más información**

Trazabilidad: Metrología  
Calidad

Términos relacionados: Certificación, homologación, metrología, verificación, normalización.

Imagen ilustrativa:




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**Edición del término**

✖ ✕ ✓

Figure 3. Example of a Thesaurus term (continuation)

The format in version 1 was remained but it was included in the work instructions an explanatory document in order for students to have the largest and most comprehensive information on what information should be incorporated in each section of the Thesaurus. Also, students were given a file about a specific term, which showed the whole information about it.

The previous Figure 2 and Figure 3 show an example of information of a Thesaurus term in format available on Virtual Campus of UMA.

### 3. Results

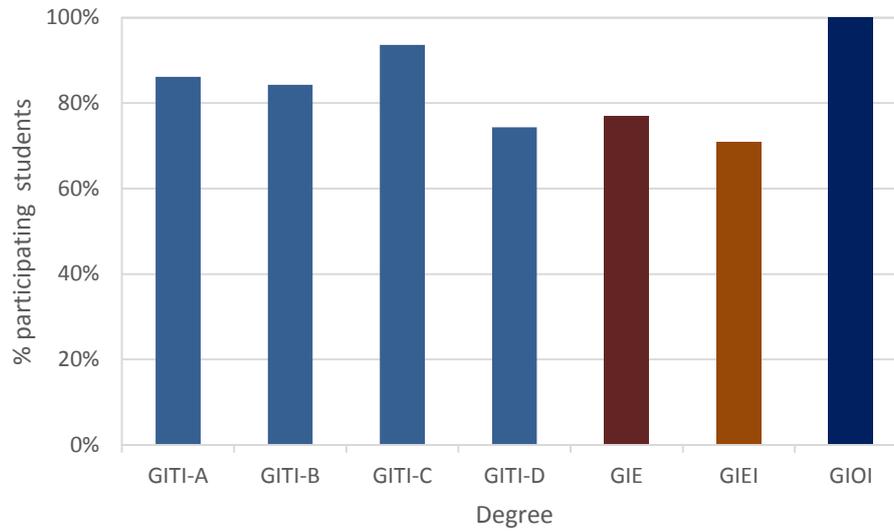
At present, this works have been just evaluated and this second submitting has shown significant improvements regarding the pilot experience, perhaps due to the more detailed information provided to students. Also, a new indicator has been introduced: groups have been revised each other, involving students in the evaluation process.

Table 5 shows the most important results of the implantation of Thesaurus activity during the first semester of 2014/2015 academic year.

Table 5. Number of Thesaurus terms and participants (1<sup>st</sup> semester 2014/2015)

Degree	GITI	GITI	GITI	GITI	GIE	GIEI	GIOI
Groups of theory	A	B	C	D	A	A	A
Number of groups	15	15	12	10	18	18	7
Participating students	56	59	44	29	73	56	25
Total students	65	70	47	39	95	79	25
Number of Thesaurus terms proposed	55	64	47	48	72	84	26
Number of Thesaurus terms developed	55	50	42	38	72	72	23
Number of Thesaurus terms accepted	50	40	39	17	43	26	21
Average grade	8,9	7,8	7,27	7,35	5,51	5,5	8

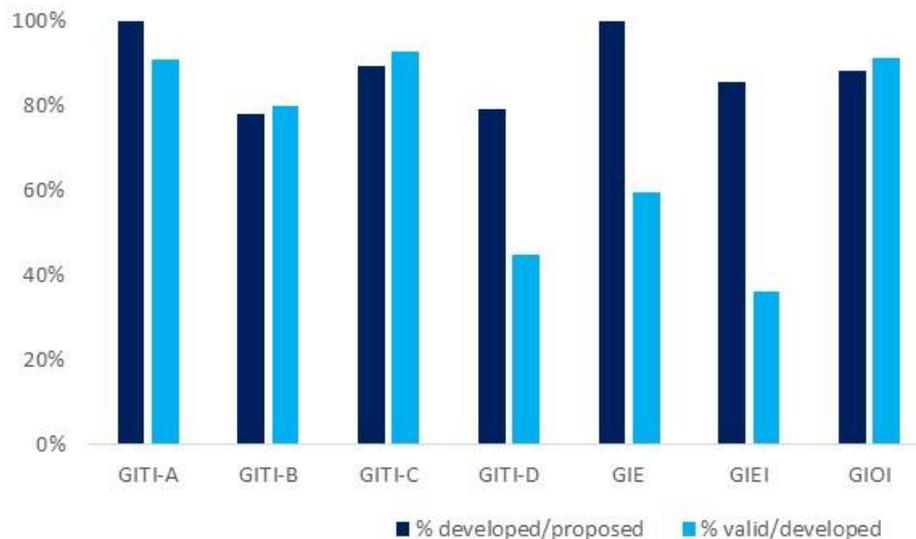
Also, despite the volunteer character of this activity, a massive number of students have participated, as Figure 4 allows to show.



**Figure 4.** Participating students

Thesaurus terms developed by these students increase those already included for the first implementation (first semester of 2013/2014), and supplemented with the next semester (2014/2015).

Figure 5 shows the percentage of Thesaurus terms that students have developed in the first semester of 2014/2015, compared to the total of proposed terms, and the percentage of valid terms compared to performed terms. It can appreciate that most of these terms were performed. However there are differences between the numbers of terms properly developed according to the degree in which this activity was proposed.



**Figure 5.** Percentage of Thesaurus terms developed and valid

Participating teachers has also found that the implementation of this activity has significantly increased the presence to tutorials by the students of these subjects, compared to previous years.

#### 4. Conclusions

It has been generated a Thesaurus of terms in the field of Manufacturing Engineering. It will be accessible from the virtual platform of the University of Malaga by means of its electronic version. For two courses, each semester, a new edition of this project is being done. For that, this teaching tool is in a continual state of growth and improvement. In each edition new terms are incorporated and terms that did not get successful results in previous editions are reassigned again.

On the other hand, the realization of Thesaurus as a learning activity for students has led to an improvement in academic results (5%), which make them especially interesting to improve the comprehensive level and to increase knowledge on a specific topic of the taught contents.

Finally, we can broaden this teaching-learning tool horizon, spreading its application to any University. This is possible thanks to the global networks that allow us to put our work at the disposal of any interested user.

#### 5. Acknowledgements

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