

## Article

# Content Curation in E-Learning: A Case of Study with Spanish Engineering Students

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**Abstract:** Over the last decade, e-learning and the use of digital tools have received a great boost in higher education. This paper presents a content curation methodology to assess the acquisition of specific content and soft skills during the attainment of a Degree in Industrial Electronic Engineering at the University of Jaén. In this teaching–learning experience, 101 engineering students were involved in activities with digital tools related to content curation, and four steps were proposed: *search*, *select*, *sense making*, and *share*. As evaluation tools, a rubric and a questionnaire of the digital tools were proposed. Moreover, a curation index was defined in order to assess the degree of achievement of the content curation. The academic results after using the rubric were better than previous years. The average content curation index obtained was 53.53. Of the four evaluated steps, *search* and *sense making* had the lowest scores and, therefore, these steps should be further developed in the future. In addition, the Kaiser–Meyer–Olkin test and Pearson’s correlation were used for analyzing the results of the questionnaires. It was concluded that the experience had a great impact on the skills related to collaborative work, digital information management, and lifelong learning, which are transversal skills at the university level. Thus, the results highlight the great educational potential of content curation.

**Keywords:** evaluation; content curation; digital tools; higher education; e-learning; collaborative work



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## 1. Introduction

Since the creation of the European Higher Education Area (EHEA), a series of guidelines have been established in Europe in order to promote the renewal of education systems. A key aspect of these guidelines is to establish an educational paradigm focused on the autonomous work of the student and the incorporation of technology in the teaching–learning processes [1]. Both approaches, theoretical–pedagogical and technological, aim to effectively carry out lifelong learning in order to achieve greater competitiveness, mobility, and European integrity. Along with these technological innovations, another of the fundamental ideas of higher education in Europe is the priority of the learning process over the teaching process. The teacher is no longer a transmitter and becomes a facilitator of the process. In this sense, students are taught to access essential resources and the teacher provides students with the essential skills to build meaningful and relevant learning for their future work. They also monitor and provide feedback on their progress, directing their professional itineraries. To this end, the so-called transversal skills are considered in higher education including critical and innovative thinking, problem solving, communication, collaborative work, and leadership. These technological and pedagogical changes imply that students not only focus on acquiring basic knowledge but also on building autonomous processes based on the search and selection of digital information [2].

In this context, higher education has undergone an intense digital transformation in the last decade and e-learning has received a major boost [3]. This digitization effort was shown during the COVID-19 crisis, where online teaching was imposed, and it showed that most universities managed to provide digital solutions to deal with the crisis. Moreover, it proved a high degree of readiness for online learning [4]. This situation has also allowed for an understanding of the preferences of students regarding the tools used in e-learning [5,6] and their level of satisfaction [7]. During this period, several digital tools were used and a major boost has been given to achieving the digital transformation in higher education [8,9]. This favorable context promotes the implementation of new methodologies based on digital tools that allows for the search and selection of information, since this is an important stage of the autonomous learning process, where the students are “learning to learn”. However, these new methodologies to develop transversal competences are not easy to evaluate [10].

In this sense, this work shows the use of content curation for the learning of engineering subjects as well as the evaluation of the use of this methodology through two tools: an evaluation rubric and the content curation index of the group of students. This proposal is novel in engineering studies in higher education and allows for the evaluation of the methodology used.

## 2. Background

### 2.1. Content Curation

The search for information and resources is one of the most important stages in the learning process nowadays [11,12]. Searching the Internet is a complex task, as the amount of information grows exponentially. It is estimated that in a few years, every 72 h, the amount of information will double and also become quickly obsolete. This will lead to a great saturation of content [13].

The abundance of information that is received by being permanently connected can lead to “information overload”, which generates anxiety and confusion [14,15]. In order to optimize searching on the Internet, it is essential to be able to locate and recognize the best and proper information. In addition, quick access and prioritization of quality over quantity are important issues. Since the demand for quality information cannot be solely satisfied by internet search engines, it is required for experts in the matter to filter and share the relevant information [16]. In this sense, continuous and autonomous learning depends on skills such as searching, organizing, and processing information [17,18].

Juárez et al. [19] consider that the ability to “learn to learn” is the best guarantee for students and future professionals to continue their educational itinerary in formal and non-formal structures. Learning collaboratively, managing information, and developing their talent adequately in digital media are essential skills. In this sense, it is necessary to create adequate resource management on the Internet through a process that would include the searching, filtering, analysis, editing, and dissemination of information [17,18].

In this context, the concept of content curation (CC) appears, and it is defined by Guallar [20] as a “System carried out by a specialist (content curator), consisting of the search, selection, characterization and continuous dissemination of the most relevant content from various sources of information on the web about a specific topic and area, for a specific audience, on the web or in other contexts, offering added value and thereby establishing a link with the audience/users”. Fernando [21] refers to this concept as “the interactive act of investigating, finding, filtering, organizing, grouping, integrating, editing, and sharing the best and most relevant content on a specific topic in a significant online digital collection, which could be important for a group of people whose sense of learning can be updated around this topic”. From the point of view of Reig [22], a content curator is a “critical intermediary of knowledge, someone who continuously searches, groups and shares what is most relevant in his/her field of specialization”.

Guallar [23] defines the methodology of content curation in four steps, called the “4S’s model”: search, select, sense making and share. In order to guarantee the effective development of the different content curation steps, the use of digital tools is recommended.

Moreover, it must be highlighted that this model is not linked to any particular digital tool. Table 1 shows the objectives of each step of content curation and the most used tools [20,23–25].

**Table 1.** Objectives of the content curation steps and tools.

Search	Search Tools
Pick a topic Discover content sources Find and collect quality content to share	Google, Scientific, Pinterest, BagTheWeb, Feedly, Pearltrees, LinkedIn, Summify, Storify, Instapaper, Delicious, Bitácoras, RSS alerts, MktFan, and IEEE
Select	Selection Tools
Classify the contents Choose relevant, credible, diverse, unique, and validator (that serve to validate or support a point of view) content	Pocket, Drive, Diigo, Evernote, Clipboard, and List.ly
Sense Making	Sense Making Tools
Organize and editorialize the content Annotate the content and add value by comments, retitling, summarizing, etc.	Scoop.it, Paper.li, Noowit, Flipboard, Dragdis, and StumbleUpon
Share	Share Tools
Determine where to share the content: social media, e-mails, web pages, etc.	Facebook, Google+, Twitter, ContentGems, Buffer, and Reddit

Content curation involves cognitive and metacognitive skills along with managing tools and disseminating content skills [18]. Content curation represents an evolution in information management activity in such a way that the person who carries out this activity becomes a “critical knowledge broker” [26,27]. The content curator is a facilitator between information and its community, selecting the best information and improving it through the addition of new digital elements. Content curation could be considered as a new methodology to be developed, as it favors teachers to become “critical intermediaries of knowledge” and help students develop the skills and attitudes necessary for the development of their profession. From this perspective, the contribution that content curation could have in the field of education would be related to favoring student-centered learning. After this process of accompaniment, students would acquire very useful competencies for learning in any area of life, becoming content curators [28].

Therefore, content curation is a new way of learning that must be introduced, since it is in accordance with a changing society, where it is necessary to be updated. In addition, from a professional point of view, companies are highly valuing lifelong learning competencies, and they give priority to these skills in order to keep companies updated. This fact enforces the incorporation of content curation in higher education.

## 2.2. Content Curation in Higher Education

In recent years, there has been a surge in the integration of digital and social media tools into the learning process [29,30]. Most university students are regular users of social networks and search engines. However, they often act as content consumers: they consume and share information with their friends, but they hardly produce quality content [19,31]. However, the use of content curation using digital tools is not common, even after the COVID-19 crisis. It is more common to find experiences that mainly use methodologies based on the personal learning environment (PLE) [32–35] than only content curation experiences.

It is common to associate content curation with the creation of personal learning environments, since they are two complementary concepts that are linked. It is not possible to carry out a good content curation if a PLE has not been previously developed with

the appropriate digital tools. A PLE is composed of a set of tools that allows to search, classify, elaborate, and share information and knowledge together with a set of resources or sources with relevant information and a personal learning network. This helps the student to share resources with other colleagues and to carry out collaborative work, enhancing the competencies related to the use of ICT tools, autonomous learning and collaborative work. In addition, content curation is also filtering and, above all, adding value to content. Therefore, there is a parallelism between PLEs and the content curation where the latter is a more complete process that, supported by a good PLE, makes sense of the information and adds value to the content (sense making). Content curation focuses on the sense making step, which is the least automated step. Machines can add and provide an initial level of filtering, but only human beings can actually curate [27].

Among the PLE experiences reported in higher education, Ruiz-Palmero et al. [32,33] focused on the role that PLEs play in the training of students. The applications and tools that most students use in non-formal learning were studied. Their conclusion was that students do not effectively use the available media and do not associate the use of PLE with academic uses. On the other hand, Area et al. [34] highlight the novelty that this new methodology supposes, evaluating the meaning, usefulness, and possible integration of the PLE in formal education scenarios. They consider that this new concept implies the awareness of a digital identity as well as the development of five competency dimensions in the intelligent use of digital culture and technology.

In engineering studies, there are some experiences that study the use of virtual classes, PLEs, LMS, and mobile learning and their impact on learning, with very satisfactory results [6,7,35,36]. Rus-Casas et al. [37] describe the educational experience of creation a PLE as a tool for the learning of subjects in STEM areas. In addition, the development of skills related to sustainable learning was achieved, following the recommendations to improve important skills in the professional field [38].

Focusing on content curation, and despite the growing role of digital curation tools and platforms, little research has focused on its use in education. Antonio et al. [39,40] suggest that it is necessary to introduce students to both content curation and web tools management. In their experiences, they use content curation tools to effectively involve students, and their results demonstrate the strategy's effectiveness. They concluded that content curation could be applied to a wide range of disciplines given that the majority of today's students have background in technology. Other studies present how content curation promotes digital skills [41–43], critical thinking [44], sharing and exchange of knowledge [42,43], collaborative learning [42], and personalized learning [45].

It is worth highlighting the experiences in which different authors use web tools related to content curation and analyze them [12,39]. Among the most used can be highlighted Storify, [39,46–49], Pearltrees [39,50], Pinterest [39,45,51,52], and Scoop.it [28,39,41,43,53,54].

Taking into account both the potential and value of content curation in different areas, it is important to consider the possibility of introducing it into higher education as a methodological tool to acquire specific content and develop lifelong learning skills [55].

### 2.3. E-learning Assessment

The new methodologies and tools require resources in order to provide an integrated and authentic assessment of student learning. Moreover, the evaluation should be seamlessly integrated with the activity and provide appropriate criteria to rate varied products [56,57].

In order to evaluate e-learning, the most used tool in the bibliography is the questionnaire. Prasetyo et al. [6] studied the acceptance factors of online meeting platforms considering as variables the user interface, the perceived ease of use, the perceived usefulness, the quality of the information, the quality of the system, and the intentions of behavior. Ong et al. [5] determined the preferences of the students considering seven attributes. The design created could be used in other courses when measuring students' preferences for online learning. García-Martínez et al. [58] analyzed the tools that students use to access information, create content, and share and interact in the framework of higher education.

The study used a quantitative approach, considering an ex post facto, transactional design. Farkosh et al. [28] showed a two-dimensional conceptual model that illustrates a taxonomy of components that are included in the curation using types of data: the knowledge exhibitions and narrative reflections. However, in the literature it is not evaluated whether the use of these digital tools reach the objectives proposed by teachers in terms of specific content and skills acquisition.

Taking into account the characteristics of the content curation strategy, we considered that one of the most appropriate way to evaluate the implementation of this methodology could be by means of a rubric. The rubric is an evaluation tool that describes the features and qualities of a product or a specific task at different levels of performance. It is a double-entry matrix that specifies the aspects to be evaluated and the possible degrees of achievement. It is intended to (i) promote what is expected of the student's work; (ii) assess its execution; (iii) encourage feedback [59,60]. The students can improve their performance by clearly knowing what is expected of them. These evaluation tools are characterized by greater accuracy, reliability, and objectivity when assessing the skills [61,62].

Conde et al. [63] consider that the rubric presents a positive assessment by the students for comprehensive and formative evaluation. This tool allows orientation and evaluation in educational practice. It describes the criteria to take into account to assess jobs or tasks and collects a quality gradient or level of depth for each criterion. Its use allows the student to be evaluated objectively, considering criteria previously explained by the teachers. Then, the students know how their work is going to be evaluated and they become key elements of their learning and assessment [64,65].

The strategy proposed in this work aimed to improve the use of digital tools for content curation in engineering subjects. The objective was to train students to become content curators, a skill that will be useful in lifelong learning and that they may apply in their professional field. In addition, a rubric was developed as an assessment tool adapted to the content curation methodology which allows to quantify the learning progress in the subjects. Finally, a content curation index was established to quantify the degree students achieved becoming content curators.

### 3. Methodology

This work describes a teaching experience that involved 101 students attaining a Degree in Industrial Electronic Engineering at the University of Jaén. Figure 1 shows a scheme of the methodology.

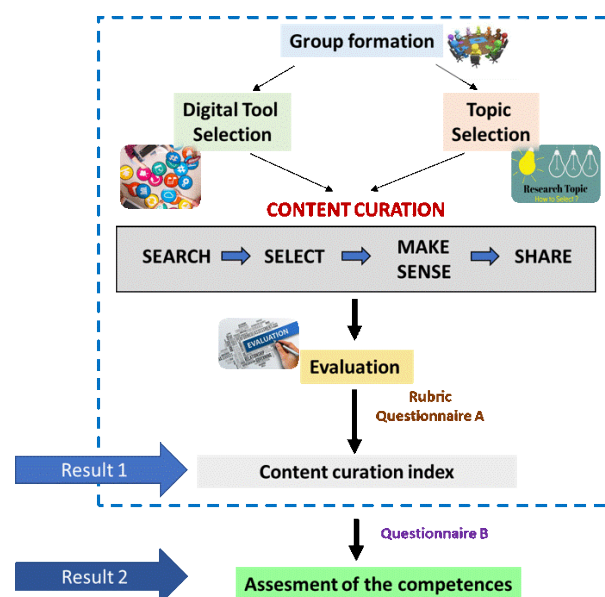


Figure 1. Methodology.



The different steps together with the used tools by the students during the experience are described below.

(a) Topic definition

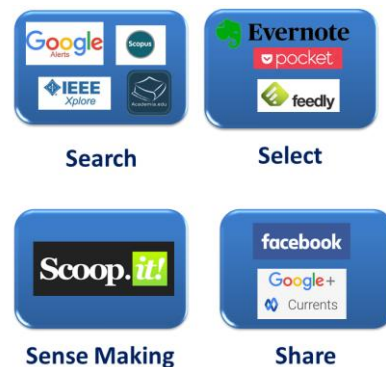
The first step was to choose the topic that the students would develop. Table 2 shows, as an example, the topics corresponding to the subject of power electronics for a Degree in Industrial Electronic Engineering.

**Table 2.** Topics regarding the subject power electronics.

Topics
<ul style="list-style-type: none"> <li>History and evolution of power electronics;</li> <li>Power electronic converters in electric traction;</li> <li>Switched regulators;</li> <li>Power electronic converters: inverters and applications;</li> <li>Control of lighting equipment with power LEDs: driver;</li> <li>Power electronics and renewable energies;</li> <li>Power electronic circuits simulation by computer.</li> </ul>

(b) ICT tools Seminar

A seminar on digital tools for content curation was given at the beginning of the course. Considering the most widely used tools in content curation [20,23,26,27,66,67], the teachers provided the Content Curation Toolkit shown in Figure 2. The recommended tools were Google and Feedly for the *search* step, Pocket and Evernote for the *select* step, Scoop.it for the *sense making* step, and finally Facebook, Google+, or Current for the *share* step.



**Figure 2.** Content Curation Toolkit recommended to the students.

In the *search* step, the recommended tools were the generic search engines (e.g., Google) and specialized search engines such as academia.edu, Scopus, or IEEE Explore. In the *select* step, the selected tools were Pocket, for its simplicity, and Evernote because it is a more specialized tool. In addition, Feedly was selected because it is one of the most popular and it is compatible with Android and IOS, and the web version has RSS readers. It can also be used as a news aggregator. The *sense making* step is one of the most important steps in content curation and, in this case, the Scoop.it tool was recommended. Finally, for the *share* step, Facebook, Google+, and Google Current were chosen. Table 3 describes some of the recommended tools for content curation.

**Table 3.** Description of the recommended digital tools for content curation.

Tool	Description
Feedly	Feedly is an RSS reader that allows users to quickly organize and access all news and updates of blogs and pages.
Pocket	Pocket is a computer application and web service that allows the user to manage reading lists obtained from the Internet. It allows for temporarily storing information found during searches and sharing it with other members of a work group.
Evernote	Evernote is a computer application with the objective of organizing personal information in an easy and agile way by means of note files, lists, and screenshots.
Scoop.it	Scoop.it is a web tool for disseminating news and content in an easy, agile, and interactive way. It allows users to participate with comments and suggestions through social networks. It is a tool of sense making in the content curation strategy.
Facebook	Facebook is a social network that allows for the publication of open content and the setting up of closed work groups to interact on a specific topic with a friendly, attractive, and well-known work environment.
Google+ and Current	Google+ and Current are work corporate social networks created by Google. They allow users in an organization to share information and collaborate with members of a team. You can exchange valuable information with other communities, conduct surveys in your organization, share posts, and much more.

(c) Work methodology

The working group, which was composed of three or four members, chose a specific topic of the subject to be developed. At every step of the methodology, the students had to select the digital tool to be used. Then, they had to use the tool and share and discuss the content of a topic with other classmates and teachers in an active and collaborative way. The Symbaloo tool was recommended for the organization of the information in a visual way [37], and Facebook, Google+, and Current were suggested for the discussion of the content.

(d) Content curation on specific topics of each of the subjects involved

Students had to complete the four content curation steps about the selected topic. In addition, if the steps of the content curation and the tools were shared in the working group, it would be positively assessed.

(e) Preparation of a report per working group and the monitoring of its evolution throughout the semester

At the end, on a stated date, the students had to deliver a Google Docs report. The work has to be carried out collaboratively by the different members of the group. Students had to focus on efficient content curation following the premises given by the evaluation rubric. It would be positively assessed if the students explained how the different tools were used in the different steps of the process and the development of new and interesting content. Moreover, the discussion and constructive criticism in the working group would be also considered.

(f) Evaluation

A rubric was used as an assessment tool that clearly indicated the achievement criteria the student had achieved [37,68–70]. In this rubric (Figure 3), the top axis included numeric values. The lateral axis included the evaluation criteria that can be summarized in four main sections:

- *Participation in the working group*: This criterion considers if the student participated in the group in an active way and with contributions in the social network with comments and suggestions, providing constructive discussions;
- *ICT Tools management*: This criterion considers the proper use of generic and specialized search engines, RSS aggregators, and the selection and storage of the contents. A positive assessment was given if the students handled different tools that improved the productivity of the work and helped to disseminate the contents;
- *Content curation*: This criterion considers the quality of the content;
- *Final report*: This criterion evaluates how the students showed and explained the work.

		LOW PERFORMANCED Punctuation 0-3/10	NEED IMPROVEMENT Punctuation 3-5/10	GOOD Punctuation 5-8/10	EXCELLENT Punctuation 8-10/10
Participation in working group		Poor participation in the group (1 or 2 times).	Discontinued participation in the group (more than 2 times but not in all the steps).	Frequent participation with comments and suggestions.	Very frequent, good and active participation with comments, ideas and suggestions.
ICT tools management	Search	The student uses generic search engines.	The student uses generic and specific search engines but he/she does not use aggregators.	The student uses generic and specific search engine and aggregators.	The student uses generic and specific search engines and Feedly as aggregator.
	Select	The student selects some information but don't use the tools.	The student selects and discusses some suitable information. He/she explains some tools but do not use them.	The student selects some useful information. He/she uses information storage and selection tools, although he/she does not explain how.	The student selects some useful information. He/she uses appropriate information storage and selection tools and explains how.
Content Curation	Sense Making	The student selects resources but he/she is not related with the specific contents. He/she does not use Scoop.it or similar tools.	The student selects poor quality resources related to specific contents. He/she uses Scoop.it or similar tools to give meaning and value to the curated information, although, the selection is not totally correct.	The student selects relevant and medium quality sources related to the specific contents. He/she uses Scoop.it or similar tools.	The student selects relevant and high-quality sources related to the specific contents. He/she uses Scoop.it or similar tools to give sense and value to the information.
	Share	The student is not even capable of doing basis selective diffusion of information.	The student understands the content curation but he/she is not capable of doing basis selective diffusion of information.	The student finds, filters, adds and shares relevant information but he/she does not use the suitable tools.	The student finds, filters, adds and shares relevant information using the suitable tools.
Final report	Criteria for searching, selecting, making sense of and sharing steps	The student neither shows nor explains the criteria for searching, selecting, making sense of and sharing.	The student shows the criteria for searching, selecting, making sense of and sharing but he/she does not explain them. The student misses some important information.	The student shows and explains the criteria for searching, selecting, making sense of and sharing. Meaning is still unclear.	The student shows and explains the criteria for searching, selecting, making sense of and sharing. He/she adds additional information (future uses, advantages and disadvantages.)  Well-developed ideas.
	Presentation	Poor first impression. There is no sequence of information.	The student presents the information in a difficult way to be followed. The student jumps around.	The student presents information in logical sequence which can be follow.	The student presents information in logical and interesting sequence, easy to understand.
	References	The student does not include bibliography and references section in the final report.	The student includes bibliography and references section in the final report. The references are not many.	The student includes bibliography and references section in the final report. The references are not in the correct format.	The student includes bibliography and references section in the final report. The references are in the correct format.
Global puntuation					

Figure 3. Rubric.

The contribution of this activity to the final mark of the subject was 15%.

(g) Content curation index and evaluation of the experience

A content curation index was defined to show whether the student had achieved good training in content curation. The content curation index aimed to objectively quantify if the students had adequately managed the different steps of the aforementioned methodology. The assessment was carried out through the rubric and the questionnaire on the tools used during each step of the content curation process. The questionnaire (Appendix A)



managed to evaluate whether the students identified the tools used with the corresponding step of the content curation process. In this sense, each step was linked to a tool, and the students had to mark the functions of that tool at that step. Based on the 4S's model [23] and previous works [24,37], all the steps were considered to have the same contribution. The index was over 100 points.

$$\text{Content Curation Index} = 0.25 * \text{Search} + 0.25 * \text{Sense Making} + 0.25 * \text{Select} + 0.25 * \text{Share}$$

Furthermore, the students rated the usefulness of the activity in the subject together with the collaborative work (Appendix B).

## 4. Results and Discussion

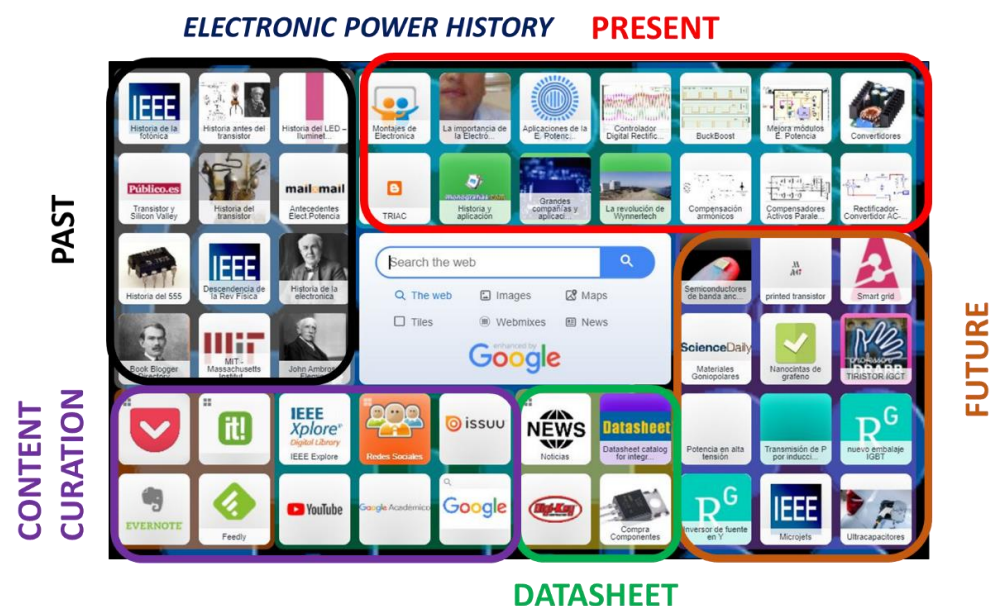
All the subjects involved in this experience were subjects of the last course of a bachelor's degree and with a small number of students (<30 students) in order to allow for better monitoring of the group activity and the student's individual work. Moreover, the maturity level of the students made it easier to develop innovative experiences.

A total of 101 students participated in the experience: 87.4% were men and the rest were women. From the rubric and two questionnaires (Appendixes A and B) the content curation index was obtained and discussed. The results of the evaluation survey of the activity and the subject are shown in which the perceptions that students had about the experience were collected. Finally, the impact of the content curation methodology on the academic results of the course are shown.

#### 4.1. Examples of Students' Works

This section presents the results of the work carried out collaboratively by the students on the topics proposed by the teachers on the subject of power electronics. For each step of the content curation methodology (i.e., *search, select, sense making, and share*), the results and the tools used are shown.

In the first step of the methodology, the groups of students selected the topic within the contents of the subject and the digital tools within the Toolkit. The periodicity of the results publication to interact with the group of students of the subject and the teacher was also considered collaboratively. Figure 4 shows an example of Symbaloo webmix, where the students organized the information obtained related to the topic of electronic power history after the *search* step. This webmix organizes and clarifies the search carried out. The student can incorporate search results of any type: articles, links, web pages, etc.



**Figure 4.** Example of a Symbaloo webmix as search step result.

In this case, the students chose to follow the subject's contents through RSS with Feedly. Figure 5 shows how Pocket was used for temporary storage of information.

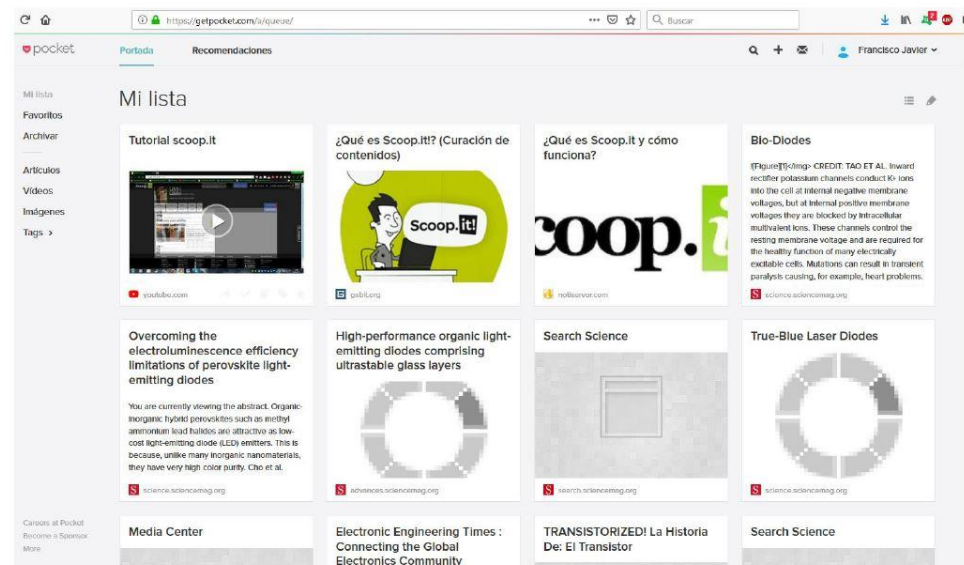


Figure 5. Example of a Pocket panel for the temporary storage of information.

Figure 6 shows how students used Scoop.it for the *sense making* step. Each topic was made up of scoops, which is the name given to the publications on this platform. The students could participate with comments, suggestions, opinions, or links through the social network. As for the sense making techniques, Scoop.it can apply most of those for blog posts, that is, abstracting, retitling, summarizing, quoting, and even parallelizing. Surely, the most appropriate one for quality content curation on the platform is summarizing, alone or combined with citing [23,54]. Scoop.it can easily collect, group, and show information, and students deepen their understanding of concepts by identifying what they think about the idea, noticing new information that may differ from their existing ideas and reasoning to develop a new understanding of the concept [54]. Scoop.it generates content based on the keywords of a given topic; then the students are responsible for tracking and evaluating this content to make an informed decision about what content they want to appear on their Scoop.it panel. If the students have studied the topics related to the subject, their contributions will be valuable, and with the teacher's review and check, they will improve their collaborative learning. The digital tools thus make the *sense making* step easier. Finally, Figure 7 shows some of the groups' results for dissemination (*share* step).

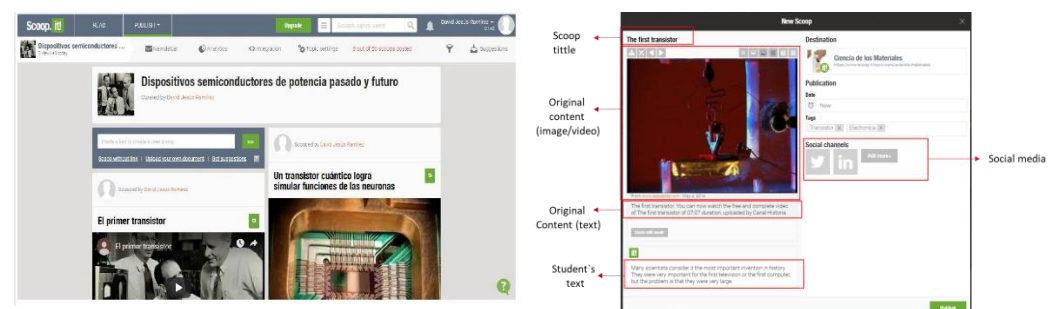
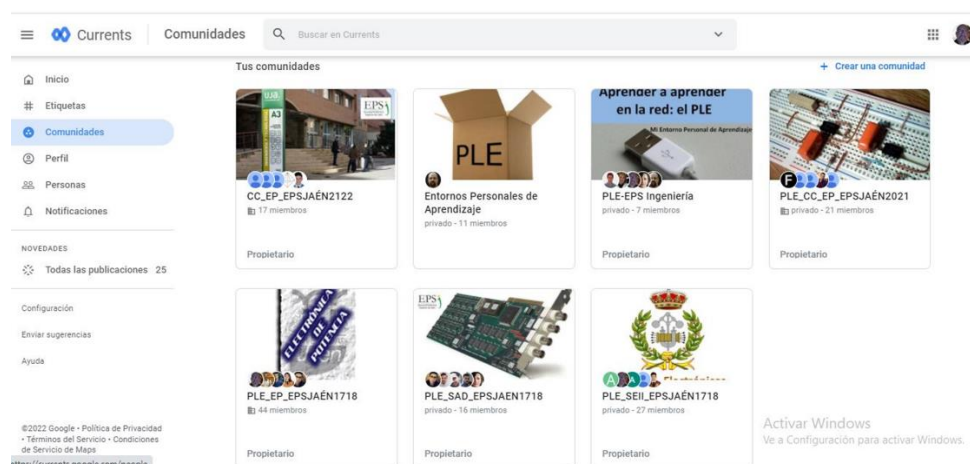


Figure 6. Example of a Scoop.it panel and a New Scoop screen for the *sense making* step.



**Figure 7.** Example of the groups' results dissemination.

#### 4.2. Rubric, Content Curation, and Academic Results

The evaluation rubric was designed considering by other authors' suggestions [37,68–70] and assigns a score to four different issues (Figure 3). Firstly, it is assessed how the students are involved in the collaborative work, and active participation, comments, and suggestions are the most valued aspects. The "ICT tools management" and "content curation" sections evaluate if the students carry out the content curation steps. It is assessed if the students used the suggested tools at each step and if they generated quality content. Finally, the "final report" section assesses whether the previous content curation steps was carried out with clear and concise criteria and if they are related to the topic set by the teacher in the subject. The score of this activity was the sum of the scores of each section, and its contribution to the final mark of the subject was 15%. In addition, a high score in all sections indicated that the students were becoming content curators. Specifically, the results obtained in the sections "ICT tools management" and "content curation" evaluated the steps of the content curation methodology. To complete this analysis, questionnaire B was also used. The objective was to verify if the students had successfully linked the tools to each content curation step. Table 4 shows the mean scores obtained in each step of the content curation process.

**Table 4.** Content curation index and mean scores obtained in each step of the content curation process.

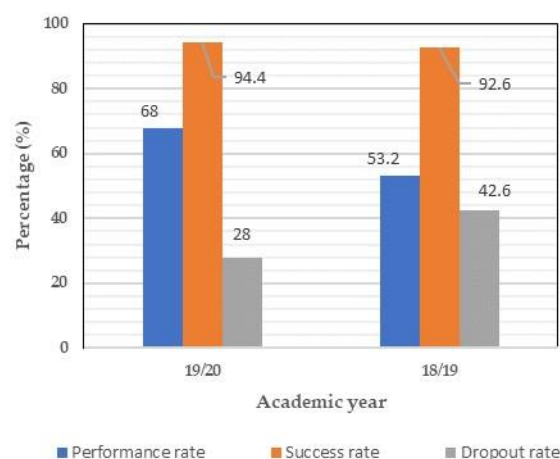
Search	Select	Sense Making	Share	Content Curation Index
33.33	60.29	36.95	69.56	53.53

The final score obtained in the curation content index slightly exceeded 50% of the total score, so it can be said that the experience was satisfactory. However, the low scores in the *search* and *sense making step* indicate that these steps must be deeply developed. Regarding *search* step, a low score (33.33) was obtained. This value shows that students do not use specific tools to search for information as it has been already observed in previous works [34]. Moreover, it indicates that students do not perform quality searches when they use generic and little specialized search engines. This procedure implies non-selective searches and generates large amounts of information. In addition, not using specific search engines can lead to obtaining information from non-verified sources instead of truthful and reliable information. On the other hand, the *select* step stands out for having a high score (60.29). In this case, the students correctly understood the usefulness of the suggested tools as reported in previous studies by Diigo and Feedly [21,34].

The score obtained in the *sense making* step was also low (36.95), as it was the most complex step within content curation. Moreover, it was the more novel step for students and a low score was expected. *Sense Making* involves creating content, adding value, and personalizing it, so it was a step that must be deeply developed. Content curation means

more than simply linking to an article, because good content curators are trusted guides that add value to content [27]. Content curation needs to continuously discover new content and be insightful about what it is shared. It is important to think about adding comments, context, and information and removing irrelevant content. Thus, the proper development of this step would be closely related to skills such as critical thinking, the ability to be autonomous and have initiative, which are very important skills to be developed in higher education. Also, it is the least automated step as machines can add and provide an initial level of filtering, but only humans can actually curate [27]. Therefore, it is necessary to improve this step in future activities, since it may provide important competencies in higher education. Finally, regarding the *share step*, it stands out for the highest score, which confirms that the students are familiar with both the proposed tools and the objective of the step itself.

Although the results obtained in the training of content curators were not as positive as expected, the activities had a great impact on academic results, compared to the previous academic year (Figure 8). The parameters used are the performance rate (number of passing students versus the total number of students enrolled, expressed as a percentage) and the success rate (percentage of passing students versus the number of students tested) and the dropout rate (percentage of students who do not finish the subject versus the students enrolled). The academic results showed a decrease in the dropout rate from 42.6% to 28% in the academic year 2019/20. The performance rate increased from 53.2% to 68% and the success rate increased from 92.6 to 94.4%.



**Figure 8.** Academic results.

These good results may be due to the use of an innovative methodology that motivated the students and drew their attention.

#### 4.3. Evaluation of the Collaborative Work, Activities, and Subjects

Once the experience was completed, the results of questionnaire B were analyzed in order to know the opinion of the students on different issues such as teamwork, activities and the subject. The statistical results of the questionnaires were calculated using IBM SPSS Statistics software version 25 and Microsoft Excel 2013. An alpha reliability test was used to verify the internal consistency of the questionnaire related to the experience (Appendix B). Cronbach's alpha values were obtained, indicating that the test was consistent. For factor analysis, the Kaiser-Meyer-Olkin (KMO) test was used with a statistical level greater than 0.6 as acceptable and using the explained variance of each factor. The KMO test showed three factors: collaborative work (CW) obtained through questions Q1–Q4, activities (AC) through questions Q5–Q12, and subject factors (SB) which were obtained through questions Q13–Q16. Table 5 shows the descriptive statistics that correspond to questionnaire B (Appendix B).

**Table 5.** Descriptive statistics and factors obtained from the questionnaire questions.

Descriptive Statistics				Factors	
	Question	Mean	Deviation	Mean	Deviation
Q1	Sharing	4.32	0.867	4.01	0.80
Q2	Interaction	4.27	0.654		
Q3	Working together	3.99	0.457		
Q4	Dividing the work	3.45	1.23		
Q5	Teacher's implication	3.86	1.021	3.53	1.02
Q6	Instructions	3.47	1.30		
Q7	Time spent	3.11	1.15		
Q8	Content curation and learning	3.85	1.31		
Q9	Activities evaluation	3.23	1.23		
Q10	Similar activities	3.53	1.14		
Q11	Effort vs. activity punctuation (marks)	3.60	1.02		
Q12	Collaborative work and motivation	3.68	1.12		
Q13	Effort vs. subject results	3.47	1.12	3.52	1.12
Q14	Content curation and subject contents	3.68	1.13		
Q15	Content curation and digital skills	3.47	1.02		
Q16	Professional skills	3.48	1.21		

Questions Q1–Q4 show that the students have understood the most important actions of collaborative work. Regarding questions Q5–Q16, the results show that the activities are very positive for the students because all the items exceed 70% of the maximum score that can be awarded. The rating provided by students about the teachers' implication and the impact of content curation on learning stands out with the highest scores, providing a positive evaluation of the experience. On the other hand, the lowest score was obtained when the time devoted to the experience was evaluated, which may be due to the fact that the students are not familiar with the tools and they had to spend more time on the experience.

To assess the experience, the relationships between the different factors were checked using the Pearson's linear correlation method (bivariate correlations). Table 6 shows the values of the coefficients and the significance.

It is observed that AC was significantly related to CW. However, there was no significant relationship between CW and SB. On the other hand, the Pearson's correlation coefficient between AC and SB indicated that there was a very significant relationship between both factors. Furthermore, the level of significance leads to this conclusion. Therefore, it can be considered that the activities carried out had a great impact on both the collaborative work and the results on the subject. It should be noted that the activities were planned and based on different digital tools, and the essence of content curation is collaborative, so collaborative work was positively promoted through the tools. Moreover, the selection of tools and their use were successful. Collaborative management tools and content curation represent a great evolution in all the fields. Among the multiple advantages that they present, such as immediacy, efficiency, flexibility and process automation, the contribution that these tools make to the updating and learning skills are noteworthy, since this type of tools require constant training to be updated and to get better [37].



**Table 6.** Pearson's correlation coefficients.

		AC	CW	SB	CW	AC	SB
AC	Pearson's Correlation	1	0.220 **			-	-
	Significance (bilateral)	-	0.007			-	-
CW	Pearson's Correlation	0.220 **	1			-	-
	Significance (bilateral)	0.007	-			-	-
SB	Pearson's Correlation			1	0.184		
	Significance (bilateral)			-	0.130		
CW	Pearson's Correlation			0.184	1		
	Significance (bilateral)			0.130	-		
AC	Pearson's Correlation	-	-			1	0.985 **
	Significance (bilateral)	-	-			-	0.002
SB	Pearson's Correlation	-	-			0.985 **	1
	Significance (bilateral)	-	-			0.002	-

\*\* The correlation is statistically significant (Significance (bilateral)  $\leq 0.01$ ).

Therefore, the experience developed in this work not only favors the collaborative work skills but also digital skills, information management and lifelong learning which are transversal skills at university levels.

## 5. Conclusions

The current situation due to the COVID-19 crisis has accelerated the integration of online teaching methodologies in universities. In many centers, teaching has been mostly developed online and/or in a mixed format: online and face-to-face. For this reason, new strategies to evaluate the e-learning process must be developed. These strategies must have objective criteria and parameters that define the scope of the online training.

This experience shows how to evaluate skills related to collaborative work, information management, and the acquisition of subject content using the content curation in an online environment. An evaluation rubric was also designed that allows for the identification of different tasks at different levels of performance related to collaborative work and content curation steps (i.e., *search*, *select*, *sense making*, and *share*). With this rubric the teacher can assess the execution of every step of the content curation around a specific topic of the subject. Moreover, this experience focuses on motivating the student using the content curation methodology at the university learning level. The selection of the topics was related to specific engineering subjects related to a degree in industrial electronic Engineering. The application of the content curation was selected as a continuous learning methodology that help the students manage information and generate quality content on a topic.

The students provided very positive feedback about the rubric used for the evaluation. The results indicate that the students managed to use the digital tools to select and share information, while it is necessary to deepen the *search* and *sense making* steps in order to make more selective searches and personalize the information in a more suitable and truthful way. In addition, the academic results obtained showed that the use of digital strategies led to higher rates of success and performance due to the greater motivation of the students and their greater implication in the learning process.

The experience succeeded in developing digital skills with the use of specific tools and promoting teamwork and studying specific content of a subject. In addition, learning evaluation was achieved. Therefore, it was shown that the use of these novel tools with a clear and detailed methodology can motivate students and enable them to acquire specific knowledge of a subject in a collaborative way. The digital tools used are versatile, so students can use them not only for academic purposes, but also for social, leisure, or

business purposes. The integration of these tools and the methodology of content curation can be the basis of effective lifelong learning. Using content curation steps effectively and efficiently ensures that the learner can develop lifelong learning and can constantly learn and keep up to date. This fact will give a competitive advantage in professional development. Content curation can be used in learning, industry (to monitor industry developments, track specific developments, latest thinking from quality sources, tips on new products and technology, and competitor tracking), research (projects, ideas, and technology), or marketing (researching clients and adding value for your customers).

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## Appendix A. Questionnaire A

### *Demographic Data and Content Curation Index*

Subject:

- ☐ Data Acquisition Systems
- ☐ Power Electronics
- ☐ Electronic Systems and Industrial Instrumentation

Gender:

- ☐ Male
- ☐ Female

Age:

- ☐ 18–19
- ☐ 20–21
- ☐ 22–23
- ☐ 24–25
- ☐ >25

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- ☐ Information management
- ☐ Publish information
- ☐ Share information
- ☐ Help understand the subject and clarify doubts

\* Note: The original questionnaire has a block of options for each tool.

## Appendix B. Questionnaire B

### *Evaluation of the Activities and Subjects*

5. Strongly agree; 4. Agree; 3. Neither agree nor disagree; 2. Disagree; 1. Strongly disagree.

Q1. The main action for the collaborative work is sharing resources.

- ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5

- Q2. The main action for the collaborative work is interacting with others.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q3. The main action for the collaborative work is working together/coediting.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q4. The main action for the collaborative work is dividing the work and join the parts.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q5. The teachers have been involved in the activity.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q6. The instructions of the activities are clear and explicit.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q7. The time that you have spent on content curation is adequate and compatible with the subject.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q8. The content curation has been significant for learning this subject.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q9. My overall evaluation of the activities is:  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q10. It would be interesting to participate in similar activities on other subjects.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q11. The mark obtained with the activities is consistent with the difficulty/effort.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q12. Working collaboratively is more motivating than working individually.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q13. The effort and time spent are consistent with the results obtained.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q14. I think that this experience is a good resource for managing learning content.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q15. The experience has improved the acquisition of digital skills.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5
- Q16. The performance of this activity has allowed me to develop competences and skills that I consider can be important in my professional future.  
☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5

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