sustainability

MDPI

Review

Systematic Review of How Engineering Schools around the World Are Deploying the 2030 Agenda

Susana Romero [1,*], Marian Aláez [2], Daniel Amo [3] and David Fonseca [4]

1 Faculty of Engineering, University of Deusto, 48007 Bilbao, Spain
2 Faculty of Law, University of Deusto, 48007 Bilbao, Spain; marian.alaez@deusto.es
3 Engineering Department, Group of Research GRETEL. La Salle, Ramon Llull University, 08022 Barcelona, Spain; daniel.amo@salle.url.edu
4 Architecture Department, Group of Research GRETEL. La Salle, Ramon Llull University, 08022 Barcelona, Spain; fonsi@salle.url.edu
* Correspondence: sromeroyesa@deusto.es

Received: 12 May 2020; Accepted: 16 June 2020; Published: 19 June 2020

check for updates

Abstract: At the UN Summit in New York 2015 it was agreed that a sustainable development of the planet is essential to strengthen universal peace in a broader capacity. On that basis, a call was made to all nations to achieve this through the 2030 Agenda. The issue is a complex one, as is evident from its 17 Sustainable Development Goals (SDGs) and their interwoven interaction. Engineering plays a leading role in achieving the great majority of the SDGs. For this reason, engineering education should focus its efforts on training engineers to be active agents of sustainability in the world. Our research question is, in fact, how the engineering higher education institutions around the world are deploying the 2030 Agenda. To answer it, we carried out a systematic review of the literature regarding SDGs and engineering schools in the Scopus and Web of Science (WOS) databases. We applied PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) methodology and, as a result, 22 papers were thoroughly studied. The results showed a consensus on the need for collaboration among the different stakeholders to achieve the desired degree profile of responsible engineers. Proposals to ensure this are diverse. They range from changes in curricula and competencies to a variety of teaching–learning strategies. Finally, future lines of research are identified from this study.

Keywords: SDGs; Sustainable Development Goals; 2030 Agenda; engineering education; systematic review; higher education

1. Introduction, Background and Literature Review

The United Nations Summit (UNS), which took place on 25–27 September 2015 in New York, agreed on a post-2015 development agenda called the "2030 Agenda" and a set of Sustainable Development Goals (SDGs). The documented result of the summit is titled "Transforming our world: the 2030 Agenda for Sustainable Development" [1] and details these two items, which are acting as drivers of more collaborative action in the field of sustainable development.

The Agenda is a plan of action for people, planet, and prosperity. It also seeks to strengthen universal peace. All countries and all stakeholders, acting in collaborative partnerships, will implement this plan. The document contains 17 SDGs, as shown in the Figure 1, and 169 targets, which entail linkages between government, academia, society, and business as a collaborative vision. These actors have to join efforts in seeking both local and global solutions to solve critical and global problems. The result of these efforts includes the mobilization of some sectors of society that are not often engaged in sustainability efforts [2].

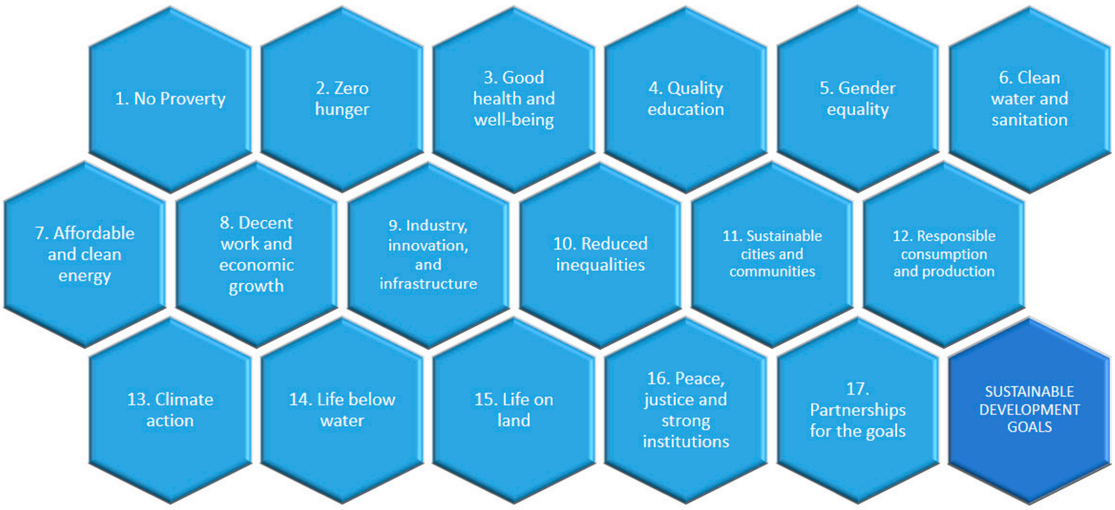

Figure 1. Seventeen Sustainable Development Goals (SDGs) [1].

All the SDGs and targets defined in the 2030 Agenda attempt to build on the Millennium Development Goals. They are intended to complete what these did not achieve (realizing the human rights of all, achieving gender equality, and the empowering of all women and girls) and to integrate, in an indivisible and balanced manner, the three dimensions of sustainable development: economic, social, and environmental. The 2030 Agenda demonstrates the scale and ambition of the United Nations Summit proposal and the importance of consolidating the 17 SDGs in higher education as a means to foster its accomplishment.

It is time to focus on Sustainability Science as a key to the implementation of the Sustainable Development Goals and, more specifically, the realization of the vision set by the 2030 Agenda for Sustainable Development [3].

Higher Education Institutions (HEIs) have also been very diligent in reacting to the UN calls to help to implement the SDGs [2]. Universities, as research science knowledge generators and fosterers, have been responding from different perspectives to the 2030 Agenda sustainability challenges. Various researchers have started different initiatives and tool developments in several universities around the world. These actions aim to tackle the multiple changes related to the implementation of sustainable development.

Within this framework of Higher Education Institutions (HEIs), this paper focuses on reporting the state of the art with regard to how engineering schools around the world are contributing to the development of the SDGs. To this end, a systematic literature review was conducted to examine practices, experiences, and proposals that foster the development of SDGs in students of HEIs.

The importance and relevance of engineering education and why it should address SDGs demand the priority of developing the necessary skills in future engineers to be able to anticipate sustainability problems, as well as to find solutions to emerging technologies in time [4]. Additionally, engineering education has to include projects that help students develop personal, teamwork, and problem-solving skills [5]. These competencies tackle SDGs in a way that allows future engineers to predict possible harm to the environment from newly created production technologies beforehand and to project measures of harm prevention. According to the UN, the area of Education for Sustainable Development (ESD) is fundamental to tackling SDG competencies, for instance, in engineering education [5].

UNESCO considers that education—SDG4—is fundamental to the achievement of the rest of the SGDs [6]. Therefore, ESD is regarded by the UN as an enabler and accomplisher for all the 17 SDGs. ESD aims for one particular objective: educating engineering students to encourage them to integrate decision-making for ESD into their future engineering practice. At present, engineering curricula are strongly focused on technical problem-solving. For ESD to be effectively implemented and naturally integrated into curricula, academics must understand and accept what ESD aims to achieve. However, in some countries, HEIs seem to have been slow in the adoption of a holistic and transformational approach to ESD and SDG values curricula integration [7]. Consequently, HEI sustainability culture has to change to foster SDG adoption by teachers, administrative staff, and principals.

As stated in the UN 2030 Agenda, global challenges are increasing in complexity [8]. Reflecting on competencies for sustainable development is a challenging and complex activity. Sustainable development is connected inextricably with a complicated web of language and terminology [9]. Hence, complex and multifaceted problems are challenging global society.

Concerning these challenges, engineers have a fundamental role to play in sustainable-oriented societies. Therefore, it is necessary for engineering students' training to ensure that they will achieve the needed knowledge and skills to respond to the challenges of the future from a humanity perspective [6]. There is a need for a more holistic educational approach, oriented to solving highly complex environmental, sociopolitical, and technical problems related to the SDGs.

Improving HEIs in terms of SDG skills and knowledge will achieve the quality in education that is needed to accomplish the 2030 Agenda challenges. Once achieved, future engineers can reduce inequalities, suppress poverty, as well as support a healthy and sustainable life [6].

HEIs and engineers are critical pieces of society to solve current and future sustainability problems. Some authors point out systemic changes in embedding education for sustainability within engineering programs. These changes aim to produce engineers who can make a positive difference to help assure a more sustainable future for present and future generations [9]. Other authors state that providing opportunities for meaningful experiences is needed. It is also necessary to reflect on how the abstract concepts that engineers learn in courses apply to the real world. All these changes and proposals aim to engage and prepare our students to be future leaders and effective members of their communities [10].

Achieving the United Nation's Sustainable Development Goals in HEIs means introducing novel pedagogical strategies into university curricula. These novel approaches may promote an enhanced acute sense of sustainability in future professionals, teachers, and decision-makers [11].

University education has traditionally included all the necessary and sufficient knowledge to professionalize students as problem-solver citizens. However, curricula adopt a structure that is split into multiple sections. This makes it difficult to understand the connections between subjects within the overall structure [12]. A unifying approach is needed to develop students' awareness of global sustainability problems and future needs.

This new view requires researchers to explore educational approaches that address complexity in order to enhance and design effective, useful, and inclusive curricula and educational experiences [12,13]. Moreover, HEIs work as a bridge between school, society, and companies. This new approach, therefore, has to affect positively the deployment of competencies for sustainability as well as to align students' professionalization with the SDGs.

There is a formal call by the UN 2030 Agenda to develop engineering capabilities and competencies for sustainability. The European HEIs are introducing new curricula and learning approaches as an initiative to fulfill the call to increase the competencies of teachers and students. The aim is to better understand the systemic nature of SDGs and facilitate their implementation in projects and learning activities [14]. This change or adoption of new curricula and learning approaches has increased HEI SGD research literature. Different authors show this increase in their studies by mentioning methodologies, experiences, and changes to curricula to deploy engineering students' competencies for sustainability and engineers' roles for a sustainable society. The increased interest and attention to engineers' roles in sustainable development have coincided with complementary initiatives in engineering degree programs. Sustainable development has made, therefore, its way into the engineering education curriculum in a variety of forms [15]. Some of the adopted methodologies are particular initiatives in project format, Project-based Learning, Challenge-based Learning, Flipped Classroom, Learning Service, or rubrics [13,16–18].

Because of the importance of the implementation and deployment of the SDGs in HEIs, a systematic review of this issue is presented below. This is a systematic review of the literature published in two major databases describing the different approaches and actions of HEIs to contribute to SDG development in higher education students. In the literature review, experiences, initiatives, new curricula, proposal changes in methodologies, and other reviews that foster the integration of SDG values in the HEI context are exposed.

Currently, we found systematic reviews related to the SDGs from a cross-sectional point of view. For example, in Vázquez-Brust et al. (2020) [19], the authors conceptualized the main dimensions of collaborative governance and the factors that influence the impact of the choice of collaborative governance on sustainable development outcomes, all focusing on the private sector. In his study, Giribabu (2019) [20] focused his efforts on better understanding the interactions between the three pillars of sustainability: economy, society, and environment, and their effects on the mapping of SDG issues. The results show that the water–food–energy nexus acts as a potential link to SDGs and helps to explain the interrelated dynamics between the human population and the natural environment, but without a relationship to engineering education and student skill enhancement. More focused on education, but far from the engineering framework, Rashid (2019) [21] reviewed the recent literature to identify the extent to which ETE (Education and Training for Entrepreneurship) research addresses the SDGs. Her findings concluded by offering ideas on how educational technology can mitigate the challenges of ETEs in fragile environments and eventually remove some barriers to the advancement of SDGs and provide recommendations for future research directions. Finally, Allen et al. (2018) [22] reviewed recent academic and expert literature, as well as the experience of various nations in implementing the SDGs. They provided a cross-sectional view without focusing on a particular study.

Focusing on educational issues and the SDGs, Smith, Tran and Compston (2020) [23] reviewed 67 engineering education programs and initiatives to assess engineering education programs that are internationally linked by the common goal of preserving life and alleviating human suffering. Desha, Rowe and Hargreaves (2019) [9] reflected on progress to enable SDG knowledge and skills in engineering studies, giving an overview of key examples of efforts within the global professional engineering and education community. Tien, Namasivayam and Ponniah (2019) [8] sought to review the literature on transformative learning theory and to derive some insight into its potential application in engineering education to deal with SDGs.

Therefore, although we found more systematic reviews of related topics, an inclusive and global systematic review of how the deployment of the SDGs in HEIs was still missing, and thus it is the main contribution of this research.

2. Materials and Methods

This chapter describes a systematic review carried out following the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses; http://www.prisma-statement.org/), which is an update and extension of QUOROM (Quality Of Reporting Of Meta- analysis). The latter was designed to improve the quality of the presentation of randomized clinical trial meta-analyses for medical journals in clinical medicine by establishing a series of standards. However, PRISMA is not as restricted to a field as its predecessor QUOROM, but can be applied to systematic reviews of all types of studies, as it is based on several successive explicit and reproducible steps, with the aim of giving the study transparency and validity.

The one presented in this paper is a qualitative systematic review, since it was based on the analysis of studies whose data were mostly of this type. Thus, a synthesis was made of the available evidence regarding aspects derived from the basic research question, classifying and analyzing the found concepts in order to interpret what has been researched and published up to this moment.

2.1. Research Question

To focus on the research question and facilitate the literature search, a specialized framework called PICO (Patient, problem or population, Intervention, Comparison or control, and Outcome) [24] was used, which is commonly used in systematic reviews. Thus, the research question posed was:

How is the 2030 Agenda (problem–result) being deployed (intervention) in the world's engineering faculties (population)? The aim was to see what actions were being explicitly carried out in engineering faculties to contribute to the achievement of the Sustainable Development Goals.

Given that one of these objectives is Quality Education, this objective was considered implicit in all interventions, and what was sought were individual actions of a university or collaborations between different agents focused on the revision of curricula, or experiences addressed to teachers or students through the application of any teaching–learning or assessment strategy. Literature reviews that were also implementation-oriented were considered, but not dissertations on the importance of engineering faculties contributing to the Sustainable Development Goals, if they did not address how such contributions were or are being made.

2.2. Search Strategy

In this systematic review, articles from scientific journals and papers published in conference proceedings from 2015 to April 2020 were considered. These papers dealt with the implementation of the SDGs in engineering higher education institutions. The search was carried out in the Web of Science and SCOPUS databases, which were chosen for their relevance in this area. The keywords were "SDG*" and "engineering education," together with synonyms or derivatives of these keywords such as "Sustainable Development Goals," "2030 Agenda," "technological school," "technological institute," "polytechnic institute," and "polytechnic school". These criteria were searched in the fields of Article title, Abstract, and Keywords. Table 1 shows how these terms were combined to perform the search, as well as the complete search strategy in both databases, as requested by PRISMA, so that the searches can be reproduced. The two first authors selected the search terms and afterwards they contrasted them with those of the other two authors until the query to be applied was found in the databases. The two first authors carried out the search in the databases independently to check that the same results were obtained.

Table 1. Search terms and fields.

Database	Search Terms			Fields
Web of Science (WOS)	"Sustainable Development Goal*" OR SDG* OR "2030 Agenda"	AND	"engineering education" OR "technological school*" OR "technological institute*" OR "polytechnic institute*" OR "polytechnic school*"	Title Abstract Author Keywords Keywords plus
SCOPUS				Title Abs Key
WOS complete search	(("Sustainable Development Goal*" OR SDG* OR "2030 Agenda") AND ((engineering AND education) OR (technological AND school*) OR (technological AND institute *) OR (polytechnic AND institute*) OR (polytechnic AND school*)))			
SCOPUS complete search	TITLE-ABS-KEY ((("Sustainable Development Goal*" OR sdg* OR "2030 Agenda") AND ((engineering AND education) OR (technological AND school*) OR (technological AND institute*) OR (polytechnic AND institute*) OR (polytechnic AND school*)))) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015))			

The symbol "*" at the end of words whose endings could vary depending on whether they were used in the singular or plural.

2.3. Inclusion and Exclusion Criteria

The papers sought had to explain how the SDGs were developed in engineering schools around the world. Thus, papers that did not focus on engineering studies and/or did not explain how the SDG development was implemented in those studies were excluded. This process was developed in several stages, at the end of which 22 articles were obtained. These are the articles presented in this work. At least two of the four authors participated in parallel in all the phases, either for searching, selecting, or extracting data, in order to achieve the reliability and security of the process as recommended by PRISMA.

2.4. Trial Flow/Selection Process

A total of 122 articles were obtained in the search, 97 of which remained once the duplicates were removed. Those that did not contain in their title, as keywords, or in the summary the concepts searched for (SDG and engineering education) in any of their forms listed in Table 1 were excluded. After that, 29 additional articles were discarded. The abstracts of the remaining 68 were then analyzed to see if they covered the research question. The first two authors carried out this task, which led to a further discard, resulting in a total of 35 final articles that were analyzed in depth. Once the four authors agreed on the concepts to identify in the articles, these articles were distributed among three of the authors, so that two of them reviewed each article. For this reason, each author reviewed between 23 and 24 articles. The third author participating in this phase analyzed the cases in which there was discordance of results and the doubts were resolved by the three authors. In this last analysis 13 new articles were eliminated because they did not carry out an implementation of the Sustainable Development Goals, or did not directly deal with them. One of these 13 articles could not be analyzed because it was not accessible. Thus, data were finally obtained for 22 articles, which are analyzed in the following sections. The four researchers fully agreed on the selection process followed and participated in the identification of representative data to be extracted for analysis. These data were refined and clarified in subsequent stages. Figure 2 shows a flow chart of the whole process.

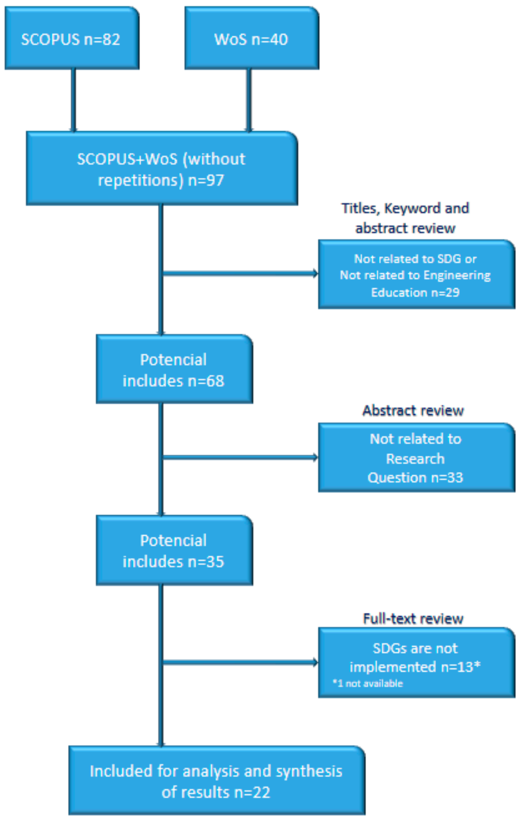

Figure 2. Flow diagram to show study selection process.

3. Results

In order to analyze the papers that were finally selected in this study, the main indicators of the research were identified. They were distributed in charts and tables to systematize the most relevant information: study descriptors (year of publication, origin, and publication details), kind of intervention, teaching–learning strategies proposed, stakeholder collaborations, and the conclusions of each study (SDG studied, main objectives, methodology, and conclusions). As mentioned above, a minimum of two authors independently analyzed the papers with the purpose of identifying the data relating to the indicators previously defined in our study. Once all the data were collected in a table, the four authors reviewed the results of each article, one by one, to determine its relevance and made a consensus to report the results shown in the following sections.

3.1. Study Descriptors

Following our search criteria, a total of 22 papers were selected out of the first list of 35. These were the 22 that addressed topics related to our research in the period studied (2015–April 2020).

Before starting the reading of the articles, the four authors suggested what could be the important concepts to be taken into account in the implementation of the SDGs in engineering studies, resulting in Tables 1 and 2 and in the three main categories shown in Tables 3–5. Similarly, for each of these categories, possible answers were identified, not incompatible with each other, that could be found when analyzing the articles.

As we can observe in Figure 3 there were a growing number of papers starting in 2017 (four papers), with an increasing percentage of around 50% in the following years (six papers in 2018, ten papers in 2019, and two papers in the first trimester of 2020)

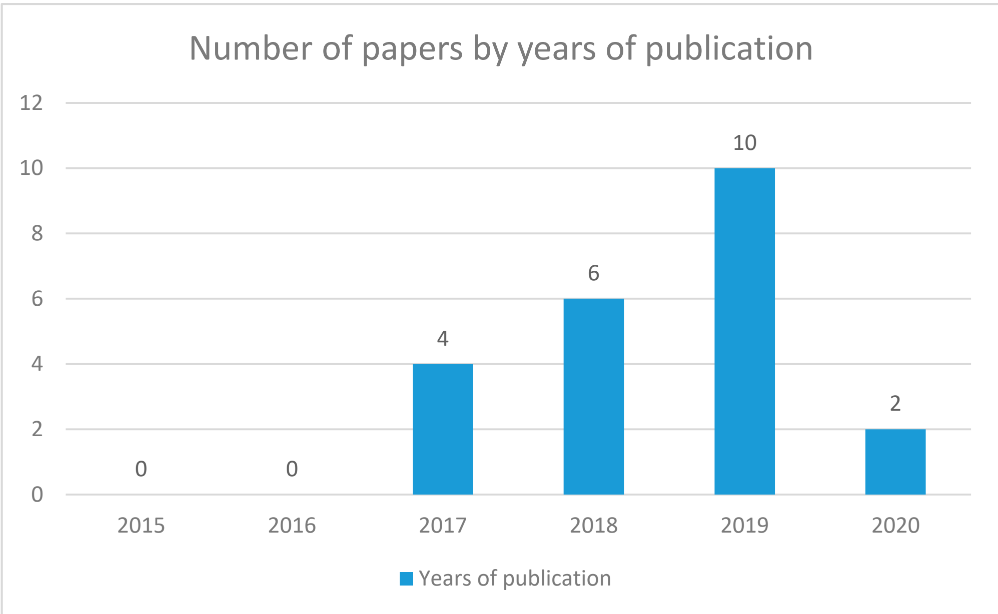

Figure 3. Number of published documents per year of publication (until 24 March 2020).

The authors' affiliations were broad, as can be observed in Table 2a. Ranked from highest to lowest, there were eight papers signed by authors from educational institutions in the USA, two from Australia, two from United Kingdom, and one each from another nine different countries around the world (six from Europe, one from South America, one from Africa, and one from Asia). As shown in Table 2b, eight papers were presented and published in the *ASEE Annual Conference and Exposition conference proceedings*, two papers were from the *European Journal of Engineering Education* and another two from the *Journal of Chemical Education*. The rest of the articles were published in eight different journals and proceedings.

Table 2. Researcher affiliation and publication in journals/conferences.

Doc.	Research Country	Doc.	Journal
[10,15,18,25–29]	USA	[15,18,26–31]	ASEE Annual Conference and Exposition, Conference Proceedings
[13,23]	Australia	[13,23]	European Journal of Engineering Education
[16,30]	United Kingdom	[11,25]	Journal of Chemical Education
[11]	Brazil	[16]	Journal of International Development
[14]	France	[32]	Sustainability (Switzerland)
[31]	Germany	[9]	Australasian Journal of Engineering Education
[12]	Japan	[12]	Proceedings of IEEE International Conference on Teaching, Assessment, and Learning for Engineering, TALE
[5]	Portugal	[5]	International Journal of Engineering Pedagogy
[4]	Russia	[14]	International Journal of Sustainable Engineering
[33]	South Africa	[10]	2018 World Engineering Education Forum–Global Engineering Deans Council, WEEF-GEDC
[32]	Spain	[33]	Proceedings of the 8th Research in Engineering Education Symposium, REES–Making Connections
[34]	Sweden		
	(a)		(b)

3.2. Interventions

In the case of interventions, the authors initially thought of six (collaboration between agents, experiences with teachers, new competencies and new learning outcomes, new subjects, new teaching–learning strategies, new extracurricular activities), but they finally considered only four: Collaboration between agents, experiences with teachers, review of academic plans, and new teaching–learning and assessment strategies. Taking into account these four types of interventions, the classification of each study is shown in Table 3:

Table 3. Classification of the papers selected by type of intervention.

Authorship	Type of Document			
	A	B	C	D
Abbott, Chipika, and Wilson (2020) [16]	X		X	X
Blatti et al. (2019) [25]	X	X		X
Brunell (2019) [26]	X			X
Cowan et al. (2017) [27]			X	X
Crespo et al. (2017) [32]				X
Desha, Rowe, and Hargreaves (2019) [9]	X		X	X
Dodson et al. (2017) [30]	X			X
Hirata (2019) [12]	X			X
Hogfeldt et al. (2018) [34]	X			X
Jahan et al. (2018) [28]	X		X	X

Table 3. *Cont.*

Authorship	Type of Document			
	A	**B**	**C**	**D**
Lepeshev et al. (2018) [4]	X			X
Malheiro et al. (2019) [5]	X			X
Mann et al. (2020) [13]	X		X	X
Oerther (2019) [18]	X			X
Serhan and Yannou-Lebris (2020) [14]	X	X	X	X
Smith, Teschner, and Bullock (2018) [15]	X			X
Smith, Tran, and Compston (2020) [23]	X		X	X
Tull et al. (2019) [10]	X			X
Willicks, Stehling, and Haberstroh (2018) [31]	X			X
Wolff, Van Breda, and Rodriguez (2019) [33]			X	X
Zelinka and Amadei (2017) [29]				X
Zuin et al. (2019) [11]				X

(A) Collaboration between agents, (B) Experiences with teachers, (C) Review of academic plans, and (D) New teaching–learning and assessment strategies.

As expected, all the papers addressed interventions related to teaching–learning strategies, and a great number (77%, 17/22) described different collaborations between agents. On the other hand, only two authors [14,25] analyzed and presented experiences with teachers.

3.3. Stakeholder Collaborations

In Table 4 we identify the typology of stakeholders with whom the different universities collaborated. Following the same structure as in previous tables, the following agents of collaboration were found: Other universities, non-governmental organizations, governments, companies, industry and technology centers, pre-university institutions, final users, quality agencies, and others.

In this case, a collaboration of technology centers was found that had not been taken into account at first. However, due to their role, they were assimilated into the functions of companies and industries.

The main collaborators we identified were other universities, companies, technological or industrial centers (A and D columns, 8/22, 36%). On the other hand, the relations with non-governmental organizations (column B, 1/22, 4.5%) was less used in the papers selected. The Other relations (column H) addressed multidisciplinary collaborations between different subjects, with diffusion of the results in different frameworks or generation of some type of partnership inside funded projects by different types of foundations.

Table 4. Types of stakeholders in collaboration with the universities and studies.

Authorship	Type of Document							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Abbott, Chipika, and Wilson (2020) [16]							X	
Blatti et al. (2019) [25]								X
Brunell (2019) [26]				X				
Cowan et al. (2017) [27]	Do not mention							
Crespo et al. (2017) [32]	Do not mention							
Desha, Rowe, and Hargreaves (2019) [9]	X	X		X			X	

Table 4. *Cont.*

Authorship	Type of Document							
	A	B	C	D	E	F	G	H
Dodson et al. (2017) [30]								X
Hirata (2019) [12]				X				
Hogfeldt et al. (2018) [34]	X		X	X		X		
Jahan et al. (2018) [28]					X			X
Lepeshev et al. (2018) [4]					X			
Malheiro et al. (2019) [5]	X							
Mann et al. (2020) [13]	X			X				
Oerther (2019) [18]				X				
Serhan and Yannou-Lebris (2020) [14]	X		X	X				
Smith, Teschner, and Bullock (2018) [15]	X					X		
Smith, Tran, and Compston (2020) [23]				X			X	
Tull et al. (2019) [10]	X							
Willicks, Stehling, and Haberstroh (2018) [31]	X							
Wolff, Van Breda, and Rodriguez (2019) [33]	Do not mention							
Zelinka and Amadei (2017) [29]	Do not mention							
Zuin et al. (2019) [11]	Do not mention							

(A) Other universities, (B) Non-governmental organizations, (C) Governments, (D) Companies, industry and technology centers, (E) Pre-university institutions, (F) Final users, (G) Quality agencies, (H) Others.

3.4. Teaching–Learning Strategies Proposed

Taking into account the teaching–learning and assessment strategies proposed, the following options were distinguished: sustainability rubric, final degree projects, flipped classroom, project-, challenge-, and problem-based learning, including inventive problem-solving, service learning, internship, practice-based education, laboratory experiment, and others.

This time, a couple of terms that had not been taken into account (Practice-based Education and Final Degree Projects) were found and added. Others were eliminated because they were not found in any article (remote laboratories).

In Table 5, we show the options addressed in each study:

Table 5. Classification of the papers selected by type of teacher or learning strategy implemented and its evaluation.

Authorship	Type of Document								
	A	B	C	D	E	F	G	H	J
Abbott, Chipika, and Wilson (2020) [16]				X					
Blatti et al. (2019) [25]				X	X				X
Brunell (2019) [26]		X							
Cowan et al. (2017) [27]	X								
Crespo et al. (2017) [32]	X								
Desha, Rowe, and Hargreaves (2019) [9]									X
Dodson et al. (2017) [30]									X
Hirata (2019) [12]									X

Table 5. *Cont.*

Authorship	Type of Document								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**
Hogfeldt et al. (2018) [34]				X					
Jahan et al. (2018) [28]								X	
Lepeshev et al. (2018) [4]				X					X
Malheiro et al. (2019) [5]		X		X					
Mann et al. (2020) [13]							X		
Oerther (2019) [18]			X					X	
Serhan and Yannou-Lebris (2020) [14]				X					
Smith, Teschner, and Bullock (2018) [15]		X		X					
Smith, Tran, and Compston (2020) [23]		X		X	X	X			
Tull et al. (2019) [10]									X
Willicks, Stehling, and Haberstroh (2018) [31]				X					
Wolff, Van Breda, and Rodriguez (2019) [33]				X					
Zelinka and Amadei (2017) [29]									X
Zuin et al. (2019) [11]				X				X	

(A) Sustainability rubric, (B) Final Degree Projects (Capstone Design), (C) Flipped Classroom, (D) Project-, Challenge-, and Problem-based learning, including inventive problem-solving, (E) Service learning, (F) Internship, (G) Practice-based Education, (H) Laboratory experiment, (J) Others.

Of the papers identified and studied 50% addressed issues related to learning methodologies focused in PBL and CBL (Project/problem- and Challenge-based Learning). Flipped Classroom, internship, and practice-based education approaches were only addressed by a single paper each. The Other approaches (J column) included interdisciplinary research projects, management of the university itself, specific tasks in the subjects, addressing of the gender gap from a national view, and reviews and compilations of conferences, seminars, and workshops.

3.5. Main Data and Conclusions of Each Study

Finally, in this section we collected and analyzed the fundamental ideas of the 22 analyzed works (in Table 6 as a resume, and after that in a more developed view), separating them by the SDGs worked in each paper, the aims, the method used, and the main results obtained.

Table 6. Summary of Sustainable Development Goals (SDGs) worked, methods, and results in the papers.

Authorship	SDG	Method and Results
Abbott, Chipika, and Wilson (2020) [16]	Do not specify	Problem-based Learning (PBL) and Case Studies. These methods woud allow the development of the SDGs with the competencies identified by US agencies for engineering studies. National quality agencies in Africa are needed for improving the studies' accreditation and the students' mobility.
Blatti et al. (2019) [25]	Do not specify	Research, dissemination, and service–learning projects. Educators can make a significant impact in their communities. Through science outreach, they can inspire students to impact positively on our planet and work toward building a sustainable and equitable future.

Table 6. *Cont.*

Authorship	SDG	Method and Results
Brunell (2019) [26]	Minimum of one in their Final Degree Project	Teamwork in the Final Project and with the support of professional mentors. They examined the impact to the environment, societal benefit, and economics. Students gained effective communication and social awareness of the global impact of their designs
Cowan et al. (2017) [27]	Do not specify	They designed and validated a sustainable rubric. The criteria identified as part of the previously discussed literature review were validated based on a survey of multidisciplinary experts, as well as a comparison to existing sustainable design frameworks. The students learned more efficiently about different dimensions of sustainability, established expectations for sustainable design, and self-assessed how well principles were applied to design projects.
Crespo et al. (2017) [32]	7,8,12,13	They designed a holistic sustainability rubric to assess student ability to incorporate sustainability principles into their work. Economic criteria were less considered and the environmental, technical, and social dimensions, the most considered.
Desha, Rowe, and Hargreaves (2019) [9]	Do not specify	An overview of key samples in Australia and the USA. They proposed that accreditation agencies update their documents, as well as educational institutions renew their students' graduation profiles and degrees.
Dodson et al. (2017) [30]	5,6	Engineering projects in a subject divided into two parts (humanities and engineering), taking into account humanistic thinking with the support of an interdisciplinary team of teachers. Students demonstrated acceptable levels of engineering knowledge within specific contexts. They also showed their desire to work for the SDGs and to consider criteria of social justice.
Hirata (2019) [12]	5,17	An active learning program designed in the STEM subjects so that students can experience which gender differences affect technologies and discover methods to prevent and resolve these aspects. The students became more sensitive to gender inequality and were able to implement learning from different subjects to achieve the solution.
Hogfeldt et al. (2018) [34]	Do not specify	Data mining from workshops, reflexive questionnaires, focal groups, stakeholders and people interested in electrical companies. High motivation, better abilities, collaborative work, and improvement of the continuous evaluation and feedback.
Jahan et al. (2018) [28]	2,3,6,7	Laboratory experiments with algae, projects, and lessons. The curriculum was successfully implemented in first-year engineering subjects and in high school classrooms.
Lepeshev et al. (2018) [4]	6,9,14,15	Literature review and verification based on experimentation. A new theory of inventive problem-solving (TRIZ) was defined. The hypothesis that the same technologies that have been used in a different way can be the solution was confirmed because of the analysis of existing cognitive technologies.
Malheiro et al. (2019) [5]	3, 7, 11, 12	Problems were proposed to students within the scope of the SDGs. They analyzed the reports and learning diaries of three team projects. The real learning framework provided students with a high degree of freedom in terms of marketing, sustainability, and ethics, and reinforced their technical–scientific and personal skills.

Table 6. *Cont.*

Authorship	SDG	Method and Results
Mann et al. (2020) [13]	4,5	Practice-based Education. Engineering training from a practice-based approach, with three premises: working on engineering practices in an authentic context; learning to be a student, engineer, and citizen; and generating opportunities to work and learn simultaneously. Clear benefits in learning and working at the same time in projects aligned with the SDGs.
Oerther (2019) [18]	Do not specify	Blended format, Flipped Classroom, mastery learning, and "buffet" evaluation. Students had different opinions depending on their characteristics; teachers thought that preparing a course like this was much more time-consuming than the traditional method. The buffet evaluation generated both new opportunities and new challenges, compared to a traditional grading system.
Serhan and Yannou-Lebris (2020) [14]	3,12	Using a Government call, a new curriculum was introduced called Idefi-Eco Trophelia, to train agri-food engineers to create food eco-innovations and introduce them to the market. Engineering students develop not only eco-design and innovation skills for new food products, but also entrepreneurship and management skills to design and carry out new business models.
Smith, Teschner, and Bullock (2018) [15]	Do not specify	Students developed a project through user-centered technologies. Students faced practical challenges, including time constraints and communications difficulties; these projects allowed students to understand the links between the social and technical dimensions of their projects.
Smith, Tran, and Compston (2020) [23]	Do not specify	Review of 67 engineering degrees to identify practices to preserve life and alleviate human suffering. It is necessary to ensure the education quality. International networks can serve as a basis to ensure that programs meet student expectations. A constructive dialogue should be opened to standardize the terms and common themes.
Tull et al. (2019) [10]	3,4,5,7	Students participated in a conference in which different universities met. They had previous learning activities. Students shared their answers of about 10 questions on Twitter. The topics covered in the reflections were too varied.
Willicks, Stehling, and Haberstroh (2018) [31]	Do not specify	Students participated in a real challenge to be solved. The best solutions will be implemented in the country to which they are addressed. Students self-evaluated their competencies before and after developing the project. Through Problem-based Learning, students learned specific and generic competencies.
Wolff, Van Breda, and Rodriguez (2019) [33]	Do not specify	Literature review of more than 50 case studies of engineering problem-solving in different engineering sectors that were brought to the classroom. They used Legitimation Code Theory (LCT) as an instrument. High degree of satisfaction in the students with the practice. They preferred the system proposed to the theoretical method.
Zelinka and Amadei (2017) [29]	Do not specify	An analytical impact approach to quantify the interactions between all the SDGs. They organized and prioritized those most likely to affect others. Analysis of the SDGs with the focus on influence and dependency with a cross-impact analysis. By focusing on the SDGs of Education, Water Sanitation and Hygiene, Energy, Cities, but especially Consumption, Governance, and Partnerships, it is possible to influence positively the other goals.

Table 6. *Cont.*

Authorship	SDG	Method and Results
Zuin et al. (2019) [11]	4,8,9,12,13	Doing the experiment and asking students. The study proved to be technically and pedagogically effective, showing that global problems can be useful tools to develop future professionals with a mentality of sustainability.

Abbott, Chipika, and Wilson (2020) [16] did not specify any particular SDG in their work. Given the importance of university studies in engineering for the betterment of Africa and considering that engineering plays a major role in at least 12 SDGs, the study aimed to make university engineering studies more attractive to students in Africa, including female students. Their approach was:

- Method: Using different references, the study defended the Problem-based Learning and Case Studies methodologies as the best methods in engineering education.
- Results: It is necessary to create national quality agencies in Africa for improving the studies' accreditations and the students' mobility. Problem-based Learning allows the development of the SDGs with the competencies identified by US agencies for engineering studies.

Blatti et al. (2019) [25] did not specify any particular SDG in their work. They focused the study on the generation of a positive impact on sustainability for the local community through the introduction of a new method that develops systematic thinking and creativity in chemical engineering through:

- Method: Introduction of research, dissemination and service–learning projects.
- Results: The educators have the power to make a significant impact in their communities, and, through science outreach, the educators can inspire students to make a positive impact on our planet and work toward building a sustainable and equitable future.

In Brunell (2019) [26], students selected a minimum of one SDG to work on in their Final Degree Project. The aim of the study was to show how using the United Nations Sustainable Development Goals along with the ASCE Envision Rating System would increase civil engineering undergraduate students' awareness of sustainability as they complete their capstone designs.

- Method: Working in groups for the Final Project and with the support of professional mentors. After the selection of one SDG at the beginning, the impact is examined with respect to the environment, societal benefits, and economics.
- Results: In additional to gaining familiarity with both the UN Sustainable Development Goals and the Envision Rating System, the experience of working closely with professional mentors requires the students to communicate effectively and become socially aware of the global impact of their designs (skills essential to all engineering graduates), whether they pursue careers in professional design or research.

Cowan et al. (2017) [27] did not specify any particular SDG, but they defined a sustainability rubric. The goal of this project was to develop and validate a sustainable design rubric that can be easily adapted and applied across engineering disciplines or for interdisciplinary problem-solving.

- Method: The rubric's constructs of sustainable design and their measures were validated in three phases, consistent with the Benson model of construct validity. The criteria identified as part of the previously discussed literature review were validated based on a survey of multidisciplinary experts, as well as on a comparison with existing sustainable design frameworks. Among other frameworks, the UN Sustainable Development Goals was developed to provide guidance to the global community on how to develop sustainably.

- Results: The students learned more efficiently about different dimensions of sustainability, established expectations for sustainable design, and self-assessed how well principles were applied to design projects.

Crespo et al. (2017) [32] addressed four SDGs: Affordable and clean energy, Decent work and economic growth, Responsible production and consumption, and Action for the climate. The goals of the study were to promote the consideration by students of sustainable development, and to obtain precise information on the strengths and weaknesses of students when incorporating the criteria of the SDGs to identify areas for improvement in the subject.

- Method: A holistic sustainability rubric was prepared to assess students' ability to incorporate sustainability principles into their work. Ten works based on SDGs in the subjects of the Master of Thermal Engineering at the University of Vigo were evaluated.
- Results: Students either did not consider or poorly considered economic criteria, and, on the other hand, they considered environmental, technical and social dimensions. Among the latter dimensions, the environmental sub-criterion was the most applied in the works, and the technical and social dimensions less so.

Desha, Rowe, and Hargreaves (2019) [9] did not specify any particular SDG, but they studied sustainability from a generic point of view. They reflected on the progress that has been made since engineering education began to facilitate the knowledge and skills necessary for compliance with the SDGs.

- Method: An overview of key samples in Australia and the USA.
- Results: The authors proposed that accreditation agencies update their documents, as well as educational institutions renew their students' graduation profiles and degrees, to ensure that their study plans develop the capacities and competencies necessary to achieve the objectives and indicators of the SDGs. They suggested conducting surveys in industries that are expert in sustainability and in the SDGs.

Dodson et al. (2017) [30] worked on two SDGs: Clean water and sanitation, and Gender equality. With the aim to study primarily how to motivate students to worry about the SDGs, they developed a set of competencies that they can help the students to achieve. They also trained the students from an engineering and humanitarian point of view, to gain the ability and inclination to help improve society.

- Method: Within a semiannual subject (Humanitarian Engineering Past and Present), they developed in two parts (humanities and engineering) engineering projects, taking into account humanistic thinking with the support of an interdisciplinary team of teachers.
- Results: Through interdisciplinary work, students demonstrated acceptable levels of engineering knowledge within specific contexts. They also showed their desire to work toward the SDGs and to consider criteria of social justice.

Hirata (2019) [12] focused his work on the Gender equality and Partnership goal from the SDGs. The goal was that students in STEM must develop skills that allow them to develop products and services that take into account aspects arising from gender differences. This approach was necessary because STEM education in Japan is based more on technological knowledge and its practical application and not as much on experiential knowledge of why gender inequalities occur and how they can be prevented.

- Method: An active learning program was designed in the STEM subjects so that students could experience which gender differences affect technologies and discover methods to prevent and resolve these aspects. A previous diagnosis was made in relation to the perception of differences by gender. After that, some cases were presented in which the students discerned which were the

structures that generated inequities and offered technical solutions using learning from different subjects. A Pre- and Post-questionnaire was made to check the changes in their perceptions of gender inequalities.
- Results: The students, after the experience, became more sensitive to gender inequality and were able to implement learning from different subjects to achieve the solution. The results obtained were communicated to the industry and society, as well as the need to educate students in these skills to collaborate in the achievement of SDG5.

Hogfeldt et al. (2018) [34] did not specify any particular SDG in their work. The challenge was related to the identification, analysis, and design of a proposal to address a socio-technical problem concerning the SDGs. In this study the aim was to analyze the changes in a Tanzanian University from a traditional methodology to a Challenge-based Learning approach.

- Method: Data mining from workshops, reflexive questionnaires, focal groups, stakeholders, and people interested in electrical companies.
- Results: High motivation, better abilities, collaborative work, and improvement of the continuous evaluation and feedback. All stakeholders, teachers, students, and authors of the challenges saw and understood the potential of Challenge-based Learning.

Jahan et al. (2018) [28] addressed the SDGs of Zero hunger, Good health and well-being, Clean water and sanitation, and Affordable and clean energy. The aim of this project was to promote the integration of engineering and the humanities from the first year of schooling by improving the teaching of fundamental engineering principles, emphasizing the link between engineering and the humanities, and encouraging students to pursue creative and conscientious solutions.

- Method: Laboratory experiments with algae, projects, and lessons.
- Results: The curriculum was successfully implemented in first-course engineering subjects and in high school classrooms.

Lepeshev et al. (2018) [4] focused on Clear water and sanitation, Preservation of marine ecosystems, Life and land, and Industry, Innovation and infrastructure SDGs. The goal of the project was the definition of cognitive technologies that will allow predicting possible ecological damages in order to prevent them, and the training of future engineers in the skills to solve ecological safety problems.

- Method: Literature review and verification based on experimentation.
- Results: A new theory of inventive problem-solving (TRIZ) was defined, as well as the didactic opportunities of the method. The hypothesis (that the same technologies that have been used in a different way can be the solution) was confirmed as a result of the analysis of existing cognitive technologies. TRIZ makes it possible to solve the problem of ensuring the stability of environmental protection.

Malheiro et al. (2019) [5] created relations between their project EPS@ISEP and the Good health and Well-being SDG, and analyzed other works related to the Affordable and non-polluting energy, Sustainable cities and communities, and Responsible production and consumption SDGs. The aim of the study was to promote, through SDG challenges, teamwork, communication, interpersonal relationship skills, and problem-solving in an international, multidisciplinary engineering environment. Specifically, they addressed the vision of how the Final Degree Project is worked, a work in which the development of products is sought to address sustainability problems.

- Method: Problems were proposed to students within the scope of the 17 SDGs. They analyzed the reports and learning diaries of three team projects.
- Results: The real learning framework provided students with a high degree of freedom in terms of marketing, sustainability, and ethics, and reinforced their technical–scientific and personal skills.

Mann et al. (2020) [13] addressed two SDGs: Inclusive education, and Gender equality. The paper raised Practice-based education as a comprehensive education approach that encompassed the complexity necessary to address the SDGs and gain authenticity in the learning environment.

- Method: They designed an engineering training from a Practice-based approach with three premises: working on engineering practices in an authentic context, learning to be a student, engineer, and citizen, and generating opportunities to work and learn simultaneously.
- Results: More research is needed about how to incorporate complexity and address different aspects of the Sustainable Development Goals within co-designed client projects. Moreover, there were clear benefits in learning and working at the same time on projects aligned with the SDGs, but the tension between work and learning must be taken care of. The Problem-based Learning method is normally integrated into traditional Study Plans, with the contents and evaluation giving rise to hybrid learning models (traditional + PBL), but, on the other hand, Practice-based Education (PBE) does not suffer from these limitations.

Oerther (2019) [18] focused his work on the People, the Planet, the Prosperity, the Companionship and the Peace goals. The aim of the project was to share the teaching format and the experience developed based on the five previous concepts.

- Method: They merged a blended format (classroom and online), Flipped Classroom, and sequential learning by levels of complexity (mastery learning) and "buffet" evaluation. Student characteristics and satisfaction were also collected from a mix of undergraduate and graduate students.
- Results: They found that students had different opinions, depending on their characteristics; teachers thought that preparing a course like this was much more time-consuming than the traditional method. The buffet evaluation was considered very appropriate since it generated both new opportunities and new challenges, compared to a traditional grading system. Because of the size of the sample, it will be necessary to repeat the experience in order to ensure the results. In addition, it will be necessary to monitor students in their professional practice to detect how these types of courses work the context of the industry.

Serhan and Yannou-Lebris (2020) [14] presented a mix of projects and approaches using one or more SDGs. The two projects presented were focused on the Health and well-being and Responsible production and consumption goals. The aim was to implement the SDGs in agricultural engineering, with two secondary objectives: that engineers and designers become aware of their responsibility in food reengineering and of their mission on the way to environmental transition; and secondly, the creation of teams of teachers, students, and industrial partners who are oriented towards conceptualization and will carry out sustainable food projects in an academic year, addressing one or more SDGs.

- Method: Using a Government call, a new curriculum called Idefi-Eco Trophelia was introduced to train agri-food engineers to create food eco-innovations and introduce them to the market. Students will understand better the complexity if they are trained in the SDG they must develop.
- Results: Through this program, engineering students developed not only eco-design and innovation skills for new food products, but also entrepreneurship and management skills to design and carry out new business models. In addition, they actively participated in a complex project, as required in their work on SDGs.

Smith, Teschner, and Bullock (2018) [15] did not specify any particular SDG in their work because they were more focused on the concept of developing projects for sustainability. The aim was analyzing how the engineering educators find creative ways to train students to support the Sustainable Development Goals and engage with stakeholders when there are not enough resources to take students to real contexts. This paper reported on two activities focused on incorporating sustainable development projects into engineering design courses.

- Method: Activities designed where the students must develop a project through user-centered technologies.
- Results: The main results were extracted from the students' reflections. Two major themes emerged from the qualitative data from both courses: the practical challenges that the students faced, including time constraints and communications difficulties, and on the other side, the ways in which these projects allowed students to understand the links between the social and technical dimensions of their projects. Drawing on these themes, the authors suggested that student participation in sustainable development projects with a focus on stakeholder engagement provides them with an understanding of the complexities and their roles in sustainable development projects.

Smith, Tran, and Compston (2020) [23] did not specify any particular SDG in their work. They collected different initiatives of engineering universities to promote a discussion among different countries and universities to ensure the integration of academic results with adequate and ethical practices. Their approach and main findings were:

- Method: Review of 67 engineering degrees to identify practices to preserve the life and alleviate the human suffering. They had three main research topics: international terms and the definitions used, study typologies and their recognition, and strategies to improve the education.
- Results: The variety of approaches raised the need to ensure the education quality. There are international networks that can serve as a basis to ensure that programs meet student expectations. A constructive dialogue should be opened to standardize the terms and common themes.

Tull et al. (2019) [10] focused their study on the SDGs Health and wellness, Quality education, Gender equality, and Affordable and clean energy. The goal was to encourage students to create mental connections between their own experiences and the concepts seen in the lectures, and the SDGs.

- Method: Students participated in a conference in which different universities met. They also had previous learning activities. They were asked about ten questions and had to share their answers on Twitter.
- Results: A total of 87 responses were obtained. The answers were classified by codes according to the topic, and 50 codes were obtained. The topics covered in the reflections were too varied.

Willicks, Stehling, and Haberstroh (2018) [31] did not specify any particular SDG in their work. The aim of the study was to raise students' awareness of the concept of civic commitment, to increase their interest in volunteer work in order to develop cooperation, and, at the same time, to train them in their degree competencies.

- Method: The fundamental methodology was the participation in a real challenge that students must solve. The best solutions would be implemented in the country to which they are addressed. In addition, students carried out a self-evaluation of their competencies before and after developing the project.
- Results: Through Problem-based Learning, students learned specific and generic competencies.

Wolff, Van Breda, and Rodriguez (2019) [33] did not specify any particular SDG in their work. In accordance with the UN, they presented a generic approach to working on various SDGs. They considered it important that students contribute to an increasingly complex society. The purpose of this paper was to show a realistic social approach to training engineering professionals in problem-solving through a theoretical vision of engineering practice derived from empirical, industry-based, and problem-solving research from the last decade.

- Method: Literature review of more than 50 case studies of engineering problem-solving in different engineering sectors that were brought to the classroom. They used Legitimation Code Theory (LCT) as an instrument.

- Results: High degree of satisfaction in the students with the practice. In general, they preferred the system proposed over the theoretical method.

Zelinka and Amadei (2017) [29] analyzed all the SDGs from a generic point of view. This article first emphasized the importance of incorporating the SDGs into engineering education, of informing engineers about their contribution to the SDGs, and of encouraging engineers to adopt a new systemic thinking mindset to address the SDGs in an integrated way. The aim was to demonstrate that the SDGs cannot be worked in isolation since one impacts on the other.

- Method: The authors proposed an analytical impact approach to quantify the interactions among all the SDGs and to organize and prioritize those most likely to affect others. They did an analysis of the SDGs, with the focus on influence and dependency with a cross-impact analysis.
- Results: The analysis showed that by focusing on the SDGs of Education, Water sanitation and hygiene, Energy, Cities, and especially Consumption, Governance, and Partnerships, it is possible to influence the other goals and help their success. Focusing on eliminating Poverty worsens poverty, as it inhibits other goals that impact Poverty.

Zuin et al. (2019) [11] focused on various SDGs: Quality education; Decent work and economic growth; Industry, innovation and infrastructure; Responsible production and consumption; and Climate action. The aim of the paper was to analyze the effectiveness of including green and sustainable chemistry in an experiment for first-year chemistry students.

- Method: Doing the experiment and asking students.
- Results: The study proved to be technically and pedagogically effective, showing that global problems can be useful tools to develop in future professionals a mentality of sustainability.

4. Discussion

The research question in this review of how engineering faculties in the world are contributing to the achievement of the SDGs finally led to the analysis of 22 papers. Figure 4 offers a synthetic view of them.

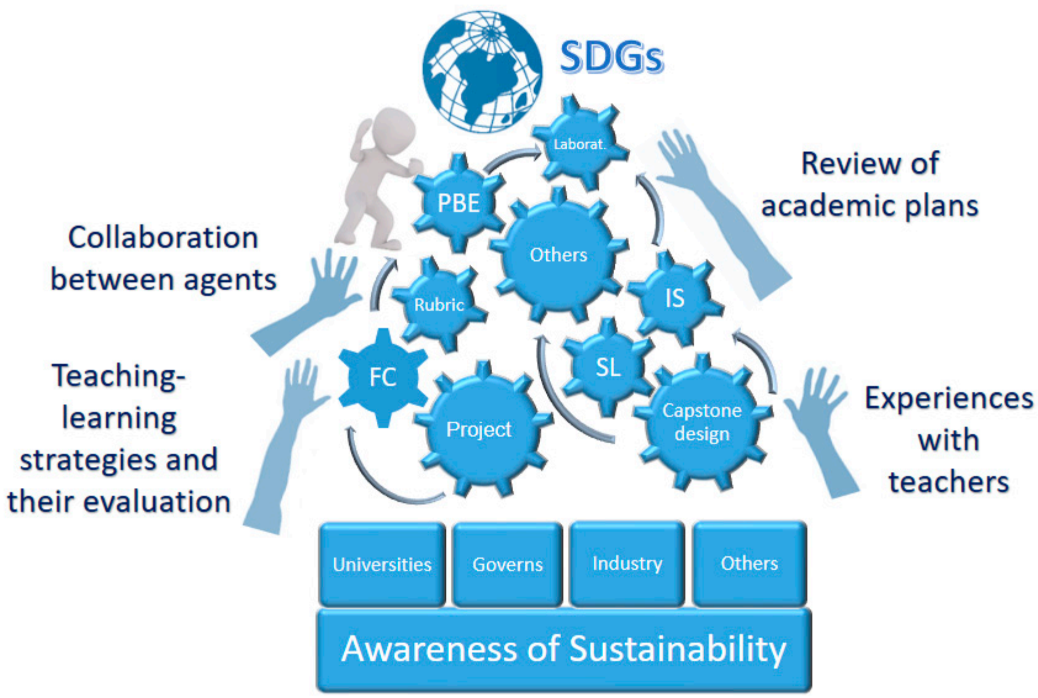

Figure 4. Synthesis of proposals.

It is a vertical structure that comes from the social awareness of the need to ensure the sustainability of the world we live in and culminates at its highest point in the achievement of the SDGs. The intermediate level is occupied by the prominent place given to engineering universities for their potential to promote the development of the skills and abilities required for the objective pursued. The intermediate gears show the necessary coordination between university management, the different collaborating agents, the professors, the service staff, and the students so that progress can be made towards the top through the curricula and the different teaching–learning strategies. At the base, the firm foundation of collaboration among the different stakeholders involved in sustainability supports the figure.

The United Nations, in drawing up its 2030 Agenda, focused on the global problem of sustainability and its 17 interrelated facets, as set out in the SDGs. The call for the participation and involvement of all agents in its achievement was one of the main catalysts for the awareness of the seriousness and complexity of the sustainability problem to which the analyzed papers refer. All of them highlighted the relevant role of engineering in this context, which is involved in at least 12 of the 17 SDGs [16]. The problem is complex, as evidenced by the multiple and profound interrelationships among them. Accordingly, Zelinka and Amadei (2017) [29] emphasized the need to organize and prioritize the objectives that can have a greater influence on the rest, to integrate them adequately into the engineering curricula. As an example, they pointed out that focusing first on the fight against poverty can worsen this objective as it inhibits others that have a strong influence on it.

Given this complexity, the collaboration of the university with its stakeholders is essential for both decision-making and implementation in everything related to sustainability. Among these collaboration agents are: (1) other universities, such as, for example, the collaboration between universities in Sweden and Tanzania to introduce new pedagogies in the latter [34]; the network of 19 European universities for the development of Capstone Projects [5]; or the consortium of French universities to respond to the initiative of the government to deploy SDGs in agricultural engineering [14]; (2) other disciplines within the same university, such as the case of chemical engineering students who are asked to carry out interdisciplinary projects that they must then explain to students from other areas [25], or the case in which a subject is divided into humanities and engineering and taught by an interdisciplinary team of teachers [30]; (3) pre-university institutions, such as the incorporation of an algae-based curriculum in the last year of secondary school and first year of undergraduate studies [28], or the project at a Russian university for the prediction of ecological damage and the resolution of ecological security problems [4]; (4) the business and industrial network, as for instance, to develop the End of Degree Projects with external mentors [26], as a destination for the analysis of gender inequalities in product design at the Japanese university [12], to train students while working [13] or, as in the case of the university in Tanzania, to carry out their projects in an electricity company [34]; (5) technology centers, where simulations are carried out [18]; (6) governments, as in the collaboration with the University of Tanzania [34], or the French public initiative for a new curriculum [14]; (6) non-governmental organizations, which provide fieldwork for students [9], and, finally, (7) the demanded collaboration with accreditation bodies and other quality institutions to discuss how to ensure and integrate academic outcomes with appropriate and ethical practices [23], to improve degrees in Africa and gain in mobility [16], or to collaborate, together with the other institutions involved, in determining the most appropriate attributes, competencies, and learning outcomes of an engineering graduate to help achieve the SDGs [9].

Stakeholders enable a debate in which they bring to the university their experience in "the real world" and give a voice to others who will be impacted by their future graduates' decisions. Only five of the total number of the analyzed papers did not explicitly contemplate collaboration with other agents: two of them were case studies in which a sustainability rubric for university projects was designed [27,32], another focused on the review of literature on case studies [33], another analyzed the interactions between SDGs [29], and a last one that was based on green chemistry experiments in the laboratory [11].

With the solid base of the contributions of the different stakeholders, it is up to the university to design the path towards the development of the engineer who works for sustainability. Given the close relationship between the technical, economic, political, and social aspects of this problem, an interdisciplinary approach among different subjects [12], taking into account the humanities [28,30], is considered fundamental for the development of the necessary systemic thinking [25,29], problem-solving [33], and creativity [25].

Eight authors referred to changes in the curricula of engineering education, either because they demanded that they achieve the SDGs [9,16,23,27] or they described a particular case in which they were changed [13,14,28,33] to progress in them. The rest described experiences that were more specific on certain subjects.

In any case, whatever changes are decided, a fundamental ingredient for the deployment of the 2030 Agenda in engineering studies is introducing the complexity and authenticity of the SDGs in the learning context [13]. For this purpose, collaboration with stakeholders is once again essential. The strategies described in the papers were very varied, depending upon the possibilities of a greater approach to reality: Practice-based Education (PBE), in which students learn by working [13]; Internship (IS) [23]; Challenge-based Learning [4,5,14,15,31,34]; Problem-based Learning [11,16,23,25,33]; the theory for inventive problem-solving (TRIZ) [4] (all of them based in projects); Service learning (SL) [23,25]; laboratory experiments and simulations [11,18,28]. Some of these strategies were used to work on SDGs in the Capstone Projects [5,15,23,26] and in some cases, the best solutions were implemented in developing countries [31]. Others supported strategies focused on developing rubrics that help students learn the different dimensions of sustainability, set expectations for sustainable design, and self-assess the extent to which they can apply these principles in their projects [27] or rubrics that are used to evaluate student work to identify opportunities to improve their learning [32], Flipped Classroom (FC) [18], or conferences and seminars [10,29].

Going back to the top of Figure 4, we have the achievement of the SDGs. Those that were most frequently worked on in the papers were SDG6 on water [4,14,28–30], SDG7 on energy [14,28,29,32], SDG9 on industry [4,11,13,14], and SDG12 on production and consumption [11,14,29,32], all of them being consistent with engineering studies.

5. Conclusions

The analyzed papers focused their discourse on the importance of sustainable development. All of them mentioned the necessary achievements of the 2030 Agenda and its SDGs and pointed out the relevant role played by engineering.

Realizing that the professionals of tomorrow are the students of today, the authors set their sights on engineering education at university. There was a primary consensus regarding the need for collaboration among the different agents involved in sustainability, as well as the aspiration for a socially responsible Engineer profile. They also agreed that it is necessary for this professional to internalize the criterion of sustainability in its multiple manifestations when making decisions, as well as to take into account the interrelationship with other knowledge sciences. Thus, the curricula, competencies, and teaching–learning and assessment strategies of engineering degrees should be oriented towards them.

Considering the leading role of teachers in these changes, it was quite surprising to see the scarce reference made to their need for training [25], their efforts to introduce the proposed reforms [18], and their necessary research activity. There was also little reference to the necessary alignment of the management of the university itself to the achievement of the objectives [9]. Finally, only one of the papers described a public initiative oriented towards the achievement of the SDGs at the university—an experience of great success and importance, although short-lived because of the arrival of budget cuts [14]. All these aspects point to the possibility of future research.

Some of the papers were theoretical, reflective, and propositional; in others, the authors described good practices for the intended purpose. In any case, there was a lack of quantitative analysis to evaluate them, and this could be another future line of research.

The limitations of our review are that only two databases were used for the selection of the papers, that only articles and conference papers were considered, that the search came up to April 2020, and that the approach was generalist and not focused on any particular SDG or on any particular field of engineering. All of them may also imply future research.

Author Contributions: Conceptualization, S.R. and M.A; methodology, S.R. and M.A.; formal analysis, S.R., M.A. and D.A.; investigation, S.R.; resources, D.F.; writing—original draft, all authors; writing—review and editing, all authors; visualization, D.F. and S.R.; project administration S.R; funding acquisition, D.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was co-funded by the support of the Secretaria d'Universitats i Recerca of the Department of Business and Knowledge of the Generalitat de Catalunya with the help of 2017 SGR 934, and also the research that led to these results was carried out using funds from "Obra Social–la Caixa" and aid for the intensification of the research activity of the PDI (Personal Docente Investigador) of the URL (Ramon Llull University) for the first term of the course 2019–20 (rector resolution URL/R21/2019) with the number: 2019-URL-IR1rQ-043. The paper also addresses the aims of the project "Improving social and collaborative competences of undergraduate students using active methodologies. A mixed assessment approach", presented at the VI Call of ACM (Aristos Campus Mundus) Research Projects—2020.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Transforming our world: The 2030 agenda for sustainable development. In *A New Era in Global Health*; Springer: Berlin, Germany, 2018.
2. Teh, S.Y.; Koh, H.L. Education for sustainable development: The STEM approach in Universiti Sains Malaysia. In *World Sustainability Series*; Springer: Berlin, Germany, 2020; pp. 567–587.
3. Schneider, P.; Lüderitz, V. Integration of ecosystem services as part of the nexus approach into the applied teaching of ecological engineering. In *World Sustainability Series*; Springer: Berlin, Germany, 2018; pp. 369–387.
4. Lepeshev, A.; Kuimov, V.; Sidorkina, O.; Kozlov, A.; Pogrebnaya, T. Ecological engineering of the sixth innovation wave in system of continuous training and Municipal Facilities Development. In Proceedings of the MATEC Web of Conferences, Ho Chi Minh City, Vietnam, 2–5 March 2018; Volume 170.
5. Malheiro, B.; Silva, M.F.; Ferreira, P.; Guedes, P. Learning engineering with EPS@ISEP developing projects for smart sustainable cities. *Int. J. Eng. Pedagog.* **2019**, *9*, 33–49. [CrossRef]
6. Tovar, E.; Tabuenca, B.; Alzaghoul, A.; Kloos, C.D.; Sluss, J.; López-Rey, Á.; Ruiz, E.; García-Loro, F.; Sancristóbal, E.; Artacho, M.R.; et al. Do MOOCs sustain the UNESCO's quality education goal? In Proceedings of the IEEE Global Engineering Education Conference, EDUCON, Madrid, Spain, 9–11 April 2019; Volume April-2019, pp. 1499–1503.
7. Trad, S.P.; Hadgraft, R.G.; Gardner, A.P. Sustainability invisibility: Are we hooked on technical rationality? In Proceedings of the 46th SEFI Annual Conference 2018: Creativity, Innovation and Entrepreneurship for Engineering Education Excellence, Copenhagen, Denmark, 17–21 September 2019; pp. 479–486.
8. Tien, D.T.K.; Namasivayam, S.N.; Ponniah, L.S. A review of transformative learning theory with regards to its potential application in engineering education. In Proceedings of the AIP Conference Proceedings, Selangor Darul Ehsan, Malaysia, 3–4 July 2019; Volume 2137.
9. Desha, C.; Rowe, D.; Hargreaves, D. A review of progress and opportunities to foster development of sustainability-related competencies in engineering education. *Australas J. Eng. Educ.* **2019**, *24*, 61–73. [CrossRef]
10. Tull, R.; Jangha, S.; Medina, Y.; Bell, T.; Parker, R. Sharing peace engineering with US-based minority students, through the UN's sustainable development goals, in Peru. In Proceedings of the 2018 World Engineering Education Forum-Global Engineering Deans Council, WEEF-GEDC, Albuquerque, NM, USA, 12–16 November 2018.

11. Zuin, V.G.; Segatto, M.L.; Zandonai, D.P.; Grosseli, G.M.; Stahl, A.; Zanotti, K.; Andrade, R.S. Integrating green and sustainable chemistry into undergraduate teaching laboratories: Closing and assessing the loop on the basis of a citrus biorefinery approach for the biocircular economy in Brazil. *J. Chem. Educ.* **2019**, *96*, 2975–2983. [CrossRef]
12. Hirata, S. Higher education practices accounting for gender differences in technological development as part of SDGs achievement. In Proceedings of the 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering, Wollongong, Australia, 4–7 December 2018; pp. 207–214.
13. Mann, L.; Chang, R.; Chandrasekaran, S.; Coddington, A.; Daniel, S.; Cook, E.; Crossin, E.; Cosson, B.; Turner, J.; Mazzurco, A.; et al. From problem-based learning to practice-based education: A framework for shaping future engineers. *Eur. J. Eng. Educ.* **2020**. [CrossRef]
14. Serhan, H.; Yannou-Lebris, G. The engineering of food with sustainable development goals: Policies, curriculums, business models, and practices. *Int. J. Sustain. Eng.* **2020**. [CrossRef]
15. Smith, N.M.; Teschner, B.A.; Bullock, R. Bringing sustainable development challenges into the engineering classroom: Applying human centered design protocols to artisanal and small-scale mining. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, 2018, Salt Lake City, UT, USA, 24–27 June 2018; Volume 2018-June.
16. Abbott, D.; Chipika, S.; Wilson, G. The potential of problem-based learning to enhance engineering education in African Universities. *J. Int. Dev.* **2020**, *32*, 44–61. [CrossRef]
17. Balbaert, J.; Park, J.; Marimon, R.; Serfozo, A.; Cazelles, M.; Domenic, S.C.; Speckstadt, A.; Skonieczna, K.; Rajnai, G.; Daza, J.P.; et al. Design of sustainable domes in the context of EPS@ISEP. In Proceedings of the ACM International Conference Proceeding Series, Jaipur, India, 21–24 September 2016; Volume 02–04-Nove, pp. 105–112.
18. Oerther, D.B. Introduction to environmental modeling: Results from a three-year pilot. In *Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings*; ASEE, Ed.; American Society for Engineering Education: Tampa, FL, USA, 2019; p. 17.
19. Vazquez-Brust, D.; Piao, R.S.; De Melo, M.F.D.S.; Yaryd, R.T.; Carvalho, M. The governance of collaboration for sustainable development: Exploring the "black box". *J. Clean. Prod.* **2020**, *256*, 120260. [CrossRef]
20. Giribabu, D. Mapping and scoping of the world concepts to the sustainable development goals: The first review. *Sustainable (USA)* **2019**, *12*, 310–322. [CrossRef]
21. Rashid, L. Entrepreneurship education and sustainable development goals: A literature review and a closer look at fragile states and technology-enabled approaches. *Sustainable* **2019**, *11*, 5343. [CrossRef]
22. Allen, C.; Metternicht, G.; Wiedmann, T. Initial progress in implementing the Sustainable Development Goals (SDGs): A review of evidence from countries. *Sustain. Sci.* **2018**, *13*, 1453–1467. [CrossRef]
23. Smith, J.; Tran, A.L.H.; Compston, P. Review of humanitarian action and development engineering education programmes. *Eur. J. Eng. Educ.* **2020**, *45*, 249–272. [CrossRef]
24. Schardt, C.; Adams, M.B.; Owens, T.; Keitz, S.; Fontelo, P. Utilization of the PICO framework to improve searching PubMed for clinical questions. *BMC Med. Inform. Decis. Mak.* **2007**. [CrossRef] [PubMed]
25. Blatti, J.L.; Garcia, J.; Cave, D.; Monge, F.; Cuccinello, A.; Portillo, J.; Juarez, B.; Chan, E.; Schwebel, F. Systems thinking in science education and outreach toward a sustainable future. *J. Chem. Educ.* **2019**, *96*, 2852–2862. [CrossRef]
26. Brunell, L. A real-world approach to introducing sustainability in civil engineering capstone design. In *Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings*; ASEE: Tampa, FL, USA, 2019; p. 18.
27. Cowan, C.; Barrella, E.; Watson, M.K.; Anderson, R. Validating content of a sustainable design rubric using established frameworks. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, Columbus, OH, USA, 25–28 June 2017; Volume 2017-June.
28. Jahan, K.; Forin, T.R.; Breen, R.; Hurley, P.L.; Pepe, E.E.; Shen, J.; Noshadi, I. Integrating humanities with engineering fundamentals. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, Salt Lake City, UT, USA, 24–27 June 2018; Volume 2018-June.
29. Zelinka, D.; Amadei, B. A methodology to model the integrated nature of the Sustainable development goals: Importance for engineering education. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, Columbus, OH, USA, 24–28 June 2017; Volume 2017-June.

30. Dodson, L.; DiBiasio, D.; Bergendahl, J.A.; Quinn, P.; Sullivan, J.M.; Gaudette, G.; Abel, C.; Boudreau, K. Knowing and caring about sanitation. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, Columbus, OH, USA, 25–28 June 2017; Volume 2017-June.
31. Willicks, F.; Stehling, V.; Haberstroh, M. Sustainable development goals meet "Third mission": The engineers without borders challenge in Germany. In *Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings*; ASEE, Ed.; American Society for Engineering Education: Salt Lake City, UT, USA, 2018; Volume 2018-June, p. 16.
32. Crespo, B.; Míguez-álvarez, C.; Arce, M.E.; Cuevas, M.; Míguez, J.L. The sustainable development goals: An experience on higher education. *Sustainable* **2017**, *9*, 1353. [CrossRef]
33. Wolff, K.; Van Breda, L.; Rodriguez, R. Trialling a problem-solving engineering learning environment. In *Proceedings of the 8th Research in Engineering Education Symposium, REES 2019-Making Connections*; SASEE, Ed.; SASEE: Cape Town, South Africa, 2019; pp. 733–740.
34. Hogfeldt, A.K.; Gumaelius, L.; Lantz, A.; Lujara, S. Understanding engineering education change with the introduction of challenge driven education in Tanzania. In Proceedings of the IEEE Global Engineering Education Conference, EDUCON, Salt Lake City, UT, USA, 17–20 April 2018; Volume 2018-April, pp. 1335–1343.