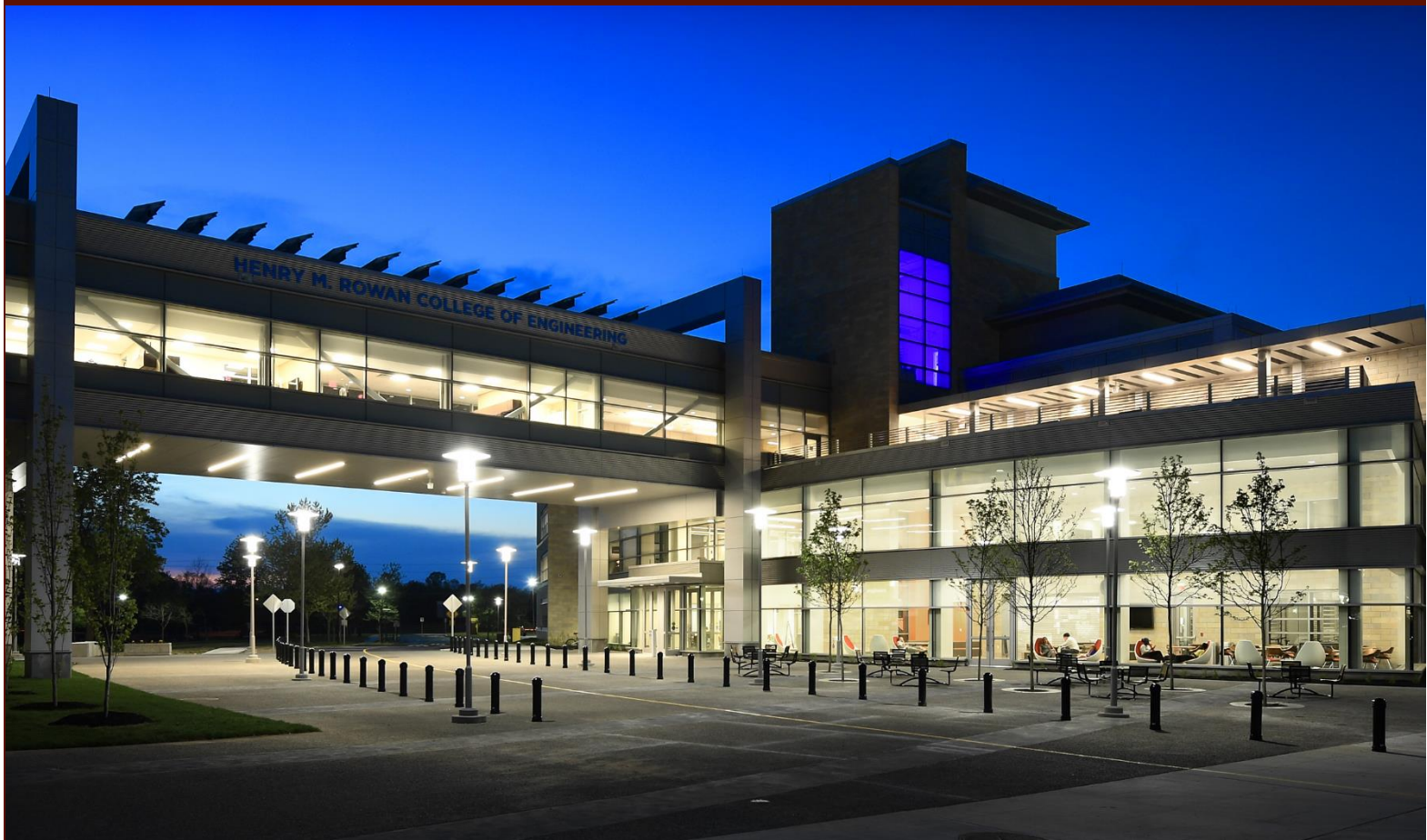


EESD 2018 PROCEEDINGS

ROWAN UNIVERSITY

June 3-6



CREATING THE HOLISTIC ENGINEER

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16 years of EESD. A review of the evolution of the EESD conference and its future challenges.

J. Segalas¹, R. Drijvers², J. Tijssen²

¹Research Institute for Sustainability Science and Technology. UPC-Barcelona Tech, Catalonia.

Jordi.segalas@upc.edu

²University of Applied Sciences Den Bosch, 's-Hertogenbosch. The Netherlands.

Abstract

Since the first Engineering Education in Sustainable Development (EESD) conference in 2002 in Delft, EESD has provided a platform for the exchange of concepts, policies, and strategies to enhance a sustainable education in engineering that train future engineering professionals with the appropriate competences to deal with sustainability challenges. During these 16 years (8 EESD conferences), engineering education has evolved and so has the EESD conference. This article aims to analyze the evolution of the EESD conferences and the future challenges of EESD through the characterization of all the papers (600) published and semi structured interviews to the coordinators of previous conferences.

Authors from The Netherlands, Catalonia and Sweden were responsible for publishing the largest number of articles (46%) and they have played key roles in the collaboration networks among the ten countries, whose authors published the majority of JCLP's articles. At the institutional level, the Universities TUDelft and UPC-Barcelona Tech were the universities with the largest number of articles (27%) and were central to the EESD's collaborative networking processes.

By investigating the co-occurrences of keywords, some topic clusters were identified. The categories that have most declined relevance during the EESD conferences are: Environmental Design, LCA and Management and policy; while Transdisciplinarity, Circular Economy, Ethics and philosophy have increased their relevance

The interviews to EESD conference organizers analysis shows that most argue that transdisciplinarity is crucial to improve EESD, that real EESD is not happening at the pace it should at universities; moreover, new topics and networking activities for conference organization are highlighted.

1 Introduction

In 2002, Delft University of Technology organized the first EESD conference in Delft. It was initially organized as an isolated event, but due to its success, in 2004 Universitat Politècnica de Catalunya Barcelona Tech took over and organized the second EESD conference in Barcelona. Since then EESD conferences have been organized (Table 1). EESD has provided a platform for the exchange of concepts, policies, and strategies to enhance a sustainable education in engineering that train future engineering professionals with the appropriate competences to deal with sustainability challenges. During these 16 years (8 EESD conferences), engineering education has evolved and so has the EESD conference.

Table 1: EESD Conferences data

Year	Country	Organizer	Theme	N° papers
2002	Holland	· Delft University of Technology	-	87
2004	Catalonia	· Universitat Politècnica de Catalunya – Barcelona Tech	-	106
2006	France	· Institut national des sciences appliquées de Lyon	-	51
2008	Austria	· Graz University of Technology	Bridging the Gap	66
2010	Sweden	· Chalmers University of Technology · Royal Institute of Technology	Learning for Transformation	65
2013	United Kingdom	· Cambridge University	Rethinking the Engineer	89
2015	Canada	· University British Columbia	Cultivating the T-Shaped Engineer	73
2016	Belgium	· Ghent University	Building a circular economy together	63

The knowledge that is gathered by the EESD through the years can be very essential for changing the education systems in the future and can help the general knowledge of society regarding sustainability. To get a clear view of the evolution that the EESD made through the years and which connections are made between different authors, organizations and countries inside it is important to analyze the steps that have been made by the organization since its start in 2002 in Delft until the last conference in Bruges in 2016. This article aims to analyze the evolution of the EESD conferences and the future challenges of EESD through the characterization of all the papers published and semi structured interviews to the coordinators of previous conferences.

2 Methodology

The methodology used is the mix concurrent nested where the qualitative research is nested in the quantitative one. The quantitative analysis consist in applying bibliometric techniques using QDAminer software analysis of discourses and networks. The qualitative analysis consist of semi-structured interviews to past EESD conference coordinators.

2.1 Quantitative analysis.

Bibliometric techniques can provide a way to analyze quantitatively the development of academic literature (Tsay, 2008). In that context, the authors developed this review paper based upon bibliometric analysis techniques. The subjects of the analyses included countries, research institutions, keywords and Networks during the EESD history.

2.1.1 Categories and content analysis.

To investigate the contributions of the EESD papers and the possible future content trends, this research team analyzed the topical clusters. The keywords and titles of articles and abstracts were used as the basis

for the analyses. The word frequency was calculated to identify the topical clusters of research in the different dimensions of EESD.

2.1.2 The social network.

The social network analysis is a method of social science, which can be used to visualize networks based upon statistical and mathematical analyses (Ye et al., 2012). Social networks consist of two parts. The first is comprised of multiple points, which represent the social actors. The second was focused upon the collaborative interconnections between and among the researchers. (Jeong-Yeon et al., 2014). In this article, this method was also employed to investigate the collaborative relationships among countries and institutes.

2.2 Qualitative analysis.

Based in the qualitative results a semi structured interview was design. Coordinators (those coordinators has been involved in the scientific committee in most of the conferences) of EESD conferences where contacted to be interviewed by skype. All interviews took place between 25 June to 5 July 2017.

Table 2: EESD chairs interviewed data

Interviewed	Organization	Conference	Role	Response
Karel Mulder	The Hague University of Applied Sciences	EESD 2002	Chair	Interview
Didac Ferrer	Universitat Politècnica de Catalunya – Barcelona Tech	EESD 2004	Chair	Interview
Michael Narodoslowsky	Graz University of Technology	EESD 2008	Chair	Interview
Magdalena Svanström	Chalmers University of Technology	EESD 2010	Chair	e-mail
Richard Fenner	Cambridge University	EESD 2013	Chair	Interview
Bernard Mazijn	Ghent University	EESD 2016	Chari	Interview

The semi structured interview was organized around the next questions.

- Are you satisfied with the progress the EESD made through the years?
- Do you feel that there has been an evolution in the topics that are discussed over the years? Which one?
- Do you feel that the evolution, regarding the education of the ‘future engineer’ is developing quickly enough?
- How do you think the EESD will develop in the (near) future and what will the major topics be? Why?
- How do you think that the organization can be improved?
- What kind of activities can be used to stimulate the collaboration between authors and/or organizations during the conferences?

Moreover interviewed have the possibility to build new discourse during the interview.

3 Results and Conclusion

To investigate the publication characteristics of the EESD, 600 papers presented between 2002 and 2016 have been evaluated. The information analyzed from these articles included titles, keywords (when possible) and year of EESD conference.

3.1 Evolution of the numbers of papers in EESD since 2002 and 2016

600 papers has been presented in the history of EESD conferences. There is not a trend in terms on number of papers or authors (Figure 1 and table 3).

Table 3: The characteristics of papers presented in EESD conferences between 2002 and 2016.

Location + year	TP	AU	AU/TP	PG	PG/TP
Delft 2002	87	185	2,13	746	8,57
Barcelona 2004	106	242	2,28	1046	9,87
Lyon 2006	51	107	2,10	413	8,10
Graz 2008	66	147	2,23	605	9,17
Gothenburg 2010	65	174	2,68	593	9,12
Cambridge 2013	89	235	2,64	762	8,56
Vancouver 2015	73	199	2,73	584	8,00
Bruges 2016	63	172	2,73	449	7,13

*TP: The number of total papers presented per year; AU: The number of authors;
PG: The number of pages*

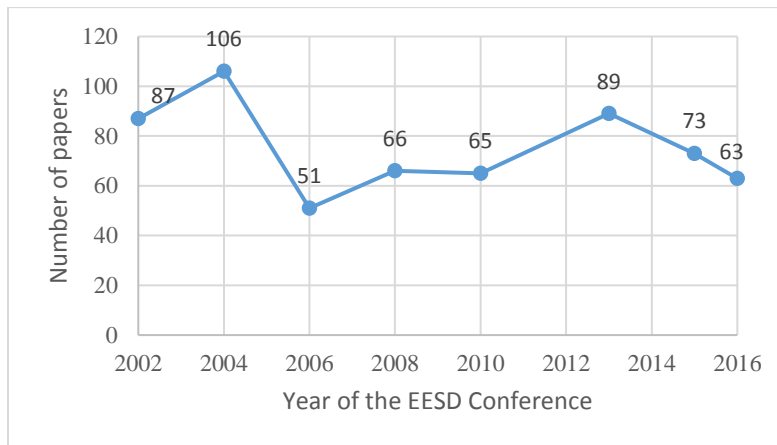


Figure 1: The number of papers per EESD Conference

The average of papers per conference of 75 papers and 182 authors. The number of authors per paper is also quite similar in all conferences with an average of 2.4 authors per paper but showing an increase of authors per paper in recent conferences.

3.2 The EESD paper distribution per country and academic institution

The contributions of authors from different countries/territories and academic institutions were evaluated by means of the addresses and affiliations of at least one author of each journal article. During the EESD conferences authors from 39 countries contributed to the conferences.

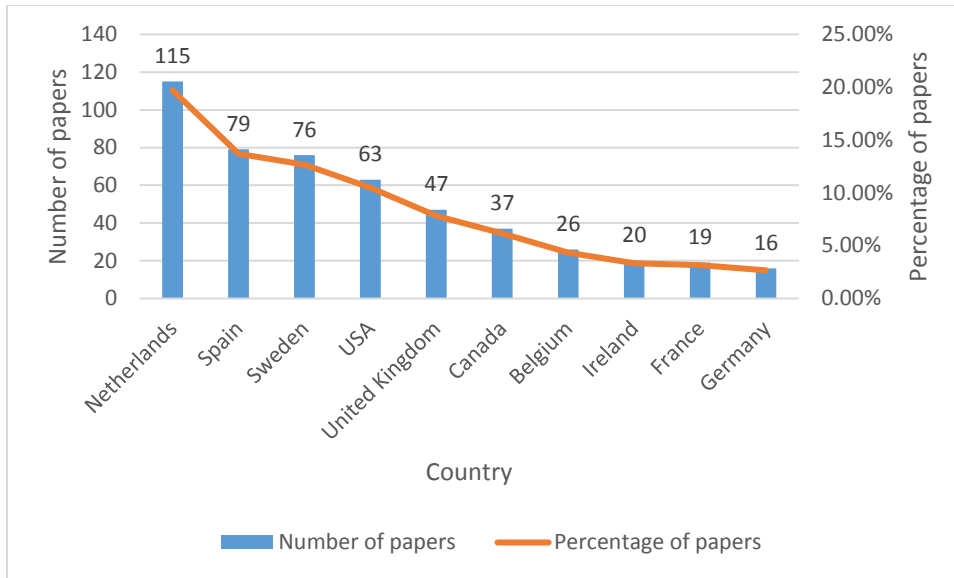


Figure 2: The number of paper presented in EESD Conferences by authors of the ten top countries.

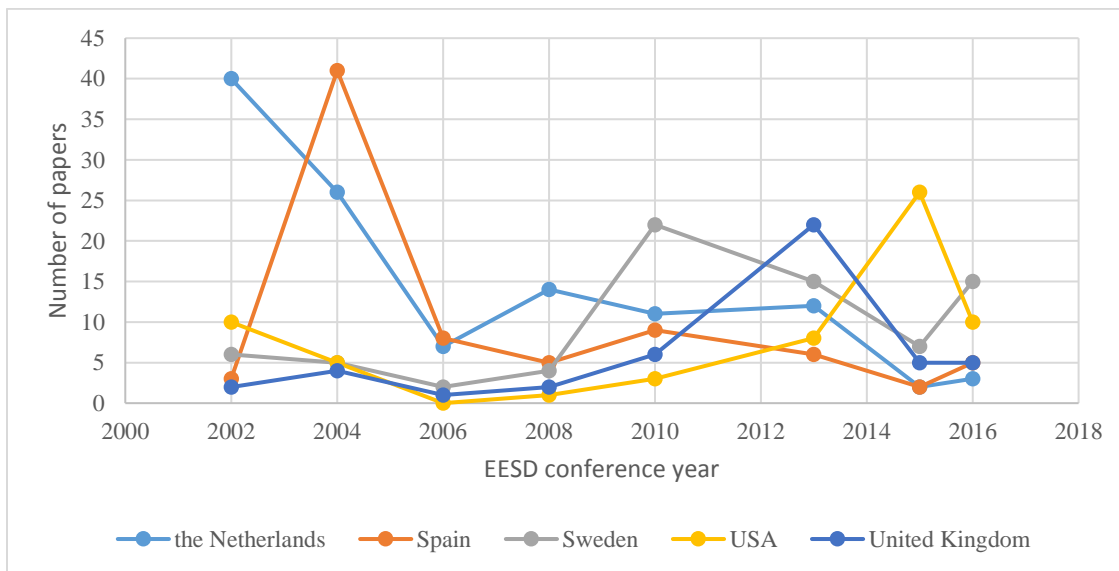


Figure 3: The number of papers in each EESD conference by authors from each of the top five countries.

The analysis shows that in terms of quantity of papers there is a considerable concentration in few universities and countries (Figure 2, 3 and 4). The most active universities are TUDelft and UPC, 80 papers each, from Holland and Catalonia respectively, which actually are the two initial organizers of the conference. An expected trend shows that the participation of “local” authors increases in each conference.

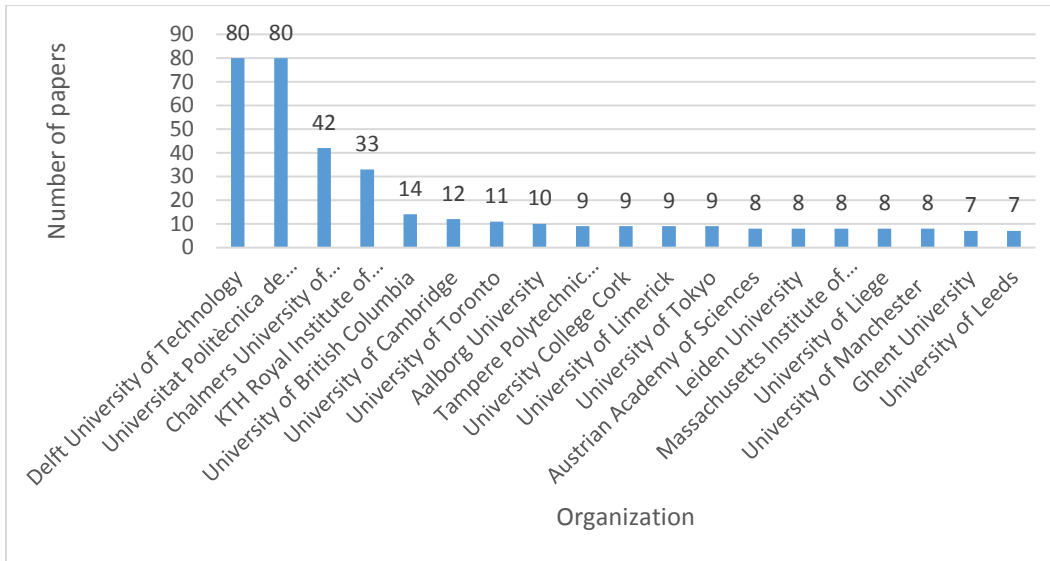


Figure 4: The number of paper presented by organization of the top ten organizations

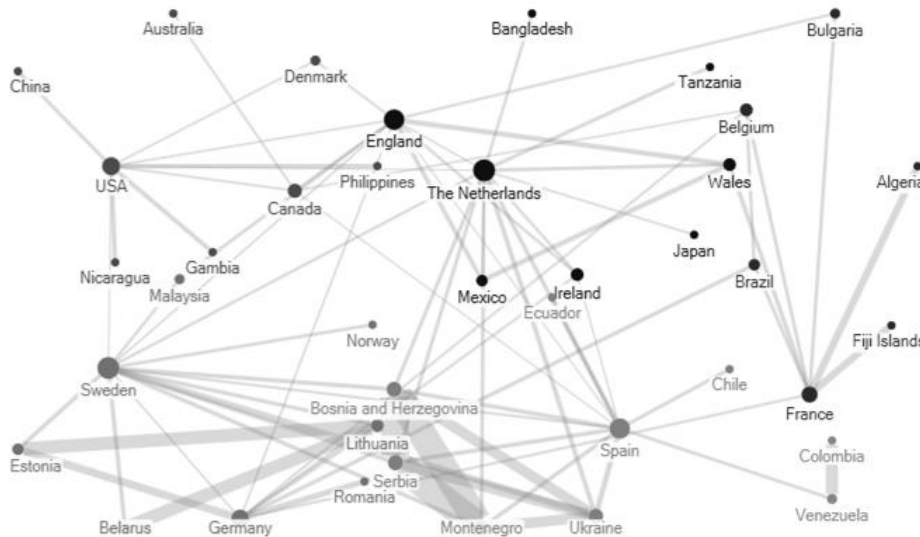


Figure 5: Network of countries that collaborated in one or more EESD-conference(s)

The cooperative relationships among the countries contributing to the EESD conferences have been documented, as presented by the cooperation network diagram in Figure 5. The share of one country regarding published papers for the EESD is shown in the size of each circle. The thickness of each line between two countries resembles the amount of times these two countries worked together on a paper. It's been found that Balkan countries show a strong network of collaboration. Sweden, The Netherlands and Spain appear as the most collaborative countries.

3.3 Keyword network analysis: distribution and trend.

The most discussed key-topics in EESD 2002 have been taken as a reference. Over time, some key-topics disappear and new ones were added. Some key-topics appeared in the papers under slightly different names while handling more or less the same matter. An example of this is environmental design. This key-topic

appeared in the papers under numerous slightly different names being, sustainable design, ecological design and eco-design. Every time one these key-topics was discussed in a paper it was coded under the name 'environmental design'. The same principle goes for the key-topic management and policy. This key-topic is a collective term for the search terms, sustainable management, environmental management and policy and management. Chemical engineering is a collective name for the search terms, chemical, mechanical, - and civil engineering. The key-topic integration, deals with both the integration as implementation of environmental practices in engineering studies.

The difference with between the key-topics renewing curriculum and integration is the fact that, renewing curriculum captures the papers that are about changing the curriculum of engineering curriculum that already deal with environmental and sustainable subjects.

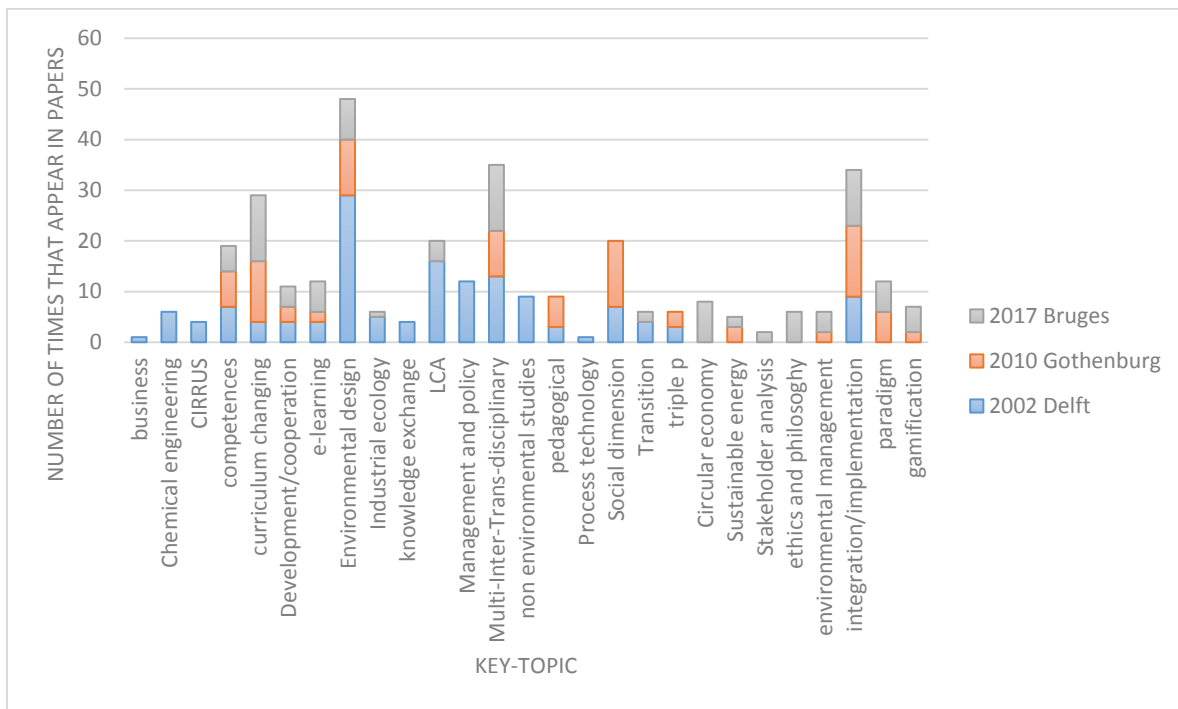


Figure 8: Network of countries that collaborated in one or more EESD-conference(s)

There are also clusters of key-topics based on terms that relate to each other. An example of this is, transition and backcasting. Both these key-topics discuss how to create a future image and how to influence it. Management and policy both discuss, making a change in a judicial sense. The terms, social dimension and ethics are merged in one key-topic because they both deal with changing the mind-set of nowadays society and making changes in the way of thinking of people to create a more holistic perception of their view of the world and to make them understand why this is necessary. E-learning captures all the papers that involve learning and education programs set up on the World Wide Web. The final set of key-topics that have been distinguished are: Competences; curriculum changing; triple P; integration; social dimension and ethics; multi-, inter- and transdisciplinary; paradigm; pedagogical; e-learning; gamification; circular economy; development/cooperation; transition and back-casting; social dimension; ethics and philosophy. Figure 8 shows the results in the first, intermediate and last EESD conference. The three most discussed key-topics in the last conference are multi-, inter- and transdisciplinary, integration and renewing curriculum are

omnipresent from the first EESD-conference in Delft until the last one in Bruges. However multi-, inter- and transdisciplinary was at the first conferences merely a topic that was discussed in other papers, it grew out to be a central theme in lots of papers in later editions. Key-topics in which the interest grew later on is learning through games. Although triple p was already discussed in Delft the interest in the topic really took a lift since Gothenburg and the later conferences, before falling into oblivion again during the conference in Bruges.

3.4 Interviews to EESD conferences' organizers.

Six out of eight organizers of EESD conferences has been interviewed (Table 2). Results of the interviews match the results of the key-topic analysis and most interviewed highlight transdisciplinarity as crucial to improve EESD, that real EESD is not happening at the pace it should at universities; The interview also show that the EESD made some progress regarding the education of the 'future engineer', but it is not enough. It is hard to convince universities and their teachers to change their way of education Interviewed claim that the social dimension of the sustainable education should play a bigger part during the conferences. The EESD should also take a more advising role towards universities. Another important topic that should be discussed in the future is how to organize a conference with new topics and networking activities like workshops and unconference methods.

4 Future view

The future view is based on both the quantitative and qualitative analysis. It seems that the European growth regarding participants of the EESD is stagnating; the core group is not growing nor changing in its composition. Therefore it is very likely a good step to expand the reach of the EESD and have more conferences outside of Europe. The first conference that took place in another continent was the conference in Vancouver in 2015. That conference formed the introduction for a lot of new members and it would a positive step if the same could happen in the U.S.A. When the conferences are every three years in Europe and alternately in the U.S.A., this would release the pressure on the core-group of the EESD who now have to (partly) organize a new conference approximately every two years. A negative side effect that European members only visit the conferences in Europe and the American members only the one on their continent.

Another future step of the EESD is to invite more students to the conferences. This could be stimulated by financing students for actively participating at the future conferences. Another option is to let students (partly) organize the conference itself. Students will bring innovating ideas, and get a better insight on the EESD itself. This will give the organization new impulses and a better dynamic between the different generations that are trying to achieve the same goals. It will also help to stimulate collaborations between organizations, universities and third parties.

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