European Journal of Engineering Education

ISSN: 0304-3797 (Print) 1469-5898 (Online) Journal homepage: http://www.tandfonline.com/loi/ceee20

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To cite this article: Rui M. Lima, Pernille Hammar Andersson & Elisabeth Saalman (2017) Active Learning in Engineering Education: a (re)introduction, European Journal of Engineering Education, 42:1, 1-4, DOI: 10.1080/03043797.2016.1254161

To link to this article: https://doi.org/10.1080/03043797.2016.1254161

EUROPEAN JOURNAL OF ENGINEERING EDUCATION, 2017
VOL. 42, NO. 1, 1–4
http://dx.doi.org/10.1080/03043797.2016.1254161

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Active Learning in Engineering Education: a (re)introduction

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ABSTRACT

The informal network 'Active Learning in Engineering Education' (ALE) has been promoting Active Learning since 2001. ALE creates opportunity for practitioners and researchers of engineering education to collaboratively learn how to foster learning of engineering students. The activities in ALE are centred on the vision that learners construct their knowledge based on meaningful activities and knowledge. In 2014, the steering committee of the ALE network reinforced the need to discuss the meaning of Active Learning and that was the base for this proposal for a special issue. More than 40 submissions were reviewed by the European Journal of Engineering Education community and this theme issue ended up with eight contributions, which are different both in their research and Active Learning approaches. These different Active Learning approaches are aligned with the different approaches that can be increasingly found in indexed journals.

ARTICLE HISTORY
Received 15 October 2016
Accepted 17 October 2016

KEYWORDS
Engineering education; Active Learning; project-based learning

1. Introduction

Active Learning practices have been included in Engineering Education programmes following recommendations from Engineering professional associations like the European Society for Engineering Education (SEFI) and the Active Learning in Engineering Education (ALE) network, political organisations like UNESCO, and national and international accreditation organisations of programmes like Accreditation Board for Engineering and Technology (ABET) and European Network for Accreditation of Engineering Education (ENAEE). The recommendation of Active Learning from those associations relate to the fact that learning is enhanced in Active Learning environments. But what does Active Learning really mean in Engineering Education and how is it executed in the best way in teaching practice? The main purpose in this special issue is to go back to the origin of Active Learning and there from take a leap towards some of the newest examples from Engineering Education practices where Active Learning is used as the main teaching method to meet some of the present developments in Higher Education.

Using the Elsevier Scopus search service (https://www.scopus.com/), it was possible to identify, on 31 July 2016, 17,523 documents published in indexed journals, which used the term 'engineering education'. The term was used to search simultaneously in title, abstract and keywords. In this number of documents, it is possible to identify documents specifically related to Active Learning. Using the same criteria and adding new specific terms allowed creating Table 1. Although this method could be improved, it allows getting a general perspective on the number of documents published in journals that are simultaneously related to 'engineering education' and Active Learning.

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Table 1. A perspective on the number of documents related to Active Learning in Engineering Education.

Terms	Results
'engineering education'	17,523
'engineering education' AND [all terms below included]	751
'engineering education' AND 'problem based learning'	225
'engineering education' AND 'project based learning'	224
'engineering education' AND 'active learning'	212
'engineering education' AND 'outreach'	133
'engineering education' AND 'flipped'	18
'engineering education' AND 'design based learning'	12
'engineering education' AND 'research based learning'	2

Using this search method it was possible to identify 751 published documents in journals since 1985, related to Active Learning in Engineering Education, and the growth till 2015 shows the increased importance of the topic for the engineering education community (Figure 1). In the first seven months of 2016, there are already 69 published documents in indexed journals, which makes expectable that the total number of published documents in 2016 to be greater than the 98 published documents of 2015.

2. The Active Learning theme issue

In order to revitalise the discussion of the meaning and usefulness of Active Learning in Engineering Education, the *European Journal of Engineering Education* (EJEE) presented this special issue to promote the investigation and reflective practice on this area of study. It has been a pleasure to invite teachers, researchers on Engineering Education, deans of Engineering Schools and professionals concerned with Engineering Education to submit papers to this special issue in Active Learning in Engineering Education. This special issue got a tremendous attention from the community and received more than 40 submissions. Approximately half of these submissions were included in the initial set of articles sent for reviewing. Each article was reviewed by three reviewers of the EJEE, in each of the reviewing phases. Most of the articles were accepted in the third phase of reviewing, and a few number of articles were accepted during the second phase and others in the fourth phase. We thank the editor in chief for his support and vision, all the reviewers for their efforts and scientific evaluations, and the authors who made this theme issue possible.

The large number of submissions and support from the Engineering Education community reinforced the vision that the discussion is important and gave the editorial team the opportunity

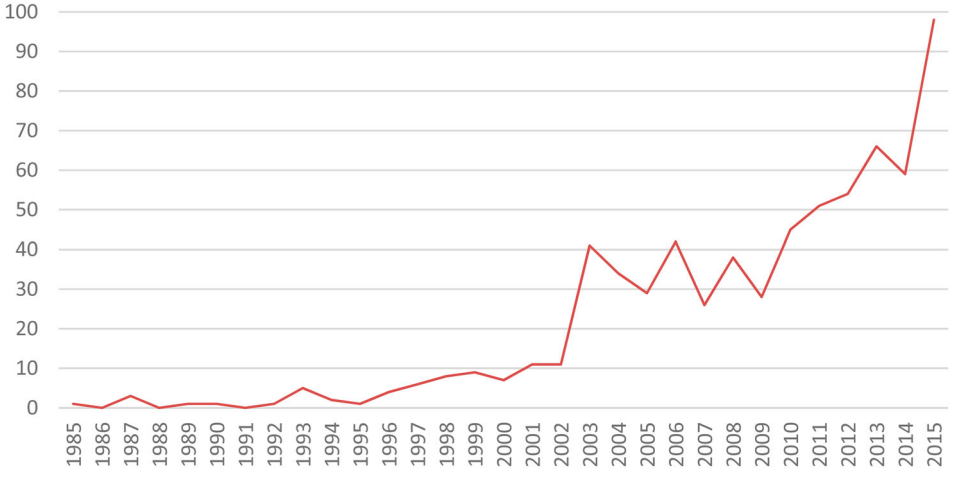

Figure 1. A perspective about the growth of published documents on Active Learning in Engineering Education.

to put efforts to create a diverse but coherent issue, with sound research-based articles, in which, every article had to present a research perspective on Active Learning.

This special issue welcomed submissions that focus on the following issues (not limited to), related to Active Learning methodologies and principles:

- Designing learning environments
- Managing the Institutional change
- Preparing teachers and students
- Assessment of student learning
- Learning in teams
- Interaction with business organisations
- Interdisciplinarity
- Development of competences
- Innovative experiences in engineering education
- Innovation and Entrepreneurship
- Research in Active Learning
- Active Learning Classroom
- Active Learning and Information and communications technology support
- Education for sustainability
- Professional needs

At the end, we were able to collect a set of great contributions with different research approaches, quantitative, qualitative and hybrid. The first paper of the theme issue, after this introduction, is authored by Christie & de Graaff and acts as a conceptual background for Active Learning, creating a work of reference for current and future researchers and practitioners. After that, the reader can find a work by Koch, Dirsch-Weigand, Awolin, Pinkelman & Hampe that researched more than 1000 first-year students enrolled in an interdisciplinary project, and found that this 'fulfil students' basic psychological needs for competence, relatedness and autonomy and enhance students' academic engagement'. The following work, by Canu, Duque and de Hosson, presents didactical engineering framework as a base for conceptual change in students' equilibrium and stability understanding. Lucke, Dunn and Christie present an increase in the level of student engagement by combining the flipped classroom concept with a student-response system. The research–learning nexus is discussed in a contribution supported by a case study of inquiry and research-based learning authored by Wallin, Adawi and Gold. Beyond the usual limits of the engineering education, Fogg-Rogers, Lewis and Edmonds present a work studying the learning impact of joining engineering students and pre-service teachers in an engineering outreach programme in primary schools. Finally, it is possible to read the description and the results of project approaches, one from Fernandes, Afonso, Fonte, Alves and Ribeiro, analysing several years of results of a course aiming at the development of entrepreneurship capabilities among engineering students, and the other, from Gómez Puente and Jansen, analyses the design products of a second-year design-based learning approach in three consecutive academic years.

3. Final remarks

The papers in this EJEE issue support the view that Active Learning is learning which engages and challenges students using real-life and imaginary situations where students engage in such higher-order thinking tasks as analysis, synthesis and evaluation. In Active Learning environments students are engaged in meaning-making inquiry, action, imagination, invention, interaction, hypothesising and personal reflection.

We hope you will benefit from your reading of this special issue on Active Learning in Engineering Education and that you will be inspired in your teaching and enlightened in your understanding of Active Learning and its use in teaching practice to enhance learning among Engineering students.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Rui M. Lima is an Associate Professor of the Production and Systems Department, School of Engineering, University of Minho, Portugal. His main research interests are related to Industrial Engineering and Management fields: Project Management, Lean Production, University-Business Cooperation and Project-Based Learning. He is the current president of the Project Approaches in Engineering Education – PAEE association, and also the current chair of the steering committee of the Active Learning in Engineering Education – ALE network. Rui has chaired 10 international conferences since 2009. He has more than 120 publications in scientific journals, conferences and book chapters, and acted as invited editor of 4 special issues in indexed journals.

Pernille Hammar Andersson is Senior Executive Educational Development Officer at the educational development department, LearningLab DTU, at the Technical University of Denmark in Copenhagen. Her academic background is in psychology and educational science and she has extensive experience from working with development of Engineering Education at different universities. Pernille is the coordinator and responsible for the compulsory teacher training programme at DTU as well as other teacher training programmes and initiatives. She also works with a wide range of projects at DTU with the aim to develop and further enhance the quality of teaching and student learning. Scholarship of Teaching and Learning (SoTL) is the underlying paradigm for teaching development at DTU. Pernille supports DTU faculty in publishing about their teaching and participate actively in SoTL herself.

Elisabeth Saalman has a PhD in Physical Chemistry and Masters' Degrees in Education. She has a position as senior lecturer in Academic development at the Department of Engineering Education Research (EER) at Chalmers University of Technology. Elisabeth is proactive in the EER's current mission to help develop the competence of Chalmers teachers in the area of teaching, learning and supervision in higher education. She is at EER engaged in development and research in the higher education area. Elisabeth's research interests are Academic development and SoTL. SoTL provides the basis for Chalmers' view of pedagogical competence and for EER's mission to work with teachers' academic development.

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