Aalborg Universitet

Problem Based Learning and Sustainability

Practice and Potential

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PROBLEM BASED LEARNING AND SUSTAINABILITY

Practice and Potential

An inventory carried out at the Faculty of Engineering and Science, Aalborg University, Denmark

PROBLEM BASED LEARNING AND SUSTAINABILITY – PRACTICE AND POTENTIAL

- *An inventory carried out at the Faculty of Engineering and Science, Aalborg University, Denmark*

May 2014

Preface

This report documents the results of the study "Sustainability at the Faculty of Engineering and Science, Aalborg University – Practice and potential". The study was initiated in February 2012 and aims to investigate the integration of sustainability in engineering and science education at the Faculty of Engineering and Science, Aalborg University.

The Dean of the Faculty funded the study and the Centre for PBL and Sustainability, part of the UNESCO Chair in Problem Based Learning, hosted it. The study was overseen by a Steering Committee representing Faculty departments and carried out by an interdisciplinary working group.

The study was organised in two phases. This report is divided into four parts, containing the study's background (Part A), research methodology and findings from phase 1 (Part B), research methodology and findings from phase 2 (Part C), and final discussion, conclusion and recommendations of the study (Part D).

The authors would like to acknowledge the important contributions to the study as well as to this report from Professor Anette Kolmos, UNESCO Chair in Problem Based Learning; Associate Professor Jette Egelund Holgaard, Director, Centre for PBL and Sustainability and Professor Erik de Graaff, UNESCO Chair in Problem Based Learning. Responsibility for all mistakes and errors in this report of course rests solely with the authors.

AAU, May 2014

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Part A. Introduction to the PBL-SUS Study

The point of departure for the study "Sustainability at Engineering and Science, Aalborg University – Practice and potential" (PBL-SUS) is the fact that Aalborg University (AAU), like many other universities throughout Europe, has signed the COPERNICUS University Charta on sustainability. This commits the university to adopt and implement the COPERNICUS Guidelines, including but not limited to, integrating sustainability into the curricula taught at the university. Thus, the study set out to investigate to which extent this has already happened at the Faculty of Engineering and Science, AAU and how sustainability could be enhanced in the Faculty curricula.

The study has been carried out in two phases and at two different levels:

> *Phase 1: Educational management level*
> *Phase 2: Academic teaching staff level*

This internal report is divided into four parts:

This Part A only contains chapter 1, describing the background for the PBL-SUS study, stating the aims, objectives and research questions guiding the study and presenting a discussion and clarification of the two main concepts in the study: Problem Based Learning (PBL) and sustainability.

Part B reports on phase 1 of the study and includes three chapters. Chapter 2 outlines the research questions addressed in phase 1, chapter 3 discusses the methodology, chapter 4 presents the findings and chapter 5 discusses and summarises the findings from phase 1.

Part C reports on phase 2 of the study and is structured like part B, i.e. chapter 6 outlines the research questions addressed in phase 2, chapter 7 presents the methodology used, chapter 8 presents the findings from phase 2 and chapter 9 discusses and summarises these findings.

Part D of this report contains two chapters. In chapter 10 the scope and limitations of the study are described and findings from the two phases are compared and discussed. Furthermore, the chapter discusses and concludes to which degree the objectives of the PBL-SUS study have been achieved. Chapter 11 contains a number of recommendations for enhanced integration of sustainability into study programmes at the Faculty of Engineering and Science.

Table 1 shows the structure of the report.

Table 1 Illustration of the PBL-SUS

Part A:	Introduction to the PBL-SUS study
	Chapter 1: Background
	Presentation of overall research questions Clarification of concepts

Part B:	Phase 1
	Chapter 2: Research questions addressed in phase 1
	Presentation of research questions for phase 1
	Chapter 3: Methodology in phase 1
	Methodological considerations regarding document analysis, interviews and a staff seminar
	Chapter 4: Findings in phase 1
	Presentation of findings
	Chapter 5: Summary of phase 1
	Discussion of findings Answers to research questions

Part C:	Phase 2
	Chapter 6: Research questions addressed in phase 2
	Presentation of research questions for phase 2
	Chapter 7: Methodology in phase 2
	Methodological considerations regarding questionnaire, interviews and a staff seminar
	Chapter 8: Findings of phase 2
	Presentation of findings
	Chapter 9: Summary of phase 2
	Discussion of findings Answers to research questions

Part D:	Lessons learned and the way forward
	Chapter 10: Discussion and conclusion
	Scope and limitations Comparison and discussion of findings Discussion of objectives achieved
	Chapter 11: Recommendations
	Recommendations based on both phases of the PBL-SUS study

	References and appendices
	Joint list of references from phase 1 and 2 Joint appendices from phase 1 and 2

1 Background

This chapter starts by describing the COPERNICUS Charter and why it is an important document for a Faculty that strives to be "*…a driving force in the creation of sustainable development, locally, nationally and internationally*" (Dean, 2012). The chapter also presents the study's aim, the objectives and the research questions. It further discusses and clarifies the two underpinning concepts of this study, namely problem based learning (PBL) and sustainability. PBL is the learning approach used at the Faculty since the inauguration of the university in 1974 and most teaching staff are familiar with the so-called Aalborg model of PBL. However, sustainability is a "new" concept in so far that not all staff is necessarily familiar with what it may entail or how to integrate it in their teaching.

1.1 COPERNICUS Charta

Since the Brundtland Commission published the report "Our Common Future" (WCED, 1987), outlining the concept of sustainable development, several declarations on the role of higher education in securing the sustainability requested in the Brundtland report have been drafted.

The CRE-COPERNICUS University Charta is one of these declarations. It was drafted by the COPERNICUS CAMPUS (the Co-Operation Programme in Europe for Research on Nature and Industry through Coordinated University Studies) under CRE (The Confederation of European Union Rectors' conferences; later the Association of European Universities) and launched in Geneva 1993.

The Charta was, as of 2005, signed by more than 300 universities across Europe, with Aalborg University being one of the first universities to endorse the Charta in 1994. Figure 1.1 illustrates the involvement of Aalborg University in the Copernicus Alliance.

The original COPERNICUS Charta had the following 10 points of action, which Aalborg University, as well as other the signatories, has committed to work towards achieving:

1. Institutional commitment: Universities shall demonstrate real commitment to the principle and practice of environmental protection and sustainable development within the academic milieu.
2. Environmental ethics: Universities shall promote among teaching staff, students and the public at large sustainable consumption patterns and an ecological lifestyle, while fostering programmes to develop the capacities of the academic staff to teach environmental literacy.
3. Education of university employees: Universities shall provide education, training and encouragement to their employees on environmental issues, so that they can pursue their work in an environmentally responsible manner.
4. Programmes in environmental education: Universities shall incorporate an environmental perspective in all their work and set up environmental education programmes involving both teachers and researchers as well as students - all of whom should be exposed to the global challenge of environment and development, irrespective of their field of study.
5. Interdisciplinarity: Universities shall encourage interdisciplinary and collaborative education and research programmes related to sustainable development as part of the institution's central mission. Universities shall also seek to overcome competitive instincts between disciplines and departments.
6. Dissemination of knowledge: Universities shall support efforts to fill in the gaps in the present literature available for students, professionals,

decision-makers and the general public by preparing information didactic material, organizing public lectures, and establishing training programmes. They should also be prepared to participate in environmental audits.

7. Networking: Universities shall promote interdisciplinary networks of environmental experts at the local, national, regional and international levels, with the aim of collaborating on common environmental projects in both research and education. For this, the mobility of students and scholars should be encouraged.

8. Partnerships: Universities shall take the initiative in forging partnerships with other concerned sectors of society, in order to design and implement coordinated approaches, strategies and action plans.

9. Continuing education programmes: Universities shall devise environmental educational programmes on these issues for different target groups: e.g. business, governmental agencies, non-governmental organizations, the media.

10. Technology transfer: Universities shall contribute to educational programmes designed to transfer educationally sound and innovative technologies and advanced management methods.

(Copernicus Alliance, 2013)

While the 10 points of action offer general guidance they are not concrete enough to specify how to undertake the actions that are asked for. This offers room for creative solutions, but requires also that institutions explore and discuss how the points of action can be contextualised and implemented in the case of each specific institution, while the lack of specific guidance can also be a hindrance for true action and change.

In 2007 a group of partner universities came together and re-organised the COPERNICUS CAMPUS that was re-launched as the Copernicus Alliance in Graz, Austria in 2010, with Aalborg University being one of the founding members. The vision for this organisation is stated below:

The vision of the COPERNICUS Alliance is to promote the role of Sustainable Development in European Higher Education to improve education and research for sustainability in partnership with society.

(Copernicus Alliance, 2013)

In 2011 the COPERNICUS Charta was re-designed and released as CO- PERNICUS Charta 2.0. In this new version of the charter the 10 points of action have been replaced by *"the following target levels:*

- Inside higher education institutions
    - o sustainable development is given fundamental status in their strategy and all their activities, i.e. institutional commitment, sustainability ethics, and dissemination of knowledge;
    - o the creative development and implementation of comprehensive and integrated sustainability actions is promoted in relation to their functions in learning and teaching, research, internal and external social responsibility.
- In relation to the whole of education
    - o institutions of higher education pay particular attention to their role(s) in realising processes of lifelong learning for sustainable development by involving formal, non-formal and informal learning in this direction;
    - o Higher Education for Sustainable Development is promoted in European policymaking.
- In relation to society
    - o universities, against the backdrop of sustainable development, have to envision that, beyond being scientific institutions, they have to act as partners in regional networks;
    - o closer cooperation with other stakeholders in local communities is aspired to better respond to their needs and requirements as well as to learn lessons from personal and corporate experiences.
- In networks of universities
    - o knowledge on Education for Sustainable Development between European Higher Education and student organisations that work for sustainability is exchanged and enhanced;
    - o European Higher Education for Sustainable Development is represented in international committees on Education for Sustainable Development"

(Copernicus Alliance, 2013)

Compared to the 10 points of action the new target levels seem even less specific and operational in terms of offering specific guidance. Thus, it becomes more crucial that institutions themselves take up the discussion about the integration of sustainability and the fulfilment of the COPERNICUS Charta at their specific institution.

1.2 Overall aim, objectives and research questions

Given that AAU signed the original COPERNICUS Charta in 1994 and was a founding member of the re-launched COPERNICUS Alliance in 2010, it is appropriate that in 2011, 17 years after having endorsed the Charta, the University management asked the question to which extent the COPERNICUS Charta targets have been achieved. More specifically this question was asked for the Faculty of Engineering and Science concerning the study programmes at the Faculty.

The overall aim of this study was to present the status quo of sustainability integration in study programmes at the Faculty of Engineering and Science in order to inform future strategies to enhance such endeavours.

Specific objectives of the study were:

1. To map existing practices and interpretations of sustainability in engineering and science study programmes at the Faculty
2. To point at future strategies for implementing sustainability adjusted to the specific programmes.

The aim and the objectives were translated into two main research questions, each broken down in sub-questions. These research questions were as follows:

1. What has been achieved so far in terms of integration of the concept of sustainability in the study programmes at the Faculty of Engineering and Science at Aalborg University?
    a. How many programmes have already integrated aspects of sustainability?
    b. How is the concept of sustainability integrated, interpreted and delimited in relation to the different study programmes?
    c. What are the existing strategies for integrating sustainability in the study programmes at both management and staff level?

d. Which role does problem based learning play in designing and carrying out engineering and science teaching and learning activities that integrate key aspects of sustainability?

2. How can a better integration of sustainability in the study programmes be ensured?
   a. How can the potential for further integration of sustainability in programmes, projects and courses be enhanced?
   b. How can the already existing elements of sustainability be sustained?

As mentioned above the PBL-SUS study was carried out in two phases, phase 1 addressing the level of educational management and phase 2 addressing the level of academic teaching staff. Table 2 shows which research questions were addressed in which phases of the study.

TABLE 2 RESEARCH QUESTIONS AND THE RELATION TO THE TWO PHASES

	Existing practices	Future strategies
Phase 1: Educational management	RQ 1, incl. 1a, 1b, 1c and 1d	RQ 2, incl. 2a
Phase 2: Academic teaching staff	RQ 1, incl. 1a, 1b and 1d	RQ 2, incl. 2a and 2b

In the following section the two main concepts, PBL and sustainability will be discussed and clarified.

1.3 Clarification of Concepts

This study works with two main concepts – problem based learning (PBL) and sustainability. To ensure a common understanding of these concepts they are clarified for the reader in the following.

1.3.1   Problem Based Learning

Aalborg University is applying a problem based and project organised teaching and learning approach throughout all of its faculties which was introduced in connection with the establishment of the university in 1974. In particular, the

Faculty of Engineering and Science has contributed extensively to the development of PBL.

Content dimension:
Interdisciplinary
Exemplary
Theory – practice relation
Critical

Cognitive dimension:
Problem based
Contextualised
Action oriented
Experience based

Collaborative dimension:
Participant directed
Team organised
Dialogic
Democratic
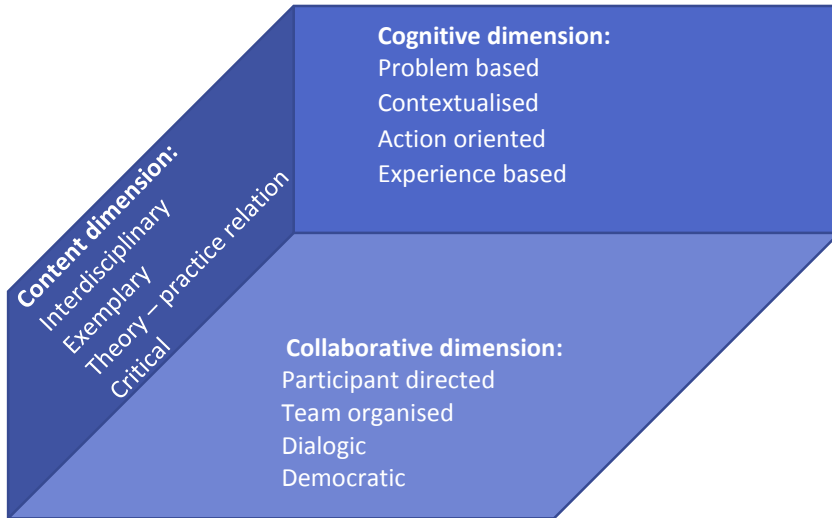
FIGURE 1.2 PBL LEARNING PRINCIPLES ALONG THREE DIMENSIONS. AFTER (GRAAFF & KOLMOS, 2003; QVIST, 2008)

Problem based learning takes its point of departure in the learning theory called social constructivism, i.e. students learn by actively constructing knowledge, based on the information inputs that they receive from multiple sources of information and in active interaction with their surroundings, including peers, teachers, experts, etc. The main learning principles of the PBL approach to teaching and learning can be organised into three dimensions: cognitive, collaborative, and content (see figure 1.2).

Based on the learning theory and the main learning principles of PBL the PBL philosophy has been used by a number of universities. The focus on learning in practice in the various university contexts means that PBL is applied differently in each place.

The current and most frequently used structure of study programmes at the Faculty of Engineering and Science is based on a semester of 30 ECTS (European Credit Transfer System), roughly corresponding to between 800 and 900 study hours. The problem based and project organised group work constitutes half of the students' workload, i.e. 15 ECTS, while the remaining 15 ECTS is divided equally between 3 courses á 5 ECTS each. All study modules, whether projects or courses, are described in the curriculum which is approved by the Dean.

The challenge for the students is to demonstrate at the end of a project that they are competent to apply theories and concepts learned in the courses and use skills acquired through the courses in the process of solving a meaningful, thematically relevant, contextualised problem through their project work. The contextualised nature of this teaching and learning philosophy often requires that teachers and students to work in multi-disciplinary teaching and learning environments.

1.3.2   Sustainability

Sustainability is part of a dominant discourse in society and thus an ubiquitous concept that is interpreted in multiple different ways. In the PBL-SUS study it was important to have a shared understanding of the concept of sustainability between the researchers, in order to appropriately analyse materials and communicate this shared understanding to the participants in the study.

Commonly, sustainability is linked to the Brundtland definition of sustainable development:

> *Development, which meets the needs of the present without compromising the ability of future generations to meet their own needs*
>
> <div align="right">(WCED, 1987, page 34)</div>

However, this definition is too loose to be useful for this study, therefore a more precise description was needed. According to Vos (2007) nearly all definitions of sustainability share three core elements:

Firstly, they "*present a way of looking at environmental problems in relation to economy and society*" *(ibid:335)*

Secondly, working with environment, economy and society in a sustainability context usually includes a focus on intergenerational equity.

Thirdly, most definitions of sustainability "*emphasize working beyond mere compliance with existing laws and regulations*" *(ibid:335)*

In addition, the social dimension of sustainability includes intra-generational equity, i.e. a fair distribution of the world's resources between members of the generations presently inhabiting the earth.

In simplified terms sustainability encompasses the three interlinked spheres environment, society and economy and the overlaps and relationships between them (see figure 1.3). This model was adopted for this study to be a suitable representation of sustainability.
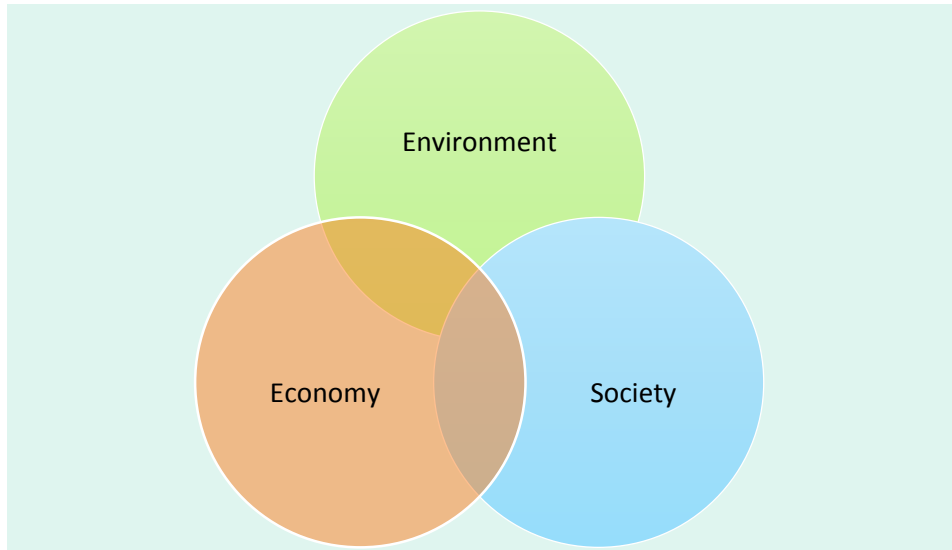
FIGURE 1.3 THREE SPHERES OF SUSTAINABILITY

To assess whether the teaching programmes contain possible aspects of sustainability, further specification of what these spheres might include had to be made. Specifically, a more detailed description of the concept of sustainability had to:

1. Encompass the essence of the Brundtland report definition and the three spheres of sustainability
2. Be broad enough to cover all programmes under the Faculty, while being detailed enough to capture aspects of the concept in various study programmes
3. Be useful in comparison with other similar studies.

In consideration of the above points this study utilised guidelines produced by the Global Reporting Initiative (GRI) as a search filter for aspects of sustainability in the study programmes. GRI is a non-profit organisation, collaborating closely with the United Nations Environment Program (UNEP) and the UN Global Compact to promote environmental, economic and social sustainability and to supply a framework for sustainability reporting for participants in the UN Global

Compact (GRI, 2013). The GRI guidelines and how they were used are described in more details in chapter 3: Methodology.

Part B. PHASE 1

Phase 1 of the PBL-SUS study was carried out between February and August 2012. This part of the report presents the following four chapters: Chapter 2 outlines the research questions and sub-questions. Chapter 3 describes the methodology used in the phase 1 study, while chapter 4 presents the findings of this study. Chapter 5 discusses and summarises the findings, including answers to the research questions.

2 Research questions addressed in phase 1

The research questions addressed in phase 1 at the level of educational management are repeated here for convenience:

1. What has been achieved so far in terms of integration of the concept of sustainability in the study programmes at the Faculty of Engineering and Science at Aalborg University?
    a. How many programmes have already integrated aspects of sustainability?
    b. How is the concept of sustainability integrated, interpreted and delimited in relation to the different study programmes?
    c. What are the existing strategies for integrating sustainability in the study programmes at both strategic and staff level?
    d. Which role does problem based learning play in designing and carrying out engineering and science activities that integrate key aspects of sustainability?

2. How can a better integration of sustainability in the study programmes be ensured?
    a. How can the potential for further integration of sustainability in programmes, projects and courses be enhanced?

Answers to the above questions about the existing situation were sought by examining existing curricula, partly through document analysis, partly through interviews with key educational managers. In the interviews also the question about future perspectives was brought up. The preliminary findings from Phase 1 were presented and discussed at a seminar for managers and study board members in August 2012 and deliberations from this seminar are also included here.

3   Methodology in phase 1

In order to find answers to the research questions as perceived at the level of educational management several methods of data collection have been used. In this chapter the three data collecting methods of phase 1 are described: Document analysis, interviews and a seminar with presentations and discussion.

3.1 Document analysis

The first method of investigation was a document analysis of the curricula of all B.Sc. and M.Sc. programmes at the Faculty that were approved and taught as full-time on-campus programmes at the time of investigation in spring 2012. This method was used to identify whether aspects of sustainability were included in the programme curricula and, if so, which aspects.

It is important to note that the document analysis represents a snapshot of the situation at the time of investigation and is not an overview of development of study programmes over time.

This focus resulted in a total of 111 programmes to be analysed, representing the three schools of the Faculty:

- School of Engineering and Science (SES) - 68 programmes
- School of Information and Communication Technology (SICT) - 29 programmes
- School of Architecture, Design and Planning (SADP) - 14 programmes

(see figure 3.1).

Curricula at the Faculty are prepared in accordance with a standard template. Included in this template are, among other aspects, the following two elements that were of major interest to this study:

- A qualification profile of the programme, categorised into three classes of qualifications: Knowledge, skills and competences.
- A tabular overview of the programme, containing all study modules contained in the programme, including the type of module (project or course), the title of the module, number of ECTS (European Credit Transfer System), type of assessment (Pass/non-pass or 7-step scale) and the type of examination (internal or external examiner).

Faculty of Engineering and Science

School of Engineering and Science (SES) (68 programmes)

- Study Board of Civil Engineering (20 programmes)
- Study Board of Energy (3 programmes)
- Study Board of Chemistry, Environmental Engineering and Biotechnology (17 programmes)
- Study Board of Mathematics, Physics and Nano Technology (12 programmes)
- Study Board of Technoantropology (2 programmes)
- Study Board of Industry and Global Business Development (14 programmes)

School of Information and Communication Technology (SICT) (29 programmes)

- Study Board of Computer Science (9 programmes)
- Study Board of Electronics and Information Technology (17 programmes)
- Study Board of Media Technology (3 programmes)

School of Architecture, Design and Planning (SADP) (14 programmes)

- Study Board of Architecture and Design (3 programmes)
- Study Board of Planning and Geography (7 programmes)
- Study Board of Land Surveyor Education (4 programmes)

Total: 111 programmes

FIGURE 3.1 ORGANISATION OF EDUCATIONAL MANAGEMENT AT THE FACULTY OF ENGINEERING AND SCIENCE AT AALBORG UNIVERSITY (AS OF SPRING 2012)

3.1.1 A search filter for analysis of sustainability

As mentioned earlier the Global Reporting Initiative (GRI) performance indicators were used as a filter to analyse the written curricula. The GRI was founded in 1997 in Boston, USA and the first set of performance indicator guidelines were launched in 2000. The version used in this study was version 3.1.

The performance indicators are divided into 6 categories, see figure 3.2. Each of the 6 categories is sub-divided into a number of aspects and each aspect lists a number of indicators.

GRI 3.1 Performance Indicators

6 Categories

Aspects: sub-division of category

Indicators: sub-divison of aspects. Qualitative description to ensure correct interpretation
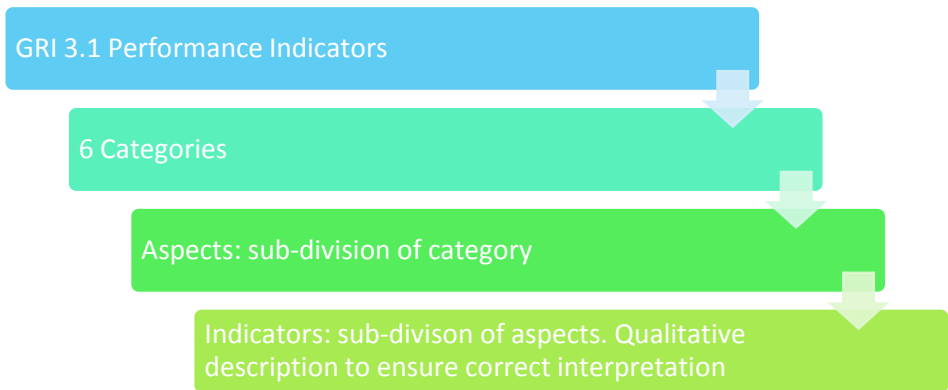
FIGURE 3.2 ILLUSTRATION OF THE GRI 3.1 PERFORMANCE INDICATOR GUIDELINE

Below are the three spheres of sustainability sub-organised into the six GRI categories including specific number of aspects and key indicators in parenthesis:

Environmental sphere (1 category):

- *Environmental (9 aspects, 30 indicators)*

Social sphere (3 categories):

- *Labour Practices and Decent Work (6 aspects, 15 indicators)*
- *Human Rights (8 aspects, 11 indicators)*
- *Society (5 aspects, 10 indicators)*

Economic (2 categories) sphere:

- *Economic (3 aspects, 9 indicators)*
- *Product Responsibility (6 aspects, 9 indicators)*

To illustrate this explanation we provide two examples, one from the category: Environment (environmental sphere), see figure 3.3.

Category: Environment

Aspect: Biodiversity

Indicator EN11: Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas.

FIGURE 3.3 EXAMPLE OF CATEGORY, ASPECT AND INDICATOR FROM THE ENVIRONMENTAL SPHERE OF SUSTAINABILITY

The other example is from the category: Labour Practices and Decent Work (social sphere), see figure 3.4.

Category: Labour Practices and Decent Work

Aspect: Occupational health and safety

Indicator LA7: Rates of injury, occupational diseases, lost days, and absenteeism, and number of workrelated fatalities by region and by gender.
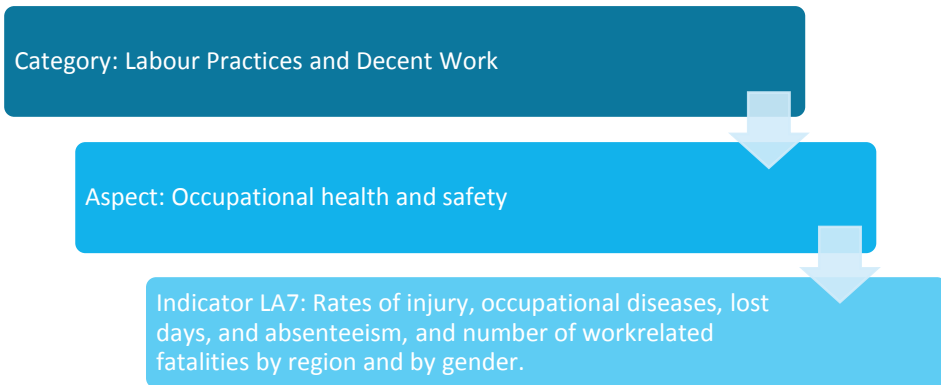
FIGURE 3.4 EXAMPLE OF CATEGORY, ASPECT AND INDICATOR FROM THE SOCIAL SPHERE OF SUSTAINABILITY

The 37 aspects i.e. biodiversity, occupational health and safety etc., included in the GRI Sustainability Reporting Guidelines were used as key words in the search for sustainability in the programme curricula.

3.1.2   The analysis procedure

The document analysis of each written curriculum was carried out in two steps. The first step consisted of reading the qualification profile and the tabular overview of the programme. If anything remotely connected to sustainability, defined by the 37 aspects, the word "sustainability" itself or even more loosely defined, was found here, a further search for sustainability in the curriculum using the aspects, was carried out.

If any of the study modules in the tabular overview of the programme made a reference to sustainability, the particular module description, with special focus on learning outcomes for the module, was read through and any occurrence of the aspects was noted.

This first level of analysis of the programmes was to ensure that aspects that were identified were appearing in the programmes in a sustainability context.

When a programme was identified to contain elements of sustainability, a more detailed content analysis was carried out in a second step of the examination. Aspects in their context were identified, using a template for the document analysis (see appendix 1). Each programme description was searched for aspects and their connection was noted. This was done to ensure that the word was actually identified in a sustainability context. As well as searching for the 37 aspects the documents were searched for the term "sustainability" and if the concept itself was found this was noted (along with the number of occurrences) in the summary for the programme.

A summary of the findings from the document analysis is presented in section 4.1.

3.2 Interviews

Following the document analysis a series of interviews with the educational managers were carried out to expand on the findings from the document analysis and to clarify strategic choices and future plans at managerial level.

Interviewees included the Faculty's dean and the vice dean for education as well as the three heads of schools and chairpersons of the study boards (see figure 3.1). A total of 17 members of educational management were invited for interviews. If chairpersons were unable to participate they were asked to suggest a

stand-in person, which happened in the cases of Computer Science, Media Technology and Planning and Geography. Only in one case no representative for the study board could be interviewed (Land Surveyor Education). In total 16 interviews were conducted.

The interviews were carried out as semi-structured interviews using an interview guide (see appendix 2).

During the interviews the respondents were provided with the illustration of sustainability, including some of the 37 GRI aspects used in the document analysis (see figure 3.5) and were asked to identify aspects that were relevant to their study programmes.
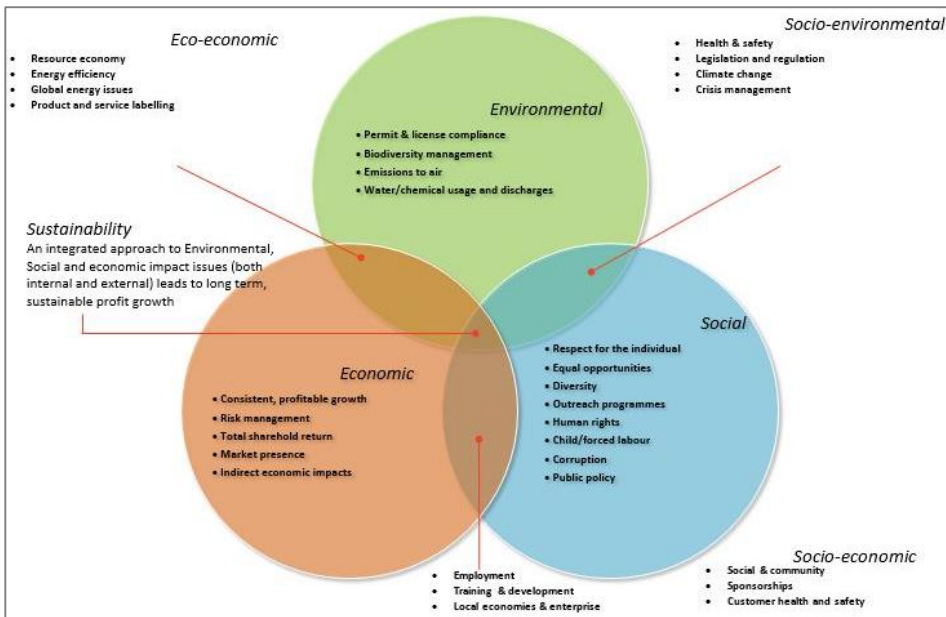
FIGURE 3.5 SUSTAINABILITY INCLUDING SOME OF THE GRI 3.1 ASPECTS (ADAPTED FROM VERIFY, 2011)

All interviews were conducted by two interviewers, one of whom participated in all 16 interviews to ensure internal validity. With the permission of the participants the interviews were recorded and summary transcripts were prepared. These transcripts were returned to the participants for verification, confirmation and for adding further comments if they so wished.

3.3 August seminar 2012

As a way of communicating the preliminary findings from phase 1 of the PBL-SUS study a seminar was organised in August 2012. All interview participants were invited to the seminar as well as all members of the 12 study boards under the Faculty, approximately 135 people in total. The number of participants attending the seminar was approximately 35.

The two overall aims of the seminar were to share findings about existing practices and interpretations of sustainability at the Faculty and to discuss, in groups of educational planners and managers, possible strategies to move forward towards further integration of relevant aspects of sustainability targeted towards different study programmes.

The seminar programme included invited speakers, group discussions and a panel debate. The dean gave a presentation of the Faculty commitment and discussed the need for compliance with the COPERNICUS Charta while the chairperson of the University Environmental Committee presented the work of the committee. Other invited speakers who had been identified through the interviews presented examples from their study programmes that included substantial aspects of sustainability. The seminar concluded with round table discussions on possibilities to integrate sustainability, followed by a panel debate on possible strategies at managerial level for this integration.

The seminar invitation brochure, including the programme, is found in appendix 3.

4 Findings in Phase 1

This chapter presents the findings from Phase 1 of the PBL-SUS study. The chapter is structured according to the method of data collection used, i.e. the first section describes findings from the document analysis, followed by a presentation of the results from interviews. The last section describes the key points raised during the August seminar 2012.

4.1 Document analysis

A total of 111 study programmes offered under the Faculty of Engineering and Science in spring 2012 were analysed, using the 37 GRI aspects as key words to search for sustainability aspects in the programmes. This presentation of the findings from the document analysis follows the hierarchical structure of the Faculty, i.e. starting with presenting the findings at Faculty level, followed by findings at the school level. The aim of the document analysis was to get an overview of visible and identifiable sustainability contents in the Faculty study programmes, at Faculty and school level. Thus, although the search filter for the document analysis was based on the GRI aspects as key words and findings could have been broken down to the level of individual study boards, this has not been done.

4.1.1 Sustainability at Faculty level

This subsection presents the findings about sustainability at Faculty level. At this level both spheres and aspects of sustainability are presented, while at the school level only spheres will be considered.

Spheres of sustainability

After an initial examination of the curricula of the 111 study programmes, 59 % were identified as not containing any visible or identifiable aspects of sustainability, neither in the competence profile nor in the overview of the programme (see figure 4.1).

Of the 111 programmes 17 % contained aspects from all three spheres of sustainability, 13 % had aspects from two spheres included, and 11 % contained sustainability aspects from one of the sustainability spheres.
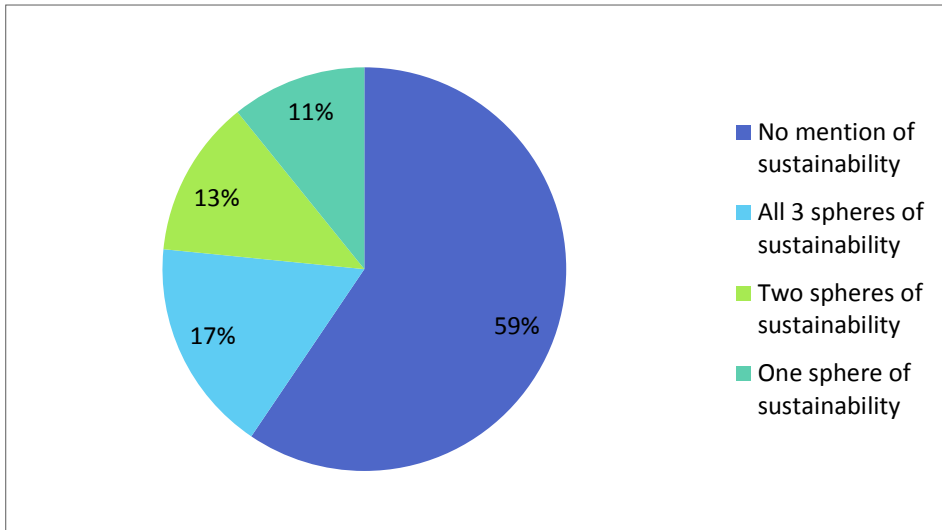
FIGURE 4.1 DOCUMENT ANALYSIS; SPHERES OF SUSTAINABILITY AT THE FACULTY LEVEL (n=111)

Aspects of sustainability

The document analysis provided information not only about the spheres of sustainability included in the study programme curricula but also about the aspects of the three spheres included, based on the GRI aspects used as search filter. Figure 4.2 provides a quantitative illustration of these aspects in the form of a word cloud where the font size of each word is proportional to the number of times the word was identified in the document analysis.

The ten aspects most often identified in the document analysis are the following, in order of priority:

- Environment
- Water
- Energy
- Society
- Materials
- Economic performance
- Product responsibility
- Public policy
- Transport
- Emissions, effluents and waste

The analysis of aspects of sustainability has not been broken down to school level. The ten aspects above will be used in a comparative discussion in chapter 10.

FIGURE 4.2 DOCUMENT ANALYSIS; ASPECTS OF SUSTAINABILITY AT THE FACULTY LEVEL

4.1.2 Spheres of sustainability at school level

The results found at Faculty level concerning the spheres of sustainability identified in the document analysis have been broken down to school level and in this subsection the results of this analysis are presented.

School of Engineering and Science

Figure 4.3 illustrates the results from the document analysis carried out at the School of Engineering and Science. In total 68 programmes from six study boards were analysed.

Looking at the programmes, 59 % were identified as containing no visible sustainability, neither in the competence profile nor in the programme overview. Of the programmes 13 % contained aspects from all three spheres of sustainability, 15 % contained aspects from two spheres and 13% contained aspects from one sphere of sustainability.
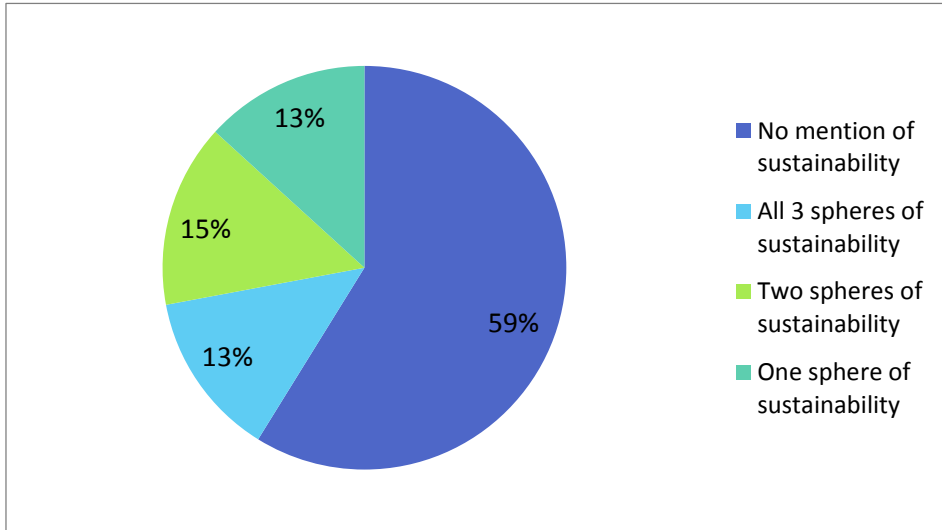
FIGURE 4.3 DOCUMENT ANALYSIS. SCHOOL OF ENGINEERING AND SCIENCE. (n=68)

More than half of the programmes under the School of Engineering and Science that featured sustainability focused on environmental sustainability.

School of Information and Communication Technology

Figure 4.4 illustrates the results from the analysis carried out at the School of Information and Communication Technology. In total 29 programmes under 3 study boards were analysed.

Looking at the programmes, 83 % of the programmes analysed were identified as containing no visible sustainability, neither in the competence profile nor in the overview of the programme. Of the programmes 4 % contained aspects from all three spheres of sustainability. The remaining 13 % of the study programmes analysed contained aspects of sustainability from either one (10 %) or two (3 %) spheres of sustainability.

Characteristic for the programmes under the School of Information and Communication Technology was a focus on social sustainability. In all of the 17 % of the programmes under this school where sustainability was found, aspects of social sustainability were included, either as the only element of sustainability, in connection with economic sustainability or in connection with both economic and environmental sustainability.
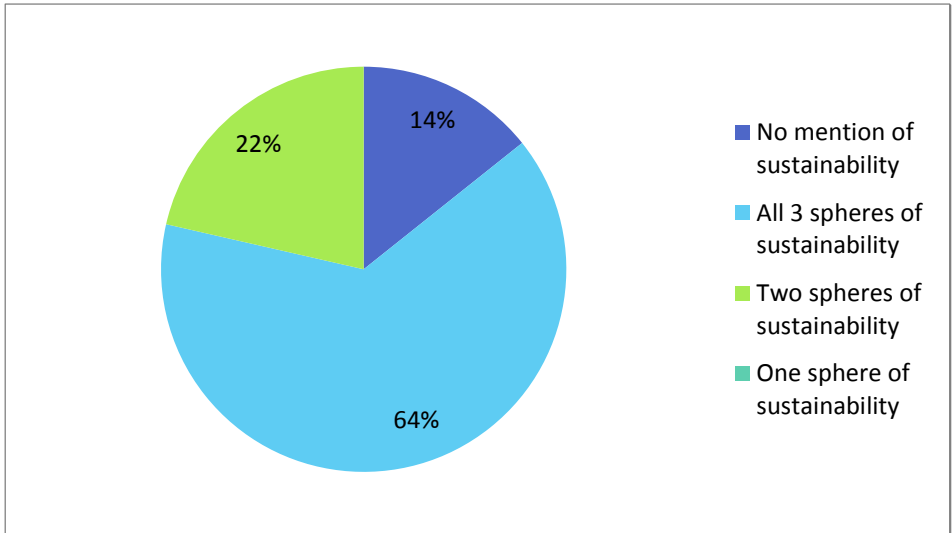
FIGURE 4.5 DOCUMENT ANALYSIS. SCHOOL OF ARCHITECTURE, DESIGN AND PLANNING. (n=14)
OGY. (n=29)

School of Architecture, Design and Planning

Figure 4.5 illustrates the results from the analysis carried out at the School of Architecture, Design and Planning. There are 3 study boards and 14 programmes under this school.

Looking at the programmes, 14 % were categorised as containing no visible sustainability, neither in the competence profile nor in the overview of the programme. Of the programmes 64 % contained elements from all three spheres of sustainability while 22 % contained elements from two spheres of sustainability – mainly the social and environmental spheres. No programmes contained elements of sustainability from only one sphere.

What stood out in the document analysis of the programmes under the School of Architecture, Design and Planning was that a large proportion of programmes (64%) included aspects from all three spheres of sustainability, mentioning a number of aspects represented in the different GRI categories, as well as the fact that sustainability was never focused on only one sphere of sustainability.

Tables with a detailed break-down of the results from the document analysis at the level of schools and the faculty can be found in appendix 4.

4.2 Interviews

A total of 16 interviews with educational managers were conducted during spring 2012, each lasting approximately one hour. After a few initial questions about the background of the interviewee (education, work experience and experience with sustainability), the interviews were guided by questions representing five themes (see appendix 2):

- Status quo
- PBL and project work
- Strategy and future perspectives
- Relevance
- Leadership

The findings from the interviews will be presented under these headings.

4.2.1 Status quo

To determine the status quo of sustainability in programmes under the Faculty/school/study board at the time of investigation, the respondents were asked to provide examples of integration of sustainability in programmes, semesters and/or study modules.

It was revealed through the interviews that the participants felt there was more sustainability represented in the programmes than what could be found in the written study programme curricula. In connection with a programme where no aspects of sustainability were found in the document analysis the representative for the study board responded:

> *The 6th semester has a course in software engineering where students were working with a case regarding development of a software system to report violation of human rights. So sustainability can happen through cases, but we do not have any courses that directly prepare the ground for sustainability, but a few courses includes target group analyses in the development phase of the system – and sustainability can be fitted into this context.*

Another participant said:

> *Sustainability is […] found in courses, but it will be more indirect – and direct and specific in the projects.*

The participants mentioned that sustainability was often addressed in and through the project work but was not necessarily included in the written curricula. One respondent expressed this as follows:

A lot of sustainability already exists in programmes, but in the future it's a question of moving it from implied to explicit, to make visible the initiatives which are already there.

This suggests that sustainability needs to be made more explicit and visible in the study programmes and in the programme qualification profiles, especially those aspects of sustainability that already forms part of the teaching programme.

During the interviews a number of respondents were uncertain about what sustainability encompasses, but during the conversation and prompted by the illustration in figure 3.5 the participants were able to identify elements of sustainability which they recognised as being present in their study programmes.

Several respondents seemed frustrated either because they would like to know more about sustainability, but were unable to find information, or because they sometimes felt that they had knowledge about sustainability which they would like to share with others, but did not know how to do so effectively across the Faculty. One respondent expressed this as follows:

It could be relevant to focus more on using sustainable materials in buildings. It is quite possible that at the university there are people working on e.g. development of new sustainable building materials or making existing materials more sustainable – lower energy consumption in production, better insulation etc. This new knowledge would be very relevant for architects and designers, but it is difficult/impossible to get in touch with relevant groups and thus gain access to such knowledge.

It was therefore suggested that an "information bank" should be developed to collect information from AAU experts as well as from other sources of information on sustainability in engineering and science education so academic teaching staff would have a repository of resources to turn to for information and ideas regarding sustainability.

With regard to the practice of labelling some programmes "Sustainable…" several respondents expressed concern that such programme titles might imply that other programmes are unsustainable, while, ironically, in some cases programmes without the word "Sustainable…" in the title were found to contain a

great amount of sustainability. Rather than including sustainability in the title, respondents felt that sustainability needed to be explicitly included in the qualification profile of the programme.

4.2.2 PBL and project work

The respondents were asked to explain how they see PBL and project work supporting the integration of sustainability. Of the 16 respondents, one respondent said that PBL and project work might be the way, but as he had no knowledge of other teaching methods he was unsure of how to make a clear statement regarding PBL and project work. The remaining 15 expressed that PBL and project work is a good way to integrate sustainability into programmes at the Faculty.

One respondent expressed it thus:

With PBL you are no longer just dealing with sustainability in theory, but also in practice – you learn how to use sustainability when you design houses – within architecture, when planning cities, within urban planning etc.

Another respondent expressed an opinion on PBL and project work as follows:

If projects can take point of departure in issues concerning sustainability you have already gotten far. It is important for students sometimes to focus on very specific scientific/technical projects, at other times it will be relevant also to focus on their context.

It is important that PBL deal with real problems – sometimes projects become task based rather than problem based – build the system that has been built a hundred times before so that you are also able to build it. That is of course important for the education that students gain the relevant skills, but the task could be formulated in connection with an actual problem so task and problem are integrated.

This statement illustrates that even if it is widely agreed that PBL and project work is the way to integrate sustainability it does not come automatically and participants felt that there is still work to be done in this regard.

4.2.3 Strategy and future perspectives

A question about the existence of a strategy for integration of further aspects of sustainability was answered with an almost unanimous "No" from respondents.

Neither at Faculty level nor at the level of schools or study boards did we find any explicit strategy for achieving the COPERNICUS target of integration of sustainability. One respondent said:

There is no strategy [to include sustainability further ed.], but there is also no strategy for NOT doing it.

One respondent did, however, indicate an awareness of sustainability at study board level in this quote:

In principle, at the study board level, it is mentioned that programmes will work towards sustainability.

The same respondent also said that there was a demand for a strategy from senior management, a demand that was more succinctly expressed by this respondent:

It is important that any strategy is supported with committed resources, otherwise it is not a strategy and nothing will actually happen. [...] The department knows that if there is not any top level commitment and financial support, it will not happen – the strategy will not be implemented!

To reveal any future perspectives, the heads of Faculty/schools/study boards were asked if there were any plans to make changes in written study programme curricula regarding the integration of sustainability. The answers to this question were again an almost equally unanimous "No".

The programmes that already have sustainability integrated had no current plans of doing more, but stated that they follow what is of interest and concern to society and update curricula accordingly.

The programmes that did not include sustainability (in written study programme curricula or identified through the interview) also had no imminent plans of including aspects of sustainability, but pointed out that this was not due to a dislike of the concept of sustainability, but because they had not given sustainability much thought. This is summed up by one respondent:

The study board has not given further integration of sustainability any thoughts. There are no plans of further integration – where sustainability is integrated, it will be kept, and where it is not integrated there are no plans to do so.

One respondent was in the process of reviewing a written study programme curricula at the time of the interview, and stated that while there were no specific plans, he would consider adding a couple of points regarding sustainability as part of the revision process.

In spite of the lack of strategies and plans for further integration of sustainability into the study programmes, some of the respondents had visions about this issue. Some participants mentioned that universities should be flagships of technological development and while green solutions might not all be financially viable, the University Campus could and should be the place to showcase to the local community and to future students the existence of innovative and sustainable technological solutions and initiatives. In relation to this vision one respondent highlighted the importance of the rule "practice what you preach":

> *It's hollow if they are taught about sustainability, but everything else at AAU is unsustainable – lights on, no recycling etc. The concept of sustainability has to permeate the whole University and project "Sustainable Campus" should have greater visibility.*

Another suggestion was that graduates from Aalborg University with a sustainability profile should become role models who might be given a "sustainability diploma" if they integrated sustainability in their education and their professional profile.

4.2.4 Relevance

With regard to mapping the relevance of different aspects of sustainability the respondents were shown the illustration of sustainability used in this study (see figure 3.5) and asked to identify aspects that might be relevant to their programmes.

The results can be seen in figure 4.6. The aspects were initially written with the same font size. To represent the weighting of the various aspects visually, a key word was increased by one font size each time it was identified as relevant by a respondent.
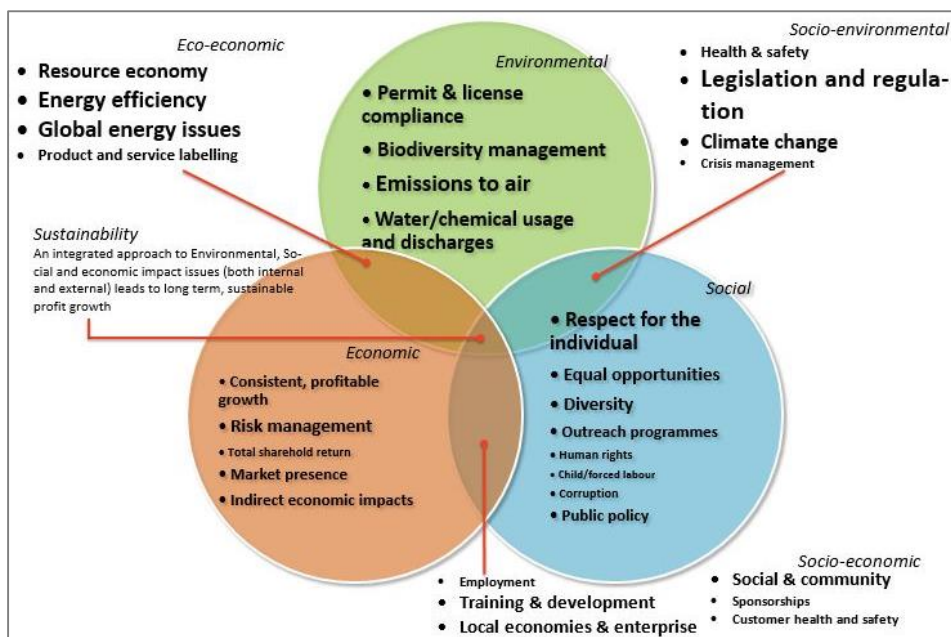
FIGURE 4.6 RELEVANCE OF SUSTAINABILITY ASPECTS. THE LARGER THE FONT OF THE KEY WORD, THE MORE RESPONDENTS FOUND IT RELEVANT.

All respondents felt that sustainability was relevant to their programmes. However, most of the respondents said that not necessarily all aspects of sustainability are relevant to their specific study programmes.

A number of respondents also mentioned that across the university/Faculty all aspects of sustainability should be covered:

> *As a whole the university should cover all elements, but some programmes focus stronger on certain aspects compared to others.*

It was important to the respondents to point out that although sustainability is an important concept, it needs to be fitted to the context of the programme. Many respondents raised the question of "what has to go?" if sustainability is to be added to the study programme, thus pointing to a curriculum overload and related questions about prioritisation within and between disciplines.

With regard to when and where to implement sustainability most respondents pointed to two approaches, as expressed in this quote:

> *It could be relevant for all students to have knowledge of sustainability. If it's a box AAU needs to tick, get it over with in the first year, if it is*

knowledge AAU wants students to use and implement as graduates in the outside world, it is better suited at the master level because the students will have knowledge and experience that the concept of sustainability can be pinned onto.

The short and quick solution would be to integrate sustainability in the first year study. However, participants agreed that with this approach there would be a risk that students would fail to develop the necessary competencies and would have forgotten what it was about by the end of their studies. The other solution was to integrate sustainability into programmes at a later stage of the study. Participants mentioned that this approach was more likely to equip students with skills and knowledge for reflection and make sure that sustainability would become part of their professional profile.

4.2.5 Leadership

Participants were asked about their perception of their role as leaders in the integration of sustainability.

There was consensus among all respondents that leadership is important, especially when it comes to visions and strategies. Yet, most of them expressed reluctance or hesitation to take on a strong and responsible leadership role.

At the study board level all 11 respondents said that they support bottom-up staff initiatives, but most of them also expressed a reluctance to "tell people what to do". One respondent said:

As head of study board, I am not the promoter, but the supporter when the research group initiates new things.

However, they mentioned that they would welcome more senior leadership to provide specific guidance on this topic:

Change will not happen unless it's directed from above or there is consensus within the involved institutes/study board.

The respondents also mentioned that they would welcome a specific vision or top-down strategy, as long as it would consider also financial resources or support that may be required, so they could work bottom-up to ensure it would fit the context of their study-board.

4.3 August seminar 2012

The seminar in August 2012 had two overall aims:

- to share the preliminary findings from the Phase 1 study about existing practices and interpretations of integration of sustainability into the Faculty study programmes with the invited educational planners and managers.
- to discuss, in round table groups of educational planners and managers, possible strategies to move forward towards further integration of relevant aspects of sustainability targeted towards different study programmes.

The seminar programme contained three types of activities: A series of presentations, followed by round table discussions, and concluding with a panel debate in which all presenters participated as panellists (see seminar programme in appendix 3).

The round table discussions and the following panel debate focused on four issues:

- Defining sustainability
- Visions for sustainability
- Integrating sustainability
- Academic staff development

In this section the findings from the August seminar are presented according to the above structure.

4.3.1 Defining sustainability

The participants in the seminar supported the idea of representing sustainability through the three spheres: environment, economy and society and commented that the GRI aspects constituted a useful frame for working with sustainability. It was mentioned that the illustration used for the round table talks (see figure 3.5) might help create an understanding of the broad and complex concept of sustainability. It was also mentioned, that the interpretation of sustainability needed to be adapted to the particular study programme and the particular professional context in which the programme is operating. Thus, there was agreement that sustainability is a complex and context dependent concept; therefore, no definition would be useful in all situations.

4.3.2 Visions for sustainability

Participants in the seminar proposed a number of visions for the work with sustainability within the Faculty and within the university. Amongst these was the vision that students would choose to study at Aalborg University because of the high visibility of sustainability teaching and practices in study programmes as well as in the operational profile of the university.

Concerning the operational profile it was suggested that one campus of the three (Aalborg, Copenhagen, Esbjerg) could become a pilot case of a green and sustainable campus and serve as a role model, not only for AAU but also, and more importantly, for society as a whole.

Among seminar participants there was agreement that to ensure that all members of Faculty jointly strive to achieve such visions of sustainability, both top-down and bottom-up initiatives are needed. Participants felt that those in leadership positions need to demonstrate clear commitment to sustainability, visions need to be explicitly articulated and clearly communicated by Faculty (and possibly university) management and Faculty management needs to support bottom-up initiatives by interested and committed academic staff members.

4.3.3 Integrating sustainability

It was widely agreed that it would not be enough to have a sustainability course in the first year. Sustainability may be broadly defined, used and implemented in the first year but there was a concern that if not taken home by schools and study-boards and integrated into programmes and used also in the rest of the study programme, it would not impact on graduates' awareness and preparedness. Participants agreed that sustainability needed to become a part of the professional profile of graduates.

It was suggested that the point of departure for the introduction of sustainability in the first year could be the PV-course (Problem based learning and science, technology and society), which is a Faculty wide first year course included in almost all study programmes. This could be supplemented by allocating "sustainability supervisors" to the first year project groups, i.e. assistant supervisors focusing on sustainability as part of the context for projects

The participants in the August seminar agreed with respondents in the interviews that PBL and project work is a good way of implementing sustainability. With regard to the project work the following four important points were made:

- Sustainability needs to be relevant and integrated
- This could be achieved through relevant semester themes
- It could be supported by modules concerning sustainability
- The Aalborg PBL model should be used actively in teaching sustainability.

Further points from the discussion about implementation of sustainability were:

- To be creative in teaching formats i.e. two teachers/workshops/mini-projects etc.
- Think – play – act, with a special emphasis on play (to promote creativity)

4.3.4 Academic staff development

A joint concern among participants was that staff development was key to changing ideas about education for sustainability.

For staff members to gain sound knowledge about sustainability and identify possibilities for integration into courses and projects, staff training on sustainability is needed.

Some of the most important points made at the seminar concerning staff development included:

- Programme leaders should have a possibility to attend professional development on sustainability
- Educational support should be offered to staff members involved in teaching
- The idea of a "driver's license" of sustainable practices was mentioned
- Each study board should appoint "sustainability ambassadors"
- "Sustainability days" could be a way of keeping focus on training staff and developing ideas

While discussing staff development it was also mentioned, that students and academic staff align with their professional field of expertise, and if sustainability is not contextualised to a professional research field or study programme it will be difficult for both students and staff to see the relevance and significance of such a concept.

5 Summary of Phase 1

Phase 1 of the PBL-SUS study has provided partial answers to the research questions and these answers will be presented in this chapter. The first section in the chapter discusses the findings from phase 1, integrating and comparing findings from the three different methods of data collection: the document analysis, the interviews with educational managers and the august 2012 seminar. In the second section the partial answers to the research questions addressed in phase 1 are presented.

5.1 Discussion of findings

Three methods of data collection were applied in phase 1 of the PBL-SUS study. In this section the findings from each of these three data collection methods are compared and discussed, pointing to both similarities and differences. The section is structured according to a combination of themes from the interview guide and the seminar programme. In subsection 5.1.1 the status quo situation is presented and discussed. This is followed by a short discussion about the uncertainty in defining the concept of sustainability in subsection 5.1.2. Subsection 5.1.3 contains a discussion of integration of sustainability into the study programmes, while subsection 5.1.4 discusses future perspectives and visions. The last subsection 5.1.5 discusses staff development and leadership.

5.1.1 Status quo

The document analysis revealed a varied picture of integration of sustainability, depending on the school, with SADP having a total of 64% of all school programmes integrating all three spheres of sustainability and only 14% with no sustainability, while SICT has 83% of programmes with no visible sustainability and only 4% with all three spheres integrated. Both of these schools are, however, small in terms of number of programmes (SADP: 14; SICT: 29) and it is SES, with 68 of the 111 programmes at Faculty level, that dominates the picture, with 59% of programmes containing no visible sustainability and only 13% integrating all three spheres. These figures are almost identical to the figures at Faculty level where 59% of the 111 study programmes contain no visible sustainability while 17 % integrate all three spheres.

In the 16 interviews it became clear that the participants felt that there is more sustainability implicit in programmes than what is explicitly found in the written

study programme curricula. Thus, there are "hidden pockets" of sustainability in the project work which should come as no surprise since both respondents and seminar participants agreed that PBL and the project work was a good way to integrate sustainability into the Faculty study programmes.

The "hidden pockets" of sustainability constitute a problem in connection with the PBL-SUS study that aims to reveal the presence of sustainability in the study programmes, because such presence could not be identified through the document analysis alone but also necessitated interviewing staff. In phase 1, however, we only interviewed educational managers, including chairs of study boards, who may not be familiar with the contents of all projects under the study board. This means that neither the document analysis nor the interviews nor the combination of these two in phase 1 gives a complete measure of the extent to which sustainability is at present integrated into the study programmes. Another problem with 'hidden pockets' is the dependency of the sustainability content on individual persons, whether project supervisors or students.

5.1.2 Defining sustainability

As mentioned above a number of respondents in the interviews were uncertain about the meaning of the concept of "sustainability" and only identified aspects of sustainability when inspired by the sustainability illustration in figure 3.5. This same uncertainty about the concept may be shared by students and project supervisors who in the project work may be working with sustainability without realising so.

Another aspect related to defining sustainability that was pointed out by both respondents and seminar participants was that, although the broad and complex concept of sustainability is seen as relevant, it needs to be contextualised and adapted to the specific professional context and profile of the programme, otherwise it will not be perceived as relevant and significant.

5.1.3 Integrating sustainability

A question discussed in connection with integrating sustainability into the Faculty study programmes was where and when sustainability should be integrated in the study programmes.

The educational managers agreed with seminar participants that integration of sustainability might start at the first year but that this is not enough for the concept to become part of the professional profile of graduates. In order to achieve this, sustainability needs to be brought into the study programme again at a later stage where the professional competences of students are more developed.

Seminar participants pointed to the Faculty-wide PV-course (Problem Based Learning and Science, Technology and Society) in the first year as the most appropriate place to start integrating sustainability, possibly including elements of sustainability in first year projects, supported by "sustainability supervisors". All participants in phase 1 agreed that PBL and project work should play a significant role in integrating sustainability into the study programmes, drawing upon the Aalborg PBL model and enhancing elements of creativity in the projects.

5.1.4   Future perspectives and visions

Notwithstanding the fact that the PBL-SUS study in this first phase did not reveal any strategies or plans for further integration of sustainability, the educational managers nevertheless had visions about sustainability for the Faculty/University. One such vision was about graduates as role models. Another vision was about the university as a flagship of technological development in terms of application of sustainable solutions, even if such solutions would not always be financially viable.

Seminar participants also expressed visions about the university, or at least one of the three university campuses, becoming a technological role model through a pilot project focusing on securing that all operations of the university are sustainable. Another vision expressed by seminar participants was that in future students would choose AAU because of the high sustainability profile of study programmes. They expressed, however, a general agreement that for such visions to become reality, clear and explicitly expressed commitment to sustainability needs to be expressed by Faculty management.

5.1.5   Staff development and leadership

From the interviews it became clear that educational managers felt that there are existing resources within the Faculty in the form of existing research and human capital. Furthermore, it was revealed that personal interests and profes-

sional backgrounds of the respondents coloured their perception of the importance of sustainability and the approach to issues of integration of the concept into study programmes.

In the seminar there was general agreement that staff development would be key to educational change towards more integration of sustainability. Thus, it was mentioned that programme leaders should undergo professional development within the area of sustainability. Similarly, teaching staff members should be able to draw upon educational support for their teaching, a suggestion that was underpinned by a suggestion from interviewees to create an information bank of resources on sustainability containing information from AAU as well as from other sources of information.

Other suggestions from seminar participants to support staff development was "sustainability ambassadors" for each study board and a Faculty/University-wide "Sustainability Day" where interested staff members could meet and share experiences.

All interviewees agreed that leadership is important in connection with educational change towards more integration of sustainability. The chairs of study boards also agreed that they would welcome a top-down initiative from senior management while supporting bottom-up initiatives from committed staff members. However, most educational managers interviewed expressed reluctance to "tell people what to do", i.e. to take on a strong and responsible leadership role. They seemed to be hoping that bottom-up initiatives would eventually solve the problem and secure sustainability aspects wherever needed. But without strong and responsible leadership a sustainable change towards integration of sustainability into study programmes will not likely to happen.

5.2 Answers to research questions

In this section we will provide partial answers to the research questions that have been addressed in phase 1, based on the findings from the phase 1 study at managerial level which are described in chapter 4. The questions are repeated here for ease of reference.

1. What has been achieved so far in terms of integration of the concept of sustainability in the study programmes of the Faculty of Engineering and Science at Aalborg University?

a. How many programmes have already integrated aspects of sustainability?
b. How is the concept of sustainability integrated, interpreted and delimited in relation to the different study programmes?
c. What are the existing strategies for integrating sustainability in the study programmes at both management and staff level?
d. Which role does problem based learning play in designing and carrying out engineering and science teaching and learning activities that integrate key aspects of sustainability?

2. How can a better integration of sustainability in the study programmes be ensured?
a. How can the potential for further integration of sustainability in programmes, projects and courses be enhanced?

Concerning an answer to the first sub-question 1a the document analysis revealed that less than half (41%) of the study programmes in the Faculty have integrated aspects of sustainability that are visible and could be identified in the written study programme curricula. The interviews, however, demonstrated that the problem based projects sometimes contain sustainability aspects that are not visible in the written curricula and are not recognised as sustainability neither by students nor by their supervisors. Given the invisibility of sustainability in projects encountered during interviews, the first sub-question about quantity of sustainability integration cannot be answered conclusively based on phase 1 results only.

It should be mentioned here that there are programmes at the Faculty where sustainability is at the very core of the programme and aspects from all three spheres are deeply integrated not only in the programme qualification profile but also in many modules of the programme.

Concerning an answer to the second sub-question 1b it can be concluded that the three different schools have different characteristics concerning sustainability, with the School of Engineering and Science focusing on environmental aspects of sustainability, the School of Information and Communication Technology focusing more on social aspects of sustainability and the School of Architecture, Design and Planning documenting in their programme descriptions a more holistic view of sustainability that includes all three spheres of sustainability. As far as a quantitative summary is concerned the environmental sphere of sustainability is by far the best represented sphere of sustainability in the Faculty programmes. Thus, a total of 37 programmes contain aspects of environmental

sustainability, with full programmes such as Environmental engineering and Environmental management being focused on the environmental aspects of sustainability. In terms of numbers this is closely followed by a total of 35 programmes that contain aspects of social sustainability but no programmes are focused on social sustainability which is hardly surprising in an engineering Faculty. Finally, a total of 24 programmes contain aspects of economic sustainability but again with no major focus on such aspects.

In response to the third sub-question 1c it can be concluded from the interviews that at present no strategies at management level exist for integration of sustainability into Faculty programmes. The programmes that are focused on sustainability are so more because of external pressure due to public regulations concerning environment or because of the initiative of interested and committed staff members, than because of internal strategies.

Concerning the fourth sub-question 1d it has already been mentioned above that there was a general agreement among respondents and participants of the seminar that problem based learning and project work is the best approach to integrating sustainability into the study programmes, not only because problem based projects by nature are multidisciplinary and complex and thus ideally suited to include sustainability aspects but also because the students learn more from their project work than they do from course work. The main problem with integration of sustainability into projects is that it tends to make the sustainability aspects "invisible" from an outsider's point of view, if neither the programme profile nor the project module description mentions any aspects of sustainability.

In conclusion, the answer to the first research question is that although there are programmes doing very well in terms of integration of sustainability, the situation leaves a lot of work to be done at the Faculty. A situation where 59 % of programmes under the Faculty do not include any visible aspects of sustainability in the written study programmes can hardly be seen as satisfactory, even if there are "hidden pockets" of sustainability in the problem based project work.

Concerning the sub-question 2a there seemed to be genuine interest and willingness amongst the interviewees and the seminar participants to implement sustainability as long as it is done in a sensible manner. This means that the specific profile and nature of the programme and the context of the professional work place needs to be taken into account. It also means that resources and support is required to equip academic teaching staff willing to try out models of

integration of sustainability in their teaching while acknowledging and respecting that many programmes suffer from an already overloaded curriculum.

Concluding on research question 2 the answer seems to be that in order for educational managers at the lower level as well as for academic teaching staff to make a serious commitment to integrate sustainability in the study programmes and in the teaching, senior Faculty management needs to clearly present visions and strategies, accompanied by incentives and support, so that sustainability does not become a matter of 'window dressing' or tokenism.

Part C: Phase 2

Phase 2 of the PBL-SUS study was carried out between February and August 2013. This part of the report contains the following chapters: Chapter 6 outlines the research questions and sub-questions addressed in phase 2 at the level of academic teaching staff. Chapter 7 describes the methodology used in the phase 2 study, while chapter 8 presents the findings of the study. Chapter 9 discusses and summarises the findings, including partial answers to the research questions.

6 Research questions addressed in phase 2

The research questions addressed in phase 2 at the level of academic teaching staff were presented in chapter 1 and are repeated here for convenience:

1. What has been achieved so far in terms of integration of the concept of sustainability in the study programmes at the Faculty of Engineering and Science at Aalborg University?
    a. How many programmes have already integrated aspects of sustainability?
    b. How is the concept of sustainability integrated, interpreted and delimited in relation to the different study programmes?
    c. -
    d. Which role does problem based learning play in designing and carrying out engineering and science activities that integrate key aspects of sustainability?

2. How can a better integration of sustainability in the study programmes be ensured?
    a. How can the potential for further integration of sustainability in programmes, projects and courses be enhanced?
    b. How can the already existing elements of sustainability be sustained?

Answers to the above questions as seen from the perspective of academic teaching staff were sought through a combination of three different data collection methods: a questionnaire survey that aimed to reveal good examples of teaching sustainability followed by in-depth interviews with some of the questionnaire respondents who volunteered. The preliminary findings of phase 2 were presented in a seminar in August 2013 and the discussions from this seminar are also included in the next chapter.

7 Methodology in phase 2

The investigation in Phase 2 adopted a methodology that focused on revealing the knowledge and experiences of teaching staff on how to integrate sustainability into their teaching in study programmes in the Faculty of engineering and science. The following three methods of data collection were used: questionnaires, interviews and group discussions conducted in a seminar, and these three methods are described in the following three sections.

7.1 Questionnaire

The questionnaire had the following aims:

1. To identify good examples of integration of aspects of sustainability in teaching activities.
2. To invite staff willing to participate in an in-depth interview about their good example.

With a mix of open and closed questions, the questionnaire was organised in three parts, as seen in figure 7.1.

Background information
- Programme/semester
- Course/project/theme

Aspects of sustainability integrated
- Environmental sustainability
- Economic sustainability
- Social sustainability

Free description of good example
- Further information about the example
- Willingness to participation in an in-depth interview about the good example
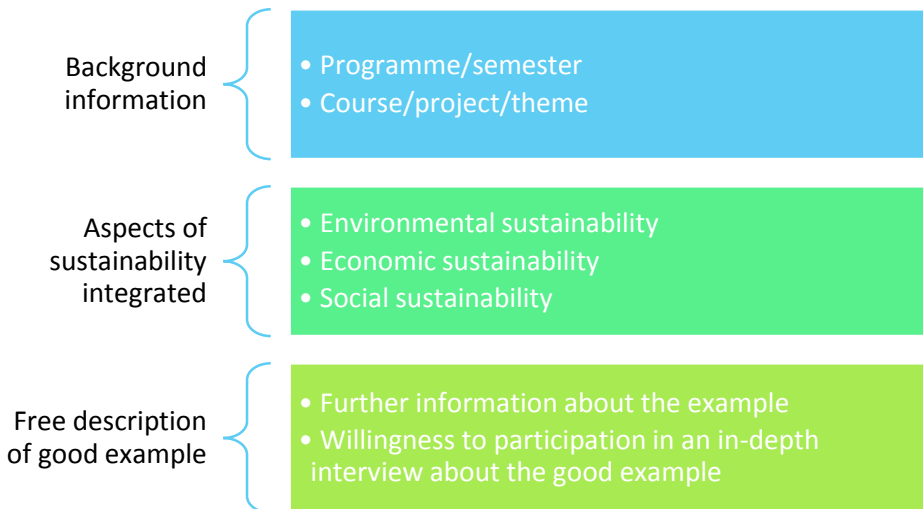
FIGURE 7.1 DESIGN OF QUESTIONNAIRE

Part 1 was concerned with the educational background and context of the example the respondent was referring to. Part 2 asked the respondent to identify aspects of sustainability that were integrated in the teaching, using the GRI list of sustainability aspects that was also used during phase 1 of the study. Part 3

encouraged the respondent to provide more detail about the teaching example while also asking whether they were interested in participating in an in-depth interview about their example.

The questionnaire was mailed out as an online questionnaire to 14% (n=196) of the 1389 academic teaching staff from across the three schools within the Faculty of Engineering and Science. Staff had one week to respond and the result was a total of 38 responses, i.e. a response rate of 19%. Figure 7.2 shows the selection process through which the 19 responses included in the quantitative analysis were selected. The figure also shows how the 17 interviewees who contributed to the qualitative analysis were identified.

The questionnaire, including a more verbal description of the selection process, can be viewed in appendix 5.

The Faculty of Engineering and Science

$E_{kin} = \frac{1}{2} \rho A u^3$

Population: 1.389 scientific staff members of Faculty

Questionnaire sent out to sample of 196 persons

38 responses

21 completed responses:
19 used in the quantitative analysis
2 discarded - outside scope of project.

17 incomplete responses

12 volunteers for interviews
3 not interviewed

Qualitative analysis – 17 interviewees

9 submitted questionnaire, 2 acting on the questionnaire, 2 invited from SICT, 2 invited sustainability experts and 2 pointed out by colleagues.
Colour indicates school affiliation.

FIGURE 7.2 SELECTION PROCESS OF RESPONSES AND RESPONDENTS FOR QUANTITATIVE AND QUALITATIVE ANALYSIS. COLOUR CODING: GREEN: SES; ORANGE: SICT; BLUE: SADP.

7.2 Interviews about good examples

Based on the questionnaire responses received interviews were arranged with 9 respondents of which two referred to the same example. A further two staff members did not submit the questionnaire but instead notified the researchers that they wanted to be interviewed together in connection with a good example of sustainability.

For strategic reasons the researchers wanted to include examples from each of the three schools. There were, however, initially no respondents from SICT (apart from one PhD programme respondent) who had volunteered to participate in an interview. Therefore the decision was made to invite two staff members from SICT who were known to the researchers to be working with sustainability in their teaching, to participate in an interview and the two staff members accepted the invitation.

Furthermore, two staff members who had recently joined AAU and were known to the researchers to have been working with sustainability for many years were approached in a similar manner and accepted the invitation to participate in an interview. Finally, two more staff members were interviewed based on recommendations from interviewed colleagues.

Thus, in total 16 interviews with 17 interviewees were carried out, representing a total of 13 good examples of teaching that integrates sustainability. The 13 examples included four examples from SES, two from SICT and seven from SADP. The list of examples is shown in figure 7.3.
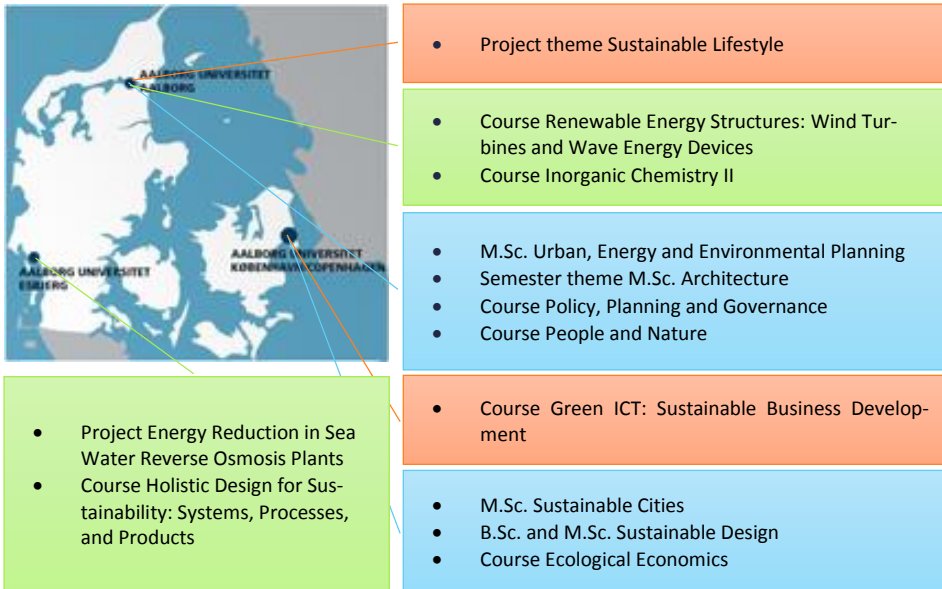
FIGURE 7.3 THE THIRTEEN GOOD EXAMPLES, INCLUDING CAMPUS AND SCHOOL AFFILIATION. COLOUR CODING AS IN FIGURE 7.2. MAP SOURCE: (AAU, 2013)

As mentioned above, a total of 17 staff members were interviewed and 15 out of 16 interviews were carried out as individual interviews, while only one interview was carried out with two staff members at the same time.

In a few cases, based on input from interviewees, questions were addressed to students who had been participating in the teaching example in question, concerning their attitude towards sustainability and the main aspects of sustainability included in the example as experienced by them. Due to lack of time this method of data collection was only applied in a few cases and only resulted in useful data in two cases.

The interviews were carried out as semi-structured interviews. Figure 7.4 illustrates the design of the interview guide. The full interview guide can be found in appendix 6.
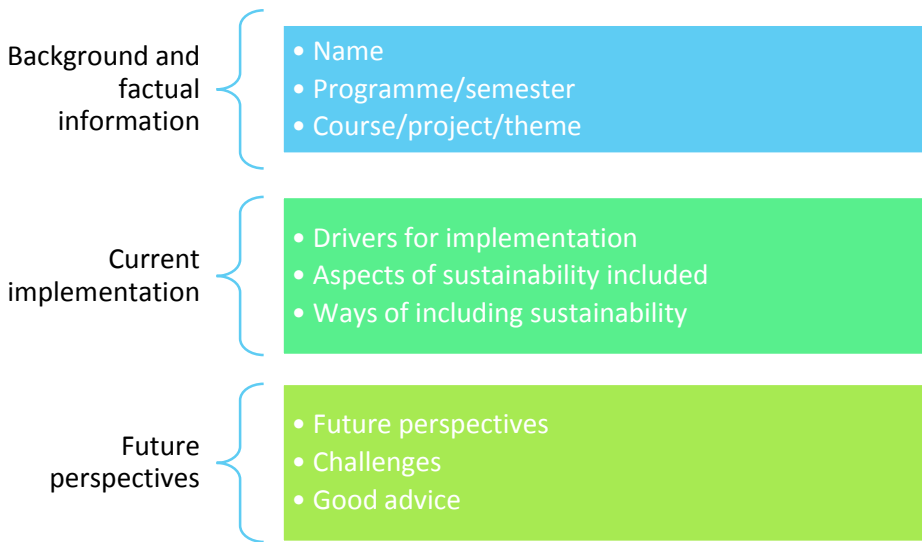
FIGURE 7.4 DESIGN OF INTERVIEWS

All interviews were conducted on the campus of the interviewee, whether in Aalborg, Copenhagen or Esbjerg. Notes were taken during the interview and the interview was also recorded with the permission of the interviewee. A summary was produced following the interview and sent back to the interviewee for verification, consolidation and approval.

7.3 August seminar 2013

As a way of communicating preliminary findings from phase 2 of the PBL-SUS study a seminar was organised in August 2013. All academic teaching staff at the Faculty of Engineering and Science was invited, including all interviewees. Approximately 25 staff members, including the three heads of schools, participated in the seminar. The participants were from the three schools and from the three campuses of the Faculty, with Copenhagen and Esbjerg campuses being connected via video conferencing link.

The overall aim of the seminar was to inspire academic teaching staff to include sustainability into their own teaching by sharing the findings from the good examples identified in the PBL-SUS study. Another aim was to continue the discussion on how sustainability can be made more visible.

The seminar programme consisted of a presentation of the findings from the PBL-SUS study, including a draft version of the Good Examples Catalogue. This presentation was followed by group discussions and the seminar concluded with a short presentation of the coming Aalborg Centre for Problem Based Learning in Engineering Sciences and Sustainability under the auspices of UNESCO.

The groups were formed according to campuses as the first criteria and according to schools as the second criteria. A total of 4 groups were formed, one in Copenhagen and three in Aalborg, one for each school. In Esbjerg only one staff member participated.

The groups were encouraged to discuss the following two questions:

- What can I do in my teaching to integrate sustainability, wherever relevant?
- How can sustainability be made (more) visible and explicit in the study module descriptions?

In preparation for the first question participants had beforehand been encouraged to bring a study module description that they would like to work with in the seminar. Groups were further asked to prepare and present a poster with main results of their discussions. During the poster presentation the research team took notes and photos.

The seminar invitation brochure, including the programme and the outline for group discussions is found in appendix 7 and summary of group posters and discussions are found in appendix 8.

8 Findings in phase 2

This chapter presents the findings from the second phase of the PBL-SUS study. The presentation of the findings is structured according to the data collection method, i.e. the first section presents findings from the quantitative analysis of questionnaire responses with good teaching examples, the second section outlines the findings from in-depth interviews with teaching staff who had volunteered to provide more information about their good example of teaching sustainability and the last section presents the findings from the August seminar.

8.1 Questionnaire

The questionnaire aimed to identify good examples of teaching that integrates aspects of sustainability, and also to invite teaching staff to share their good examples in an in-depth interview. The 19 questionnaires analysed included 11 examples from SADP, 5 examples from SES and 3 examples from SICT.

This section starts with a presentation and overview of spheres and aspects of sustainability identified at the Faculty level. In the next subsection the findings are broken down by schools and by GRI aspects.

8.1.1 Sustainability at Faculty level

In this subsection the findings from the quantitative analysis of the 19 questionnaire responses are presented at the Faculty level. First the results for the three overall spheres of sustainability, environment, society and economics, are presented, followed by a presentation of an overview of the specific aspects of sustainability as found in the GRI aspects.

Spheres of sustainability

Of the 19 teaching examples analysed ten included a combination of all three spheres of sustainability, five examples contained combinations of environmental and economic spheres while two combined environmental and social spheres of sustainability.
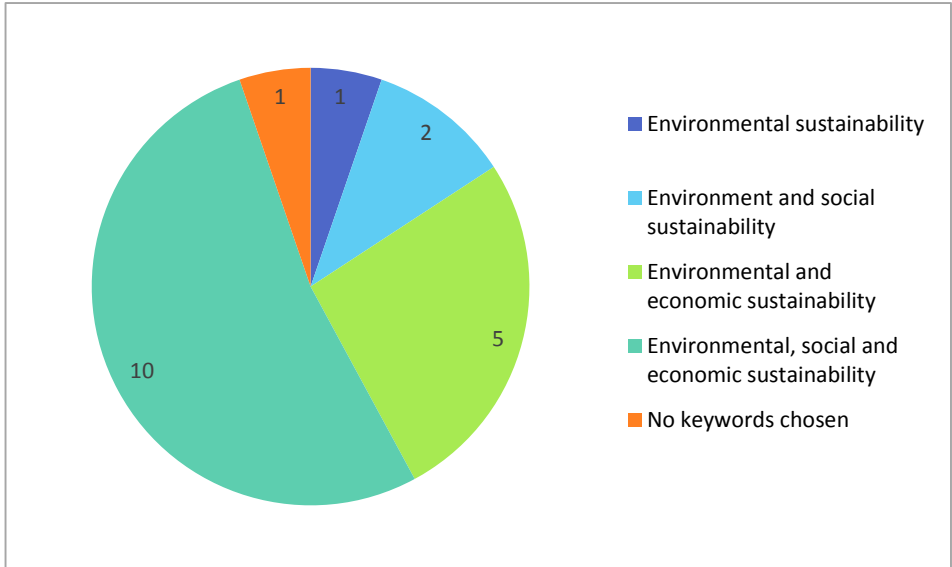
One example included only the environmental sphere and one example did not identify any of the three spheres, but included a more qualitative description of sustainability (see Figure 8.1).

Aspects of sustainability

The quantitative analysis of the questionnaire responses received provided information about the aspects of sustainability included in the teaching examples. An overview of the sustainability aspects included at Faculty level is presented in figure 8.2, while aspects, broken down by the three spheres of sustainability and by the three schools, will be presented in subsection 8.1.3. Based on the quantitative analysis a word cloud was constructed to provide a relational and visual representation of data (see figure 8.2)

Each word in the word cloud is written with a font size proportional to the number of times the word was identified in the questionnaires analysed. The ten most frequently identified aspects of sustainability included in study programmes at the Faculty are the following, in order of frequency:

- Environment
- Energy
- Society
- Materials
- Transport
- Emissions
- Water
- Community
- Products
- Biodiversity

In the final chapter 10 the above list of important aspects of sustainability integrated in teaching examples will be compared to a similar list found in the document analysis in chapter 4.

8.1.2 Spheres of sustainability at school level

A closer look at the examples from each of the three schools showed that at the School of Engineering and Science examples, 3 out of 5 combined the three spheres of sustainability, environmental, social and economic, while the remaining two combined the environmental and economic spheres of sustainability (see figure 8.3).
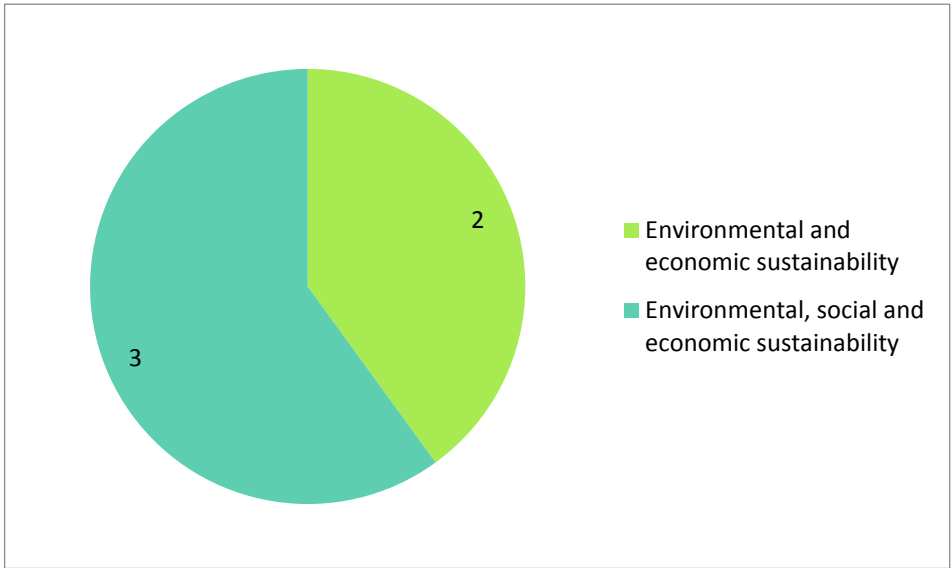
FIGURE 8.3 QUESTIONNAIRE; SPHERES OF SUSTAINABILITY INCLUDED, SCHOOL OF ENGINEERING AND SCIENCE (n=5)

 From the School of Architecture, Design and Planning, 7 out of 11 teaching examples combined the three spheres of sustainability, two combined the economic and environmental sustainability spheres, and one combined the environmental and social sustainability spheres.

The remaining one example included only environmental sustainability (see figure 8.4).

The three examples from the School of Information and Communication Technology included one example combining environmental and social sustainability, one example combining environmental and economic sustainability and one that did not identify any of the three spheres (see figure 8.5).

8.1.3   Aspects of sustainability at school level

The questionnaire was based on the aspects of sustainability found in the GRI guidelines; thus, findings have been broken down to the level of aspects of sustainability and the results of this analysis are presented in this section for each of the three spheres of sustainability.

Environmental sustainability aspects

Out of the 19 questionnaires analysed, 18 examples covered aspects within environmental sustainability. The analysis showed that the five examples from School of Engineering and Science covered the aspects: environment; materials; energy; emissions, effluents and waste; products and services and transport. The 11 examples from the School of Architecture, Design and Planning covered all nine aspects of environmental sustainability identified in the GRI key words, while the three examples from School of Information and Communication Technology included the aspects: environment; materials; energy; products and services (see figure 8.6).
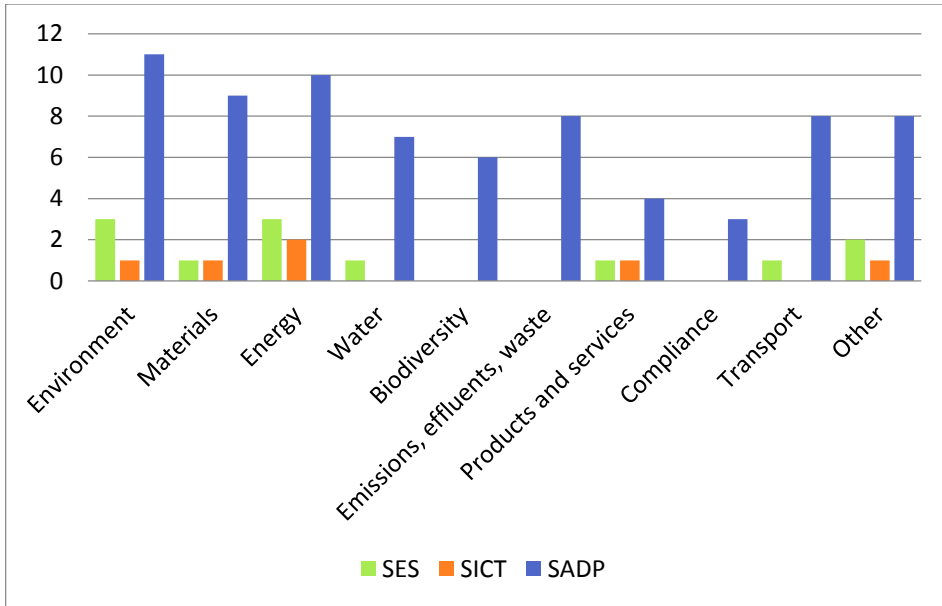
Social sustainability aspects

Concerning social sustainability 14 of the 19 aspects included in the GRI guidelines were identified and 12 examples included such aspects. The five GRI aspects not identified in any of the examples were: freedom of association and collective bargaining; child labour; forced and compulsory labour; diversity and equal opportunity; equal remuneration for men and women.

Most of the respondents included one to three aspects of social sustainability, with the exception of two respondents from SADP who identified 11 and 8 aspects of social sustainability, respectively.

The 11 SADP examples included 12 out of the 19 social sustainability aspects, the five SES examples included security practices, society and public policy aspects, while the three SICT examples identified security practices (see figure 8.7).
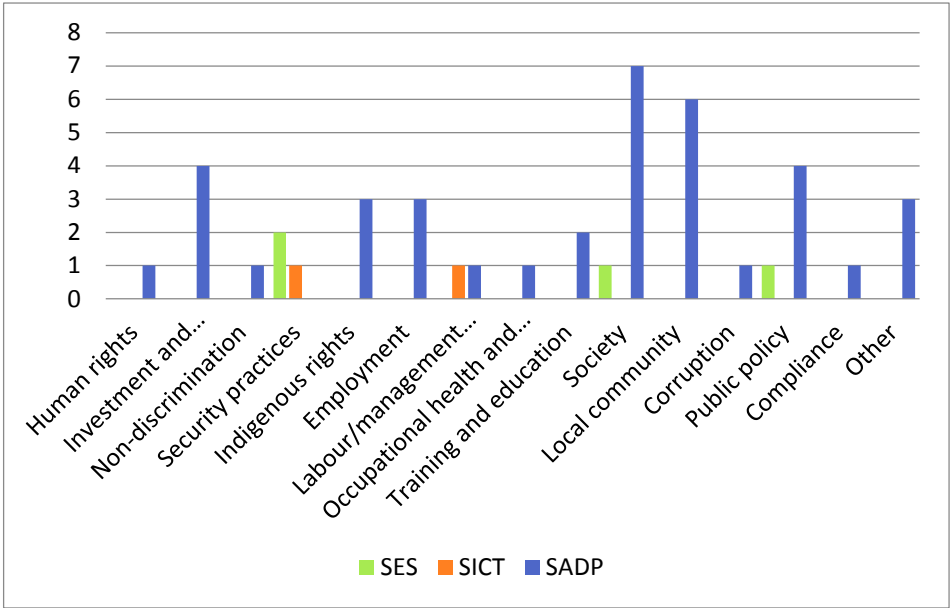
FIGURE 8.7 QUESTIONNAIRE; ASPECTS OF SOCIAL SUSTAINABILITY INCLUDED

Economic sustainability aspects

Of the 19 questionnaires analysed, 15 included aspects of economic sustainabil-
ity. Overall, all nine aspects of economic sustainability identified in the GRI 3.1
guidelines were covered by the reported teaching examples.
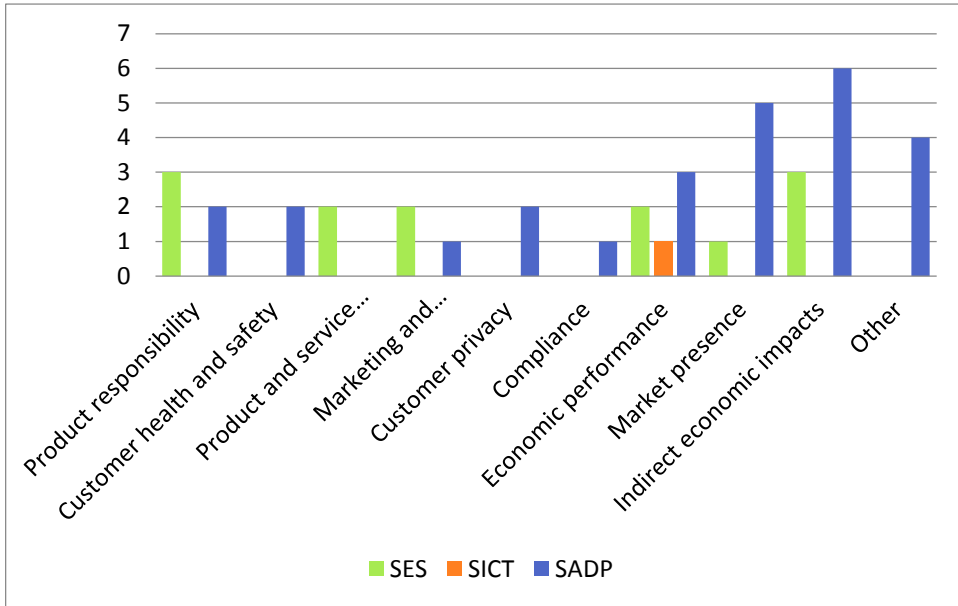
FIGURE 8.8 QUESTIONNAIRE; ASPECTS OF ECONOMIC SUSTAINABILITY INCLUDED

However the number of aspects in each example varied; for example, 10 examples included one or two aspects, four included four to five aspects, and one included seven aspects of economic sustainability (see figure 8.8).

8.2 Interviews

The aim of the interviews in phase 2 was to produce in-depth descriptions of good teaching examples where sustainability is an integrated component of the teaching. These descriptions should address the reasons for integration, how sustainability was integrated, which aspects of sustainability were integrated, which challenges the teaching staff had met in the process of planning and/or implementation, which future perspectives there were for teaching sustainability and finally any good advice to other staff members interested in trying out the integration of sustainability in their teaching.

The good examples demonstrate a variety of models of integration of sustainability throughout the Faculty of Engineering and Science. Included are programmes, semesters, project themes and courses where sustainability is the core element in the teaching, as well as courses and projects where sustainability is included as one among other elements of the teaching. The full description of the thirteen good examples can be found in the publication "Good Examples

Catalogue. Problem Based Learning and Sustainability in Engineering and Science Education – Practice and Potential" which is accessible at this link: http://vbn.aau.dk/files/196495477/Good_Examples_Catalogue.pdf

The following presentation of the findings from the interviews about the good teaching examples is organised into two subsections. The first subsection presents what we have called 'Drivers of change', i.e. answers to questions about who or what initiated the integration of sustainability and why this was done. The second subsection focuses on the 'Challenges for change', i.e. answers to a question about which challenges the person interviewed had experienced in connection with the integration of sustainability.

8.2.1 Drivers of change

From the interviews it emerged that the integration of sustainability in teaching programmes at the Faculty of Engineering and Science depended on a number of factors, the most important being the following four: Personal interest and commitment; re-invention and contextualisation of teaching; attraction of students; external partners and stakeholders. This subsection has been structured according to these four factors.

Personal interest and commitment to sustainability

One of the strongest drivers of change towards integration of sustainability encountered in this study was personal interest and commitment of the lecturer.

The course Policy, Planning and Governance in the M.Sc. Urban, Energy and Environmental Planning is one of the 8th semester courses. The lecturer has a long-standing interest and experience in dealing with issues related to social aspects of sustainability, including, for example, global issues and the consequences of resource flows between poorer and richer countries.

The course Green ICT: Sustainable Business Development is an elective course in the 9th semester of the M.Sc. Innovative Communication Technologies and Entrepreneurship (ICTE). The course was designed and implemented by the lecturer when taking up a position as assistant professor and based on a personal interest and previous work with sustainability. Under the theme of Green ICT all the three spheres of sustainability are included.

The course People and Nature is a joint 5th semester course in the B.Sc. Urban, Energy and Environmental Planning and B.Sc. Geography. This 5 ECTS course is

the result of merging two smaller courses. The lecturer responsible for the new course found that the new course gave more room and thus better opportunities for integrating sustainability aspects, such as, for example, how human beings influence, shape and impact on the natural environment and biodiversity. The lecturer took the opportunity to integrate sustainability in the lectures, as well as in 50% of the written examination.

Re-invention and contextualisation of teaching

Some of the interviewees in the study commented that sustainability allowed for a more holistic perspective and for better interconnection between theories and contextualised real life perspectives, thus providing opportunities for re-inventing and contextualising courses and/or programmes.

One example is the 8th semester of the M.Sc. Architecture, where the semester theme is Sustainable Architecture and thus sustainability is a core element of the semester teaching. The point of departure for integrating sustainability in the semester was a concern about climate change and a research project aiming to reduce CO_2 emissions in urban areas in connection with building constructions. This led to the development of a new approach in architecture education and profession: the integrative design approach. The integrative design approach has been implemented in the 8th semester, with a specific focus on sustainability aspects, bringing together technical, functional and aesthetics aspects of the design of low energy buildings. Presently, a research group in the Department of Architecture, Design and Media Technology explores approaches and plans for a full programme in sustainable architecture.

In the course People and Nature the new semester structure with three 5 ECTS courses meant that two courses were joined to develop a new and more innovative course with more sustainability aspects integrated and a particular focus on impacts of human activities in the natural world.

In the course Inorganic Chemistry II sustainability was integrated in an attempt to contextualise chemistry through integration of sustainability aspects, thereby making the learning more meaningful for students.

The main driver behind the creation of the M.Sc. Sustainable Cities programme was a wish to break away from traditional sector thinking (unconnected thinking of economists, planners and engineers) and instead introduce a cross-sectorial systemic approach to urban development. The programme represents a new

and innovative approach to teaching urban development, and the aim is to educate graduates who will be able to think across sectors: water, energy, transport resources.

In almost all the good examples, the opportunity to contextualise the programmes and courses through sustainability has been exploited, either through the application of specific learning approaches and activities (e.g. using real life situations and contexts) or through themes integrating sustainability and specific discipline content.

Attraction of students

Several interviewees pointed out that integrating sustainability as a visible part of the teaching was a way to attract students, especially international students coming from diverse backgrounds. This was the case, for example, for the two programmes M.Sc. Urban, Energy and Environmental Planning and M.Sc. Sustainable Cities.

In the courses Ecological Economics, People and Nature, Inorganic Chemistry II, the interviewees pointed out that the integration of sustainability and the teaching activities used in this connection gave students the opportunity to actively engage with sustainability.

In other examples, such as the project Energy Reduction in Sea Water Reverse Osmosis Plants, or the project theme: Sustainable Lifestyle, the focus is on introducing students to relevant aspects of sustainability through the project work and students reportedly responded positively to the concept.

External partners and stakeholders

Some of the study programmes where sustainability forms the core of the education, whether at B.SC. or at M.Sc. level, have been established in response to external societal changes and legislation. A similar driver of change is collaboration with external partners and stakeholders who are supportive in the process of establishing the study programme. Such drivers are most clearly illustrated by the M.Sc. Urban, Energy and Environmental Planning programme.

This programme was established in the 1980's with a focus on international technology planning and still receives a mix of international and Danish students with diverse educational backgrounds and expertise. The programme has strong connections with industry that support the programme, for example, by provid-

ing traineeship placement for students. According to the interviewees such business connections may contribute to the popularity of the programme among students. They also pointed out that by keeping in contact with their former students they manage to establish new external partnerships.

The M.Sc. Sustainability Cities is an example of a programme established in response to growing societal challenges in relation to urban planning in mega-cities. The programme leaders collaborate closely with the municipality of Copenhagen, which provides authentic learning opportunities concerned with sustainability in an urban context. Similarly to the M.Sc. Urban, Energy and Environmental Planning programme, the M.Sc. Sustainable cities programme involves a focus on multidisciplinarity.

The B.Sc. and M.Sc. Sustainable Design programmes started in September 2013 with an explicit focus on sustainability and on extending the focus from a product level to a services and systems level. The group designing the programmes have 10 years of experience designing education for sustainability and have been inspired by a variety of international contacts, who also contributed to the accreditation of previous programmes.

The course Green ICT: sustainable business development includes visits and relationships to companies as part of its teaching activities on sustainability. The lecturer mentioned that support for identifying relevant external partners was received from the head of the research group.

8.2.2   Challenges identified by participants

The description of the good examples also included challenges that participants had identified when integrating sustainability in their teaching. The challenges differed depending on whether participants referred to programmes, courses, or projects. Focusing on the experiences about how to implement sustainability and what challenges to expect has been an important part of the PBL-SUS study. The following subsection will present the main challenges which are: Lack of clear definition of sustainability; over dependency upon individual champions; lack of managerial and financial support; rigid semester structure. This subsection has been structured according to these challenges.

Lack of clear definition of sustainability

Given that sustainability is a complex and multidisciplinary concept with a multitude of different aspects, it may happen that in study programmes that involve

many teachers, different perceptions of the concept are presented to the students. This may sometimes cause confusion and frustration for students but is not necessarily a negative thing because it will challenge students to discuss and delimit the concept and thereby achieve a definition useful for them.

This challenge was encountered in the course Holistic Design for sustainability: Systems, Processes and Products, where two non-aligned definitions of sustainability were presented to the students. This gave rise to some confusion and frustration among students who referred to this as a dilemma.

Another challenge that may arise due to the complexity of the concept is that students arrive with one perception of what sustainability encompasses and are met with another perception in the programme. This has, for example, been a problem in the M.Sc. Sustainable Cities programme.

In the project theme: Sustainable Lifestyle, the interviewee pointed out that there is a need for a definition of sustainability that both students and teaching staff use.

Over dependency upon individual champions

In some examples, most often in the examples where sustainability is part of the teaching but not a core theme, the presence of sustainability in the teaching is due to the interests, commitment and personal effort of individual lecturers. The sustainability aspects were, however, not necessarily supported by the programme curriculum or the course module description. The risk in such cases is that once the individual champion is no longer involved in the teaching, sustainability may no longer be included. This is, for example, the case in the courses Inorganic Chemistry II and Renewable Energy Structures: Wind turbines and Wave Energy Devices.

In the course Renewable Energy Structures: Wind turbines and Wave Energy Devices, the interviewee's concern was how to involve other colleagues to talk about other aspects of sustainability, thus providing a more holistic view on course subjects and contents. This would also substantiate the presence of sustainability in the course.

In the course Green ICT: Sustainable Business Development the driver for change was personal interest and the interviewee is presently the only teacher teaching the course but she states that there is a joint interest among other colleagues and therefore she is not concerned about future perspectives.

Another challenge identified in some of the examples and, again, most notably in the examples where sustainability is a part but not a core element of the teaching, is the lack of support, whether managerial support or financial support. This lack of support was described as making the teaching more difficult for the champions than it would be, had support been forthcoming.

The course People and Nature is an example of the lack of support from management and the lack of financial support; thus, the teaching activity planned for sustainability was jeopardised.

The 8th semester theme Sustainable Architecture in the M.Sc. Architecture programme faced challenges in its early history, in connection with establishing a community of practice with sustainability as integrative part in the late 1990s when financial support from the Danish government was not forthcoming.

Rigid semester structure

Until 2010 the semester structure in the Faculty study programmes included a problem based group project of minimum 15 ECTS and two categories of courses: the project supporting courses (PE-courses) and the study unit courses (SE-courses), with courses in both categories of varying length (from 1 to 5 ECTS), depending upon the importance of the topics covered in the courses. While SE-courses were included in the curricula and approved by the Dean, the PE-courses were subject to discussion amongst the teachers responsible for a given semester and thus could be changed from year to year. This approach provided for flexibility and offered room for trial runs of courses of an appropriate length on new topics, such as sustainability. The total semester length was and still is 30 ECTS.

In 2010 this semester structure was changed to a more rigid structure, with 15 ECTS projects and 3 courses of 5 ECTS each. All study modules, whether projects or courses are included in the curricula and changes have to be approved by the study board, school and the Dean.

This challenge was mentioned by the interviewee for the course Ecological Economics. The same challenge was mentioned by the interviewee for 8th semester M.Sc. Architecture who said that the structure had presented a barrier in the planning of the semester. It should be mentioned, however, that in one exam-

ple, the course People and Nature, the new and larger course of 5 ECTS presented an opportunity for the integration of sustainability, simply because of more time available.

8.3 August seminar 2013

The seminar aimed at inspiring academic teaching staff to include sustainability in their teaching by presenting the preliminary findings of the PBL-SUS study, including a draft version of the Good Examples Catalogue. Group discussions focused on two questions:

1. *What can I do in my teaching to integrate sustainability, wherever relevant?*

2. *How can sustainability be made (more) visible and explicit in the study module description?*

This section is structured according to these two questions, with a last subsection that includes seminar participants' suggestions on how to ensure that the integration of sustainability occur.

8.3.1 Integration of sustainability in my teaching

Only one group took the point of departure for their discussion in two specific study modules brought by the participants. Throughout the discussion the participants realised that the modules already contained a fair amount of sustainability aspects, although this was not visible in the study module descriptions. Thus, the discussion focused on the need to make sustainability visible.

Other groups discussed at a more general level the question of integration of sustainability. Some of the ideas presented for integration of sustainability in programmes where it is not a core element, were the following:

- Integrate sustainability in the first semester PV-course in B.Sc. programmes – *"plant some seeds [for a] sustainable mindset from the first semester"* (SICT Poster, Appendix 8)
- Pinpoint in the curriculum study activities in which sustainability can be integrated on an ongoing basis
- Create elective study activities including sustainability for students from different programmes
- Establish Free Study activities including sustainability in one or more semesters

- Integrate sustainability in the project module descriptions
- Re-design courses to integrate sustainability as a core theme
- Focus on learning outcomes - make sure they reflect the kind of graduates the Faculty wants to educate
- Integrate a systems thinking approach in the projects, for example by introducing 'mega projects' that span across programmes and departments

The seminar participants issued a caution against green washing of study programmes that contain little or no sustainability aspects – not everything should be called "sustainable".

8.3.2 Making sustainability more visible

The group that discussed the two specific study modules also discussed how to make the existing sustainability contents more visible and their suggestion was to make sure that existing elements of sustainability should be integrated into the course description. They stressed that sustainability should avoid simply becoming an "add-on" with no relations to the remaining contents of the courses.

Another suggestion was that the overarching philosophy and vision for a given study programme, reflecting the future role of graduates in the world outside university, should be made visible and clear in the curricula. This role of graduates should include an awareness of sustainability and should be included in programme curricula and in the overall programme qualification profile.

In line with the above suggestion was another suggestion that pointed to the importance of reflecting upon the engineering competences required for the world of tomorrow, which faces more and more complex problems. What is a good solution today may not necessarily be the best solution for tomorrow and *"we want to educate students for the future - not for the past"* (SES discussion summary, Appendix 8).

A point that was brought up by several participants in group and plenary discussions was the need to prepare a reference paper for the Faculty, with the aim of making the Faculty vision about sustainability visible and clear. This paper should outline what might eventually become a shared definition of sustainability across the Faculty. Such a paper should relate sustainability to other similar issues, such as, social responsibility, ethics etc. It should be broad enough for each department, each programme and each research group to 'see themselves', i.e. to identify relevant aspects of sustainability in the paper.

8.3.3   Requirements for integration of sustainability

Several participants pointed to the need for an overall strategy at Faculty level. Some of the suggestions made were the following:

- A policy framework from top management
- The need to develop a joint strategy and make it visible
- A decision by the Dean to prioritise sustainability in the study programmes
- Allocation of resources
- Set up an office that can provide support to module responsible teachers to include lectures, cases etc. on sustainability
- Secure employee ownership of sustainability
- Provide staff training on sustainability
- Integrate sustainability as a part of everyday life at the campuses for both students and teachers.

In conclusion, the seminar participants were committed to sustainability and wanted to see many more good examples of integration but also felt a need for top management support for this to happen.

9 Summary of phase 2

From the findings in phase 2 of the PBL study new partial answers to the research questions, seen from the perspective of academic teaching staff, may be added to the answers found in phase 1. These answers will be presented in the second section of this chapter. First, the findings from the three different methods of investigation: the questionnaire, the in-depth interviews and the August seminar, will be compared, integrated and discussed.

9.1 Discussion of findings

In chapter 8 the findings from the questionnaire, the in-depth interviews and the August seminar 2013 were presented. In this section we want to integrate and discuss the findings, pointing out and discussing similarities and difference between the findings. The section includes the same themes as found in sections 8.2: Interviews and 8.3: August seminar 2013 but organised in a different way. Thus, the first subsection discusses the main identified drivers of and challenges for change towards integration of sustainability, including proposed actions to counteract the challenges. The second subsection outlines experiences of integrating sustainability from the good examples, combined with the suggestions for integration from the seminar. It also discusses the challenge of invisibility of existing examples of sustainability teaching and what might be done to overcome this challenge. The third and last subsection presents and discusses the suggestions made by participants, either in the form of good advice or as requirements that are seen as important for change to happen and become permanent.

9.1.1 Drivers of and challenges for change

The two most important drivers identified in the phase 2 study for change towards integration of sustainability were:

1. personal interest and commitment of an individual teaching staff member, a so-called "champion"
2. a response to external societal or legislative demands, combined with support and encouragement from external partners and stakeholders.

Concerning the first driver it is at the same time one of the main challenges, because when teaching of sustainability depends too much on the champion, without significant support from colleagues or from management, the teaching

is not sustainable and chances are that once the champion is no longer there to deliver the teaching, it disappears. The dependency upon champions might be overcome by including existing sustainability teaching in the relevant study module descriptions or in the overall programme qualification profiles.

Concerning the second point the participants in the August seminar 2013 pointed at the need for the Faculty to educate graduates for the future, not for the past, i.e. graduates should be professionally prepared and personally willing to take on the great challenges that face the world of tomorrow – if not of today – and be competent to deal with them at a professional level.

In the process of integrating sustainability the good examples demonstrated that in some cases there is an added advantage of re-invention and innovation of the study module or programme in question and, in addition, an increased student interest and thus higher student influx to the study module or programme. Both of these benefits have been identified as drivers of change.

Another main challenge that was identified in both phases of the study is the overwhelming uncertainty about what the concept of "sustainability" means, how it should be interpreted, how it might be delimited and – most importantly – how it can be made relevant and significant in the professional context of a given study programme. This uncertainty – not to say ignorance – about the concept has led to the existence of "hidden pockets" of sustainability, i.e. situations where students and supervisors are working with sustainability in projects without realising so, as was pointed out in phase 1 (see section 4.2 Interviews).

The participants in the August seminar 2013 discussed this challenge and suggested that a reference paper should be prepared for the Faculty, with the aim of making the Dean's vision about the role of the Faculty as a driver of sustainable development explicit and clear. Such a paper should be sufficiently broad for all study programmes and all research groups to be able to identify relevant aspects for the teaching and research and it should be discussed and communicated widely across the Faculty, to eventually become a shared definition of sustainability.

9.1.2   Integration and visibility of sustainability

The good examples that were identified in the questionnaire and further explored in the in-depth interviews demonstrate a range of different ways of integrating sustainability into study modules, project themes, semesters and/or programmes. Common to most of the examples is that they have clear elements of real life problems, examples, study visits, external collaboration etc. I.e. contextualisation of the teaching of sustainability is a key word.

The suggestions made by seminar participants for enhanced integration of sustainability focused on introduction of the concept in the first year, followed by study activities integrating sustainability at higher semesters, either in projects or as elective or free study activities.

Concerning visibility the existence of a reference paper as mentioned above would greatly improve the visibility of at the overall Faculty level. In order to secure, that sustainability also becomes visible at lower levels, i.e. at the level of academic teaching staff and students, seminar participants suggested a focus on what is written in the study programme curricula, in the qualification profile as well as in the study module descriptions. The qualification profiles should reflect the kind of graduates that the Faculty wants to educate; thus, if sustainability is part of a vision it should be visible in the qualification profile. The "hidden pockets" of sustainability, whether caused by champions who integrate elements of sustainability in teaching without this being visible in study module descriptions or by uncertainty about the concept in connection with projects, the "pockets" might be made visible by being included in study module descriptions, thereby also securing the sustainability of sustainability teaching.

9.1.3   Requirements for change

In the in-depth interviews interviewees were asked to give good advice on how to integrate sustainability in teaching, and in the August seminar the participants were discussing what they perceived as necessary requirements for integration of sustainability to happen. The combination of these findings has been organised in four themes: Top management initiatives; External demands and legislation; research based teaching; department initiatives.

Top management initiatives

The main requirements stated by participants to the top management of the Faculty, that is, the Dean, were focusing on leadership support in the form of a clear and visible strategy and a policy framework for integration of sustainability. If sustainability is to be integrated in the study programmes this should be a priority and communicated as such by the Dean. Linked to the clarity and visibility was a request that there should be focus on employee ownership of sustainability, i.e. academic teaching staff as well as educational managers should feel that they have a stake in achieving the Faculty vision and that concept is relevant and significant for their research and teaching.

Another requirement was for resources to support the integration of sustainability, for example, in the form of an office that could provide support to module responsible teachers to include lectures, cases etc. on sustainability.

A last point of action recommended to top management, possibly at the University level, was to integrate sustainability as a part of everyday life at the campuses for both students and teachers by transforming the university into a 'green organisation', practicing what is preached about sustainability.

External demands and legislation

As already mentioned above one of the important drivers for change towards sustainability has been external demands, either from society at large or from the legislators. Therefore it was recommended to keep an eye on new legislations within the professional field of the study programme. In the process of doing so it was also recommended to look towards the corporate social responsibility profile of companies because more and more companies are incorporating sustainability as a key component of their operations and university graduates should be prepared for this challenge once they take up employment in such companies.

Research based teaching

Several participants, both in the in-depth interviews and in the seminar, mentioned the importance of securing research based teaching. This could be done by identifying new possibilities for research, including research funding, which according to one participant would be more easily forthcoming for research on sustainability and by bringing in your own research on sustainability into the teaching.

Since staff is employed by the departments the responsibility for staff training on sustainability rests with the departments. Seminar participants saw such staff development as being crucial for the integration of sustainability in the teaching. Another initiative that would be a responsibility of the departments is the establishment of cross-departmental collaboration and interdisciplinary communication, a requirement for realistic, real life sustainability teaching.

9.2 Answers to research questions

This section provides answers to the research questions addressed in phase 2 at the level of academic teaching staff. The research questions are repeated here for reference:

1. What has been achieved so far in terms of integration of the concept of sustainability in the study programmes at the Faculty of Engineering and Science at Aalborg University?
    a. How many programmes have already integrated aspects of sustainability?
    b. How is the concept of sustainability integrated, interpreted and delimited in relation to the different study programmes?
    c. -
    d. Which role does problem based learning play in designing and carrying out engineering and science activities that integrate key aspects of sustainability?

2. How can a better integration of sustainability in the study programmes be ensured?
    a. How can the potential for further integration of sustainability in programmes, projects and courses be enhanced?
    b. How can the already existing elements of sustainability be sustained?

The following discussion is organised according to the two research questions, i.e. in the first subsection is presented answers to the three sub-questions and the first main question about what has already been achieved, while in the next subsection the question about better integration is answered through answers to the two sub-questions, followed by an answer to the second main question.

9.2.1 Answer to the first research question

The questionnaire resulted in only 38 responses of which 19 were included in the analysis. This is a response rate of 19%, too low to provide any significant results. Thus, we cannot claim that the findings give a complete picture of integration of sustainability in study programmes at the Faculty and therefore, based on the findings from phase 2, it is not possible to provide an answer to the first sub-question 1a (see chapter 6: Research questions addressed in phase 2).

Concerning the second sub-question 1b the study did, however, provide some insight into the ways of integrating, interpreting and delimiting sustainability in study programmes. As demonstrate in the good examples the degree of sustainability integration varies, ranging from programmes where sustainability is at the core of the programme and includes a multitude of sustainability aspects from all three spheres of sustainability to study modules where a few lectures deal with a few aspects of sustainability to projects where the sustainability aspects are wholly within one sphere and are present but not very prominent. For further information about the integration and interpretation of sustainability in the good examples please refer to the Good Examples Catalogue.

With regard to the fourth sub-question 1d about the role of PBL, it is a methodological problem that the response rate was very low and the phase 2 findings were very limited. As mentioned above only 19 questionnaires were included in the analysis and of these 19 only two described Master projects and one described a project theme, while the remaining 16 presented either programmes, semester themes or courses. The finding is surprising since all respondents in both phase 1 and phase 2 agreed that the problem based project work is the best place to integrate sustainability. It would not be justified, based on the very limited data, to say that PBL plays no significant role in integration of sustainability. Rather, the finding points to the need for further, more thorough investigation of the role of PBL in integration of sustainability.

In conclusion, the answer to the first research question is that although there are prominent success stories about programmes with sustainability as the core elements and with a multitude of different aspects from all three spheres of sustainability as integrated elements in both courses and projects, the majority of programmes were not represented in the findings of phase 2. Therefore, in terms of a quantitative and substantiated answer to the research question, this cannot be presented, based on phase 2 finding.

9.2.2 Answer to the second research question

The sub-question 2a about how to enhance the potential for further integration was specifically discussed in the August seminar 2013 and participants had a number of suggestions. These suggestions spanned from writing a reference paper elaborating on the Faculty perception of the concept over suggestions to top management about strategy and policy frameworks to specific suggestions about how and where to integrate elements of sustainability into the teaching and at the same time include such study activities in the written curricula.

The second sub-question 2b about how to sustain the already existing elements of sustainability was discussed with the participants in the in-depth interviews as well as in the August seminar 2013. From interviewees the answer was mainly focused on support, either support from colleagues within the department or financial support from management. Seminar participants, in their discussions, focused on the visibility of sustainability activities, the point being that if such activities are included in the written study programme curricula then they will automatically become more sustainable and not dependent only upon the individual champions.

Concerning the support from colleagues as called for by champions, seminar participants brought up the need for staff development, which would enable colleagues to participate in the teaching and thus help sustaining it. The call for financial support was not prominent in the debate amongst seminar participants; they, however, called for managerial support in terms of visions, strategies and policies for integration of sustainability, all of which would support and sustain existing elements of sustainability teaching.

In conclusion, the second research question could be answered in short by managerial support, in terms of: clearly formulated and communicated perceptions of sustainability; strategies and policies for achieving integration in study programmes; financial support wherever needed; support for staff development on sustainability teaching.

Part D: Lessons learned and the way forward

The last part of this report aims at drawing together and summarising the lessons learned about integration of sustainability into the Faculty study programmes. Based on lessons learned, recommendations will be suggested for taking this important work with sustainability further, attempting to achieve a much broader coverage of sustainability than what is found today in the Faculty study programmes. Part D contains two chapter of which chapter 10 contains scope and limitations of the study, comparison and discussion of findings from the two phases of the study and conclusions to the achievement of the two study objectives. The last chapter 11 contains recommendations for staff at different levels of the Faculty hierarchy.

10 Discussion and conclusion

In this final chapter of the report on the PBL-SUS study we will draw conclusions from the two phases of the study. In the first section the scope and limitation of the study are described and discussed. The second section discusses similarities and differences between the results from the two phases. In the third section the overall objectives are addressed, discussing and concluding to which extent the study has achieved these objectives. In the last section we, the authors of the report, propose recommendations to management and staff at the Faculty of Engineering and Science. The recommendations are based on inputs from respondents and are aimed at taking this work with integration of sustainability further.

10.1 Scope and limitations of the PBL-SUS study

The aim of this study was to present the current status quo of sustainability integration in study programmes at the Faculty of Engineering and Science, in order to inform future strategies to enhance such endeavours. A number of important findings could be identified. However, this study also has a number of limitations that we want to draw attention to, partly to make reservations about the findings, partly so the limitations may be addressed in any future work on this topic.

The document analysis used the aspects of sustainability from the GRI guidelines as key words to identify aspects of sustainability in the study programmes. However, the GRI guidelines was not developed for such a purpose but rather to

provide a reporting system for measuring and reporting sustainability-related impacts and performance of companies. While we found that the aspects were covering a wide variety of possible aspects around sustainability, a different framework focusing on sustainability implementation in higher education might have been more suitable. At the time of our investigation we did not find such a framework and future work may involve developing a tool for this purpose.

Interviews with selected educational managers provided results that represent opinions of individuals. The conversations we had with them, including providing a figure showing different sustainability aspects, may have introduced an element of bias and thereby shaped their responses, thus reducing the reliability of our findings. To address this limitation we used the same question format and the same figure for all interviews. A problem of inconsistency between the aspects of sustainability presented in the figure and the aspects of sustainability used as key words in the document analysis and as check boxes in the questionnaire prevented a comparative analysis between the relevance of sustainability aspects as seen from the mangers' perspective and the aspects of sustainability actually integrated in the study programmes. Future work may want to develop a figure that is consistent with whatever definition of sustainability is being used in the study.

In-depth interviews conducted with participants who were willing to share their teaching and learning experiences provided results that represent the opinions of self-selected participants or participants whom we approached and who then decided to share their stories with us. The obvious limitation to the results of these interviews is that they represent opinions of highly motivated and committed individuals. We are aware that there may be many more people with important insights and practices and future work should investigate opinions among a broader sample of academic teaching staff.

Questionnaires were sent to teaching staff at the Faculty. Our intention was to mail the questionnaire to all teaching staff. However, we encountered the problem that the questionnaire was filtered out by firewall and, despite our correspondence with the University's IT personnel to allow the questionnaire to be mailed out to all staff, it was brought to our attention too late that the questionnaire had only been sent to 14 % (n=196) of academic teaching staff. This is an obvious limitation to the results from the questionnaire and future work should repeat this investigation and aim for dissemination of the questionnaire to all academic teaching staff.

Another limitation is the questionnaire response rate of 19 % (n=38). Given that the aim of the questionnaire was to identify good teaching examples, we never expected the response rate to be very high and throughout the study the goal for the number of good examples had been set at approximately three to four per school. The final result – seven examples from SADP, four examples from SES and two examples from SICT – are, however, fairly representative for the amount of sustainability teaching found in the document analysis. In connection with a broader dissemination of the questionnaire in future work, more good examples may be identified and should be added to the ones already identified.

10.2 Comparing results from the two phases of the study

With regard to what has been achieved so far in terms of integration of sustainability, the document analysis in Phase 1 revealed that apart from the "sustainability programmes and semesters", i.e. programmes or semesters where sustainability is part of the core curriculum (mainly within SADP), the existence of sustainability in the written curricula is limited – more than 50 % of all Faculty programmes make no explicit reference to sustainability.

This finding was not fully supported by findings from interviews with chairpersons of study boards who indicated that there were "hidden pockets" of sustainability, particularly in project work. "Hidden" in so far that while sustainability was not visible in the written curricula it was described as an integrated part of the problem based project work. This observation from the chairpersons was often mentioned after they had been presented with the overall illustration of sustainability, including some of the GRI aspects (see figure 3.5). This result is in agreement with the finding that almost all interviewees in Phase 1 agreed that the problem based project work supports the integration of sustainability, due to its multidisciplinary nature. At the same time, however, the embedding of sustainability into project work tends to make it invisible, thus creating the "hidden pockets" of sustainability

In Phase 2 the low questionnaire response ratio may result from the fact that the majority of programmes do not contain sustainability. However, the analysis of the questionnaire responses we received does not confirm the existence of "hidden pockets" of sustainability in the projects – of the 19 responses analysed only three concern projects that integrate sustainability while not being part of a "sustainability programme", whereas five concern courses that are not part of a "sustainability programme or semester". Based on these results there seem to

be more "hidden pockets" of sustainability in courses than in projects. Possible explanations of this contradiction are:

- the chairpersons do not have a good overview of what happens in projects
- the project supervisors are not aware of the fact that what students are doing in their project work is in fact (related to) sustainability
- the project supervisors do not see the contents of project work as part of their teaching responsibility and therefore do not consider reporting project work on sustainability in a questionnaire about teaching sustainability.

The second explanation above relates to a conclusion from both Phase 1 and Phase 2: There is a need for discussions leading to a clearer conceptualisation of what could be understood by "sustainability". Whatever the explanation, seen in the light of the problem based learning focus of this study, it is important to reveal the "hidden pockets" of sustainability - if and where they exist - and to make them visible.

Concerning strategies for the integration of sustainability in the Faculty study programmes, the findings from Phase 1 were that, at the time of the preparation of this report, no strategies existed at any level of educational management. The driver for introducing sustainability into the first "sustainability programmes" established at the Faculty has in most cases been external pressure, such as environmental or building legislation. In Phase 2 we found that drivers were most often the personal interest and commitment of individual staff members, in some cases backed by departmental heads, but hardly anywhere did we find a strategy, at managerial or at individual level, for integrating sustainability.

In Phase 1 we found that there are different foci for the three schools, with the School of Engineering and Science focusing mainly on environmental aspects of sustainability, the School of Information and Communication Technology focusing mainly on social aspects while the School of Architecture, Design and Planning integrates aspects from all three spheres of sustainability. This picture, however, cannot be confirmed by the findings in Phase 2, especially not as far as SICT is concerned, mainly because there are too few questionnaire responses (3 responses) from SICT staff members. For SDAP and SES more responses were received but still not enough to validate the findings from Phase 1 about different foci for different schools.

10.3 Conclusion concerning achievement of objectives

In this section we will consider the results of the study in relation to the original objectives, in an attempt to conclude to which extent the study has actually achieved these objectives.

The overall objectives of the PBL-SUS study were:

- To map existing practices and interpretations of sustainability in engineering and science education programmes at the Faculty
- To point at strategies for implementing sustainability adjusted to the specific programmes.

With regard to the first objective the study has indeed provided an overview of existing practices regarding integration of sustainability in the Faculty study programmes, most clearly presented in the Good Examples Catalogue. It has, however, also revealed a very wide span in interpretations of sustainability and showed that there is some confusion and uncertainty about how this concept can be interpreted and understood within the different professional fields of engineering and science.

Given the limitations to the Phase 2 questionnaire we cannot claim that the map provided is complete – there may be "hidden pockets" of sustainability in problem based projects that this study has not managed to reveal for a number of different reasons, one of them being the confusion and uncertainty mentioned above about the interpretation of the concept.

The map that the study has provided shows a somewhat disheartening picture of a Faculty where sustainability could not be clearly identified in more than half of the study programme curricula. Thus, based on these findings it would seem that a majority of engineering and science students graduate from Aalborg University without having been directly confronted with the concept of sustainability or prepared for taking on the challenge of contributing to sustainable development.

In conclusion, the first objective has been partial achieved, in so far as a map has been prepared but this map may not give the complete picture of the existing practices concerning sustainability teaching within the Faulty. Furthermore, concerning the interpretations of sustainability the map does not provide sufficient information because of the great uncertainty found throughout the Faculty about the interpretation of the concept.

With regard to the second overall objective – to point at strategies adjusted to specific programmes – the study has attempted to do so, partly through group discussions in connection with the two August seminars in 2012 and 2013, partly through publishing the Good Examples Catalogue that may serve as a source of inspiration to teaching staff within specific programmes.

The study, however, made it very clear that the task of adjusting the concept of sustainability to specific professional contexts and thus to specific study programmes has to take place in close collaboration between educational managers responsible for the specific curriculum (i.e. chairs of study boards), teaching staff responsible for the actual teaching of courses and supervision of projects within the specific programme and "sustainability experts" either from a relevant "sustainability programme" or from the Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability, under the auspices of UNESCO. Prerequisite conditions for this collaboration to occur are that time and space is provided and all Faculty staff, including educational managers, take an active part in discussions.

In conclusion, the second objective has been achieved in so far as participants in the study, both interviewees and seminar participants in both August seminars, have contributed to recommendations for implementing sustainability at a generic level. The adjustment to specific programmes has to be carried out by an interdisciplinary group of experts, partly from the professional field, partly form the sustainability field.

11 Recommendations

In this last chapter we offer recommendations on how to further integrate sustainability into the Faculty study programmes. The recommendations are structured according to the different levels of educational responsibility, starting with general considerations about the strategy for change, followed by recommendations to Faculty management as well as to the two middle levels of educational managers, i.e. heads of schools and chairs of study boards, respectively, and ending with recommendations to members of the academic teaching staff who may be interested in integrating sustainability into their teaching. The recommendations are based on input from study respondents as well as on the authors' own reflections.

11.1 Strategy for change towards integration of sustainability

Respondents in both phases of the PBL-SUS project provided suggestions on what could be done to strengthen a further integration of sustainability throughout the study programmes at the Faculty of Engineering and Science. The overall sentiment was that there is a need for a strategy, embracing a combination of bottom-up and top-down initiatives.

Bottom-up initiatives have been and will continue to be initiated by the committed individual drivers of sustainability, those champions who are particularly passionate about sustainability and who are willing to invest time in developing engaging teaching programmes that integrate relevant aspects of sustainability and thus prepare students to face the grand challenges.

If willing to share their ideas and experiences these champions may act as role models for colleagues and other teaching staff members. A visible and continuously updated web presence of the Good Examples Catalogue would allow for the sharing of ideas and experiences, examples and contacts.

Bottom-up initiatives are, however, seldom long-lived unless they are supported from the top. Top-down initiatives could include making available the necessary resources to support the champions and possibly provide incentives for the staff members who might be interested but not quite as passionate as the champions. Top-down initiatives should also include strong and visible leadership from the Faculty management at all levels in the process of introducing sustainability into the teaching.

11.2 Recommendations to Faculty management

One of the most frequently made recommendations to Faculty management was that the Faculty should have a vision for sustainability, formulated by top management. In the August seminar 2012 the Dean of the Faculty indeed expressed one such vision:

Aalborg University will be a driving force in the creation of sustainable development, locally, nationally and internationally

(Dean, 2012)

Other formulations of similar visions were: AAU as a flagship of sustainability; AAU campuses being sustainable organisations, with students living sustainably while at university; AAU as a role model for the surrounding community.

A vision directly linked to the area of the PBL-SUS project was that future students may choose AAU *because* of the sustainability profile in the programmes.

Thus, there is no lack of visions about the sustainability profile of the Faculty but there is a need to formulate a clear, explicit and well-articulated vision at Faculty level and to communicate this vision, clearly and explicitly, using all possible means of communication, to all staff members within the Faculty, in order to create understanding and commitment among all stakeholders, from top management all way down through the hierarchy to the lowest levels of young employees and even to students, including potential future students.

Commitment to a vision will not, however, be created through one-way communication only. There is a need to let staff members at all levels participate in discussions and decision making about the desirability of integrating aspects of sustainability into study programmes. This process of discussion would seem even more important when dealing with a contested concept such as sustainability, in consideration that there was widespread confusion and uncertainty about the interpretation of the concept in different professional contexts.

The vision should be accompanied by the reference paper mentioned earlier (see subsection 9.1.1), outlining the concept of sustainability in such a way that it might eventually become a shared definition of sustainability across the Faculty. Furthermore, the vision should be followed up by a Faculty strategy for sustainability integration in study programmes at the Faculty.

Another recommendation to Faculty management expressed by a number of respondents is that resources for the task of integrating sustainability into Faculty study programmes should be made available, both for the individual teacher who wants to include it and for the staff members who have to review curricula to secure the visibility of sustainability in the curricula.

Due to a number of recent significant changes in study programmes, such as the introduction of the Bologna agreement in 2007 and the new 3 x 5 ECTS course structure in 2010 there seems to be a general feeling among chairs of study boards that new initiatives, involving yet another review of curricula cannot be carried out without extra resources.

A wish expressed by a number of respondents in both Phase 1 and Phase 2 is that an information/knowledge data bank on sustainability be established within the Faculty. The Good Examples Catalogue can be viewed as one such source of information and inspiration. It can be found here:
http://vbn.aau.dk/files/196495477/Good_Examples_Catalogue.pdf

Another source of information and inspiration might be the MUSLI: Meeting place for University Sustainability Learning Initiatives, mentioned on page 60 of the Good Examples Catalogue and further described here:
http://www.pblee.aau.dk/musli/

It is the hope of the authors of this report that Faculty management will be supporting the MUSLI initiative, thereby enabling it to become the dynamic and interactive information/knowledge data bank requested by interested staff members.

Yet another recommendation to Faculty management – or possibly to University management - is to establish an annual "Sustainability Day", similar to the University Teaching Day, with key note speeches and workshops about integration of sustainability into teaching activities. Experience from a workshop on sustainability in the recent University Teaching Day 2014 demonstrated that innovative examples of teaching may be created in an interdisciplinary dialogue between interested workshop participants. Such "Sustainability days" could be a way of keeping focus on developing ideas and training staff through a peer teaching/-learning approach.

11.3 Recommendations to heads of schools

The three schools face some common challenges in terms of integrating sustainability into their study programmes, such as, conceptualising sustainability within the school context and finding space for sustainability in already overcrowded and rigid curricula.

A recommendation to the three schools is to make sure that all staff within the school with responsibility for educational planning, such as all members of study boards, including chairs, and all programme leaders undergo continued professional development with regard to sustainability, to allow them to come to terms with how the concept can be interpreted and understood in different fields of engineering within the school. The above mentioned confusion and uncertainty about the interpretation of the concept was found in all three schools and might be overcome through such initiatives.

If such continued professional development is carried out in the form of problem based learning workshops, where participants work with the study programmes they are responsible for, making visible already existing sustainability aspects and/or integrating (more) sustainability into the programmes, an added advantage might be updated study programmes.

Another recommendation to the three heads of schools, possibly in collaboration with the Faculty management, is based on a remark often encountered during the study: that in an overcrowded curriculum structured around 3 x 5 ECTS courses there is no room for a non-core activity such as sustainability. Therefore, it is recommended to critically review the 3 x 5 ECTS structure in order to consider how to make the semester structure more flexible and better suited to the purpose of integrating sustainability – and other important non-core topics, such as, for example, innovation, entrepreneurship and cultural communication - into curricula.

11.4 Recommendations to chairs of study boards

The study boards are responsible for the detailed planning and implementation of the study programmes and are in direct contact with the teaching staff; thus they are very important players in a desirable change towards (more) integration of sustainability into the study programmes – without the consent and active participation of study boards such integration will not happen.

Most importantly and a first step towards integration of sustainability is that the study boards initiate discussions about the Faculty reference paper mentioned above (see subsection 9.1.1) outlining the concept of sustainability, in order to raise the level of awareness among members of the study board about the concept and further define what it might entail in their own professional field. Outcome of such discussions could be identification of sustainability themes that are perceived as relevant for the particular professional field. Invited participants in such discussions could be the teaching staff members whose good examples have been identified through this study or it could be external sustainability experts from within the professional field.

Another recommendation is that each study board should appoint "sustainability ambassadors", i.e. staff members who are already working with sustainability in their teaching. These ambassadors should be supported in collaborating with and inspiring other interested teaching staff. Such collaboration might take place in connection with the above mentioned "Sustainability Day".

Two other recommendations to the study boards are aimed at overcoming the present situation of vulnerability of sustainability teaching in non-sustainability programmes. In order to make the existing teaching sustainable it is recommended that study boards, in collaboration with research groups working with sustainability, appoint co-teachers so that at least two members of teaching staff who are also involved in research on sustainability, are capable of teaching the sustainability elements. Also, it is recommended that the sustainability aspects be made visible by formal integration into the study programme curricula, whether in programme qualification profiles or in learning outcomes for specific study modules.

Concerning the actual teaching of sustainability the following recommendations are made:

The 1st year course called Problem Based Learning and Science, Technology and Society (PV-course) should be modified to include an introduction to sustainability. Sustainability may be included in 1st year projects as well, with the assistance of 'sustainability supervisors'. This is already happening in a number of cases, such as, for example, electronics, medialogy, biology etc., whether under the umbrella of "sustainability" or simply based on the inherent interests of students.

For students to get a sound feel for the complexity of the concept of sustainability in the professional context of the study programme, it is necessary to bring it into the study programme again at a later stage when students have acquired deeper professional knowledge, skills and competences within their chosen field of specialisation. This could be done, for example, through a relevant semester theme where relevant sustainability aspects are integrated into the problem based project work which is being supported by course modules or workshops including sustainability. In this way students would integrate sustainability as a part of their professional profile.

Mega-projects that span across a number of different professional fields of study, would allow students to work with real life complex and ill structured problems and are therefore very well suited to integration of sustainability. One problem with such mega-projects is, however, that often they are carried out as extra-curricular activity and not recognised as part of a professional competence profile. It is recommended that mega-projects be recognised as part of a professional profile in line with other projects.

11.5 Recommendations to heads of departments

A number of the above recommendations deal with continued professional development (CPD) of both managerial and teaching staff. The responsibility for and the funds to implement such CPD activity rests with the departmental heads, therefore, in this section we present recommendations on CPD to heads of departments.

All staff within the department with responsibility for educational planning, such as all staff members and chairs of study boards and all programme leaders, should undergo CPD with regard to sustainability, to allow them to come to terms with how the concept can be interpreted and understood in different fields of engineering. The above mentioned confusion and uncertainty about the interpretation of the concept found among many respondents in this study might be overcome through such initiatives.

Furthermore, all teaching staff within the department should undergo similar CDP – without sound knowledge of what the concept of sustainability may encompass in different fields of engineering and science it is hardly fair to ask teachers to integrate it into their teaching.

11.6 Recommendations to academic teaching staff

Last but not least a few recommendations to teaching staff within the Faculty.

To the staff members who are already integrating sustainability into their teaching the recommendation is to keep up the good work and to share your ideas and experiences with other interested colleagues, both through face-to-face discussions but also by posting your experiences on-line, either on the Good Examples Catalogue web page which we hope will be created as a continuation of this study or on the MUSLI home page found here:
http://www.pblee.aau.dk/musli/

Another recommendation is to work towards ensuring that your good work with sustainability is made visible in the formal curriculum of the programme that your teaching is a part of, by having it included either in the qualification profile or in the study module description for the study module that you are teaching. Furthermore, you might continue to be on the outlook for more aspects of sustainability that might be integrated into your teaching – such aspects might be identified through interdisciplinary discussions with interested and committed colleagues from other departments in an annual "Sustainability Day".

To those staff members who are interested in experimenting with integration of sustainability into their teaching but not quite sure about how to do so, a recommendation is to look up the Good Examples Catalogue which you find here:
http://vbn.aau.dk/files/196495477/Good_Examples_Catalogue.pdf
In the catalogue you might seek out the examples that inspire you, possibly contact the contact persons responsible for the examples to get more information and more ideas and then try it out. This process of experimenting with teaching is always best carried out in collaboration with an interested colleague and the sustainability of sustainability teaching is enhanced if two teachers collaborate. You will gain experiences, good and bad, in the process and these experiences can be shared with other colleagues via MUSLI or Good Examples Catalogue and thereby you may gradually become more confident in the field of sustainability.

Other staff members who presently do not explicitly include any aspects of sustainability may want to familiarise themselves with the concept, in order to be able to determine whether indeed no aspects of sustainability are of relevance to their teaching. Another recommendation is to talk with colleagues who have already integrated sustainability into their teaching, in order to maybe be inspired by their example.

11.7 A final word

It is important to stress that while all graduates should have sustainability as a part of their professional qualification profile not all study modules should include sustainability. Sustainability should not simply be an "add-on" to any study module and there should be no green washing of study modules that do not contain sustainability aspects. Thus, even in the ideal sustainability curriculum there will be many study modules, especially course modules, where there will be no mention of sustainability at all.

As has been pointed out in this study sustainability is closely connected with the contextualised problem based projects and as such is best integrated into the project work.

The overall aim of these recommendations is to secure that graduates from the Faculty of Engineering and Science, Aalborg University, through a sound understanding of the concept of sustainability as an important part of their professional profile and through professional competences acquired within the broad field of sustainability, may contribute to achieving the vision of the Dean.

References

AAU, 2013. *Facts about Aalborg University.* [Online]
Available at: http://www.studyguide.aau.dk/digitalAssets/35/35915_kort-over-aau.jpg
[Senest hentet eller vist den 3rd October 2013].

Copernicus Alliance, 2013. *Copernicus Alliance.* [Online]
Available at: http://www.copernicus-alliance.org/
[Senest hentet eller vist den May 2013].

Dean, 2012. *PBL-SUS seminar.* Aalborg, Aalborg Universitet.

Graaff, E. d. & Kolmos, A., 2003. Characteristics of Problem-Based Learning. *International Journal of Engineering Education,* 19(5), pp. 657-662.

GRI, 2013. [Online]
Available at: https://www.globalreporting.org/resourcelibrary/G3.1-Quick-Reference-Sheet.pdf
[Senest hentet eller vist den 19 February 2013].

http://vbn.aau.dk/files/196495477/Good_Examples_Catalogue.pdf, 2014. *Good examples catalogue - Problem Based Learning in Engineering and Science Education - Practice and Potential,* Aalborg : Department of Planning.

Qvist, P., 2008. *Democratic learning in the Aalborg Model. Participant directed learning in groups. Results from questionnaire surveys.* Colima, Mexico, Paper presented at International Conference PBL.

Verify, 2011. *Verify Sustainability.* [Online]
Available at:
http://www.verifysustainability.com/Pie%20Diagram/PieDiagram_Open_Page.aspx
[Senest hentet eller vist den 22 Februar 2013].

Vos, R. O., 2007. Defining sustainaibility: a conceptual orientation. *Journal of Chemical Technology and Biotechnology*, Issue 82, pp. 334-339.

WCED, 1987. *Our Common Future: Report of the World Commission on Environment and Development.* Switzerland: s.n.

Appendix

Appendix 1: Document analysis – template

Appendix 2: Interview guide – phase 1

Appendix 3: August 2012: Seminar invitation and programme

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Appendix 7: August 2013: Seminar invitation, programme and discussion points

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Appendix 1: Document analysis – template

AIM OF STUDY

The document analysis of curricula from The Faculty of Science and Engineering at Aalborg University aims to discover the existing extent of sustainability in current curricula. The results will form the basis for interviews with heads of schools, study boards and Ph.D. programmes.

The document analysis has three steps.

This analysis is for:

School: Study board: Degree:

Step 1: qualitative read through

Read through **Competence profile of the program** and the **Overview of the program**.

Apparent extent of sustainability in curriculum

If sustainability is apparent here (also in a broader sense of the word), continue with the document analysis based on the GRI 3.1 and listed below.

Step 2: quantitative search for aspects and their context
If further subcategories/connections are needed, feel free to add columns.

Search for GRI 3.1 aspects and their context in curriculum

1. Italics: words not used specifically in curriculum
2. Bold: more frequent words (>2)

Environmental	
Categories	**In connection with…**
Environment	
Materials	
Energy	
Water	
Biodiversity	
Emissions, effluents, and waste	
Products and services	
Compliance	
Transport	

Human Rights	
Categories	**In connection with…**
Human rights	
Investment and procurement practices	
Non-discrimination	
Freedom of association and collective bargaining	
Child labour	
Forced and compulsory labour	
Security practices	
Indigenous rights	

Labour practices and decent work	
Categories	**In connection with**
Employment	
Labour/management relations	
Occupational health and safety	
Training and education	
Diversity and equal opportunity	
Equal remuneration for men and women	

Society	
Categories	**In connection with…**
Society	
Local community	
Corruption	
Public policy	
Compliance	

Product responsibility	
Categories	**In connection with…**
Product responsibility	
Customer health and safety	
Product and service labelling	
Marketing and communication	
Customer privacy	
Compliance	

Economic	
Categories	**In connection with…**
Economic performance	
Market presence	
Indirect economic impacts	

Step 3: summary of findings

Summary of findings

Appendix 2: Interview guide – phase 1

Background

- Name
- Title
- Background (expertise, work experience, personal experience with relation to sustainability)

Status quo

- Could you please give us some examples of how aspects of sustainability (broadly defined – environmental, social and economic) are already implemented in your current study programmes? Please specify the aspects and the programmes.
- Are you aware of any courses within the Faculty that integrate aspects of sustainability? If so: Which programmes and which particular aspects are you thinking of/looking at?

PBL and project work

- How do you perceive the role of PBL and project work to support the integration of sustainability (or aspects of sus) in the programmes?

Strategy and future perspectives

- Does the Study Board/School/Faculty have a strategy for the integration of further aspects of sustainability into the study programmes? If so: Could you please elaborate? If not: Why not?
- Does the Study Board/School/Faculty have any plans to make changes regarding the integration of sustainability into the study programmes in the near future? if so: Which changes? If not: Why not?

Relevance

- Are there (other) aspects of sustainability that you see as relevant to your programmes? If so: Which aspects? If not: Why not?
- Which aspects of sustainability do you think should be included into University teaching? And which aspects should not or cannot be included? Why/why not?

Leadership

- How do you see your role in implementing sustainability in the programs under your Study Board/School/Faculty?

- Can you recommend staff for us to talk to? Someone who takes the initiative on sustainability or is passionate regarding sustainability?

Appendix 3: August 2012: Seminar invitation and programme

Schools and study boards are invited to seminar on PBL and Sustainability in Engineering and Science Education

Friday 24 August 2012 from 9.00-12.00 at the Utzon Centre

Schools and study board members are invited to participate in this seminar on PBL and sustainability. The objectives of this seminar are to discuss ideas and strategies on how to integrate sustainability into education or make existing sustainability units visible. There will be presentations of newly conducted study by and a series of best practice cases.

This seminar is the first initiative by the Centre of PBL and Sustainability that has the task to initiate a new UNESCO Aalborg Centre. One of the first activities is a study of the integration of sustainability in Engineering and Science education at the Faculty of Engineering and Science. The results will be presented at the seminar.

Preliminary programme

09.00-09.10:	Eskild Holm Nielsen: Welcome, the initiative of PBLSUS (UNESCO II Centre) and the Faculty commitment of CO-PERNICUS
09.10-09.30:	Kirsten Krogh Hansen: Results from the PBLSUS inventory
09.30-09.45:	Søren Løkke: Environmental Committee at AAU: Who, what, why, where
09.45-10.00:	Andrew Jamison: Sustainable frame of mind of engineers (shaping the frame for further discussion)
BREAK	

*****continued from previous page*****

10.15-10.30:	Martin Lehman: Historical perspective on initiatives that have been going on
10.30-10.45:	Iwona Windekilde: Working with green ICTs
10.45-11.00:	Mary Ann Knudstrup: representing study board and working with sustainability
BREAK	
11.15-11.45:	Discussion of possibilities to integrate sustainability
11.45-12.15:	Questions to the panel and discussion
12.15-12.30:	Concluding remarks
12.30	Lunch

Centre for PBL and Sustainability

● ● ●

Please sign up for the seminar at: http://cpd.aau.dk/ucpbl/seminar/

Further information regarding the Centre for PBL and Sustainability can be found at: http://www.ucpbl.net

For further information regarding this event please contact:
Kirsten Krogh Hansen (kkh@plan.aau.dk)
Kathrin Otrel-Cass (cass@learning.aau.dk)
Mona-Lisa Dahms (mona@plan.aau.dk)

PROGRAMME

09.00-09.15:	Eskild Holm Nielsen: Welcome, the initiative of PBL-SUS (UNESCO II Centre) and the Faculty commitment of COPERNICUS/ECIU
09.15-09.30:	Søren Løkke: Environmental Committee at AAU: Who, what, why, where
09.30-09.45:	Andrew Jamison: Sustainable frame of mind of engineers (shaping the frame for further discussion)
	BREAK
10.00-10.15	Iwona Windekilde: Working with green ICTs
10.15-10.30:	Mary Ann Knudstrup: Working with sustainability in Architecture and Design
10.30-10.50:	Kirsten Krogh Hansen: Results from the PBL-SUS inventory
	BREAK
11.05-11.35:	Round table discussion of possibilities to integrate sustainability
11.35-12.05:	Panel debate: Possible strategies
12.05-12.20:	Concluding remarks
	LUNCH

Chaired by head of steering committee
Anette Kolmos

Chaired by task group member
Kathrin Otrel-Cass

Appendix 4: Detailed tables from document analysis

School of Engineering and Science	Number of programmes
No mention of sustainability	40
All 3 spheres of sustainability	9
Environmental and social sustainability	7
Social and economic sustainability	1
Environmental and economic sustainability	2
Only environmental sustainability	6
Only economic sustainability	2
Only social sustainability	1
Total	68

School of Communication and Technology	Number of programmes
No mention of sustainability	24
All 3 spheres of sustainability	1
Environmental and social sustainability	0
Social and economic sustainability	1
Environmental and economic sustainability	0
Only environmental sustainability	0
Only economic sustainability	0
Only social sustainability	3
Total	29

School of Architecture, Design and Planning	Number of programmes
No mention of sustainability	2
All 3 spheres of sustainability	9
Environmental and social sustainability	3
Social and economic sustainability	0
Environmental and economic sustainability	0
Only environmental sustainability	0
Only economic sustainability	0

Only social sustainability	0
Total	14

Faculty of Engineering and Science	Number of programmes
No mention of sustainability	66
All 3 spheres of sustainability	19
Environmental and social sustainability	10
Social and economic sustainability	2
Environmental and economic sustainability	2
Only environmental sustainability	6
Only economic sustainability	2
Only social sustainability	4
Total	

Appendix 5: Questionnaire

The Questionnaire

Thank you for registering your good example of "aspects of sustainability in my teaching/supervision"

This registry has three sections:
1. section: Background information of your example
2. section: Aspects of sustainability covered
3. section: Free description of your example

(If you have more than just one good example, please select one)

Is your example related to teaching or supervision?

(1) ❑ Teaching

(2) ❑ Supervision

(3) ❑ Teaching and supervision

Which programme is your example from?

_____

Which semester is your example from?

(1) ❑ 1. semester

(2) ❑ 2. semester

(3) ❑ 3. semester

(4) ❑ 4. semester

(5) ❑ 5. semester

(6) ❑ 6. semester

(7) ❑ 7. semester

(8) ❑ 8. semester

(9) ❑ 9. semester

(10) ❑ 10. semester

(11) ❑ Other (i.e. WOFIE, solution labs, etc.) Please state _____

The concept of sustainability is traditionally organised into three interconnected areas; environmental, social and economic sustainability. The aim of the next section is to identify what areas of sustainability are covered in your example.

Following is a list of key-words that covers the broad definitions of sustainability please tick the areas covered in your example.

Are the following aspects of environmental sustainability included in your teaching/supervision?
(Please tick all relevant boxes)

	Included in my teaching/supervision
Environment (miljø)	(1) ❑
Materials (materiale/stof)	(1) ❑
Energy (energi)	(1) ❑
Water (vand)	(1) ❑
Biodiversity (biodiversitet)	(1) ❑

Included in my teaching/supervision

Emissions, effluents, waste (emissioner, spildevand, af-fald)	(1) ❑
Products and services (pro-dukt og ydelse)	(1) ❑
Compliance (overholdelse-)	(1) ❑
Transport (transport)	(1) ❑

I (also) include the following other elements of environmental sustainability in my teaching/supervision

_____

Are the following aspects of social sustainability included in your teaching/super-vision?

(Please tick all relevant boxes)

Included in my teaching/supervision

Human rights (menneskeret-tigheder)	(1) ❑
Investment and procurement practices (investering- og an-skaffelsesprocedurer)	(1) ❑

Included in my teaching/supervision

Non-discrimination (anti-dis-krimination)	(1) ❑
Freedom of association and collective bargaining (foren-ingsfrihed og kollektive forhan-dlinger)	(1) ❑
Child labour (børnearbejde)	(1) ❑
Forced and compulsory labour (tvangsarbejde)	(1) ❑
Security practices (sikkerhed-spraksis)	(1) ❑
Indigenous rights (urbefolk-ningers rettigheder)	(1) ❑
Employment (beskæftigelse)	(1) ❑
Labour/management relations (arbejdsgiver/arbejdstager re-lationer)	(1) ❑
Occupational health and safety (arbejdsmiljø og sikker-hed)	(1) ❑

Training and education (Praktik og uddannelse)	(1) ❑
Diversity and equal opportunity (Diversitet og ligestilling)	(1) ❑
Equal remuneration for men and women (lige løn for lige arbejde)	(1) ❑
Society (samfund)	(1) ❑
Local community (lokalsamfund)	(1) ❑
Corruption (korruption)	(1) ❑
Public policy (Offentlige målsætninger)	(1) ❑
Compliance (overholdelse-)	(1) ❑

I (also) include the following other elements of social sustainability in my teaching/supervision.

_____

Are the following aspects of economic sustainability included in your teaching/supervision?

(Please tick all relevant boxes)

	Included in my teaching/supervision
Product responsibility (produktansvar)	(1) ❑
Customer health and safety (kundesundhed- og sikkerhed)	(1) ❑
Product and service labelling (mærkning af produkt og ydelse)	(1) ❑
Marketing and communication (marketing og kommunikation)	(1) ❑
Customer privacy (kundens privatliv)	(1) ❑
Compliance (overholdelse-)	(1) ❑
Economic performance (økonomiske resultater)	(1) ❑
Market presence (tilstedeværelse på markedet)	(1) ❑

Included in my teaching/supervision

Indirect economic impacts (in-
direkte økonomiske konse-   (1) ❑
kvenser)

I (also) include the following other elements of economic sustainability in my teaching/supervision.

_____

An important part of sustainability is inter-generation and institutional partnerships, as illustrated below.

Adapted from Verify Sustainability (2008)
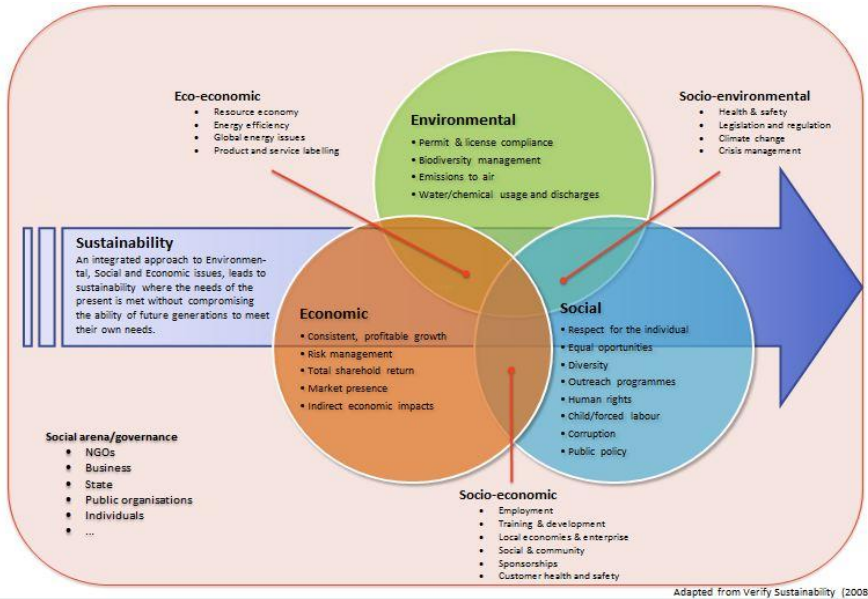
The next questions will cover these aspects of sustainability.

Which stakeholders or social arenas come into play in your example?

_____

What is done in your example to make students aware of consequences for future generations?

_____

This final section will give you a chance to describe your good example in further detail.

In your own words, please describe your example.

_____

If you are interested in participating in a further case study of one of your pro-grammes/courses/project themes/groups/good examples etc., please state your name and contact information.

(The case study will be carried out in the spring of 2013. Each study will be planned to fit the case, but most likely the case studies will include an interview and possible observation)

_____

Thank you for your participation!

Processing of questionnaire responses

A total of n=196 questionnaires were mailed out as an online questionnaire and 38 responses were received, i.e. a response rate of 19%. Of the 38 responses 21 questionnaires were completed, while 17 were only partially completed. The 17 partially completed questionnaires were not included in the analysis of results. Of the 21 completed questionnaires, two respondents, who had volunteered for an interview, submitted examples concerning PhD programmes which were outside the scope of this study, leaving a total of 19 questionnaires which were included in the data analysis. All 19 questionnaires were included in the quantitative analysis. Due to lack of information only 17 were included in the qualitative analysis (i.e. in the Good Examples Catalogue). 12 questionnaire respondents volunteered to participate in an interview. Interviews about good examples were arranged with 9 of the 12 respondents; the remaining three were not interviewed either because it was impossible to settle on a date or because contact details were missing. Instead, the information from two of the three questionnaires was included in the Good Examples Catalogue as additional information to an example or as a short story. The remaining completed questionnaires were also included in the catalogue either as additional information or as short stories.

Appendix 6: Interview guide – phase 2

Please tell us again about the study activity (course or project) that you described in your example for incorporating sustainability into your teaching.

Please share any documents: Programme/course/project descriptions, teaching plans, assessment plans etc.

What/who initiated this study activity and why?

Probing question:
To which extent did you have to adapt/change the study programme to incorporate the sustainability aspects?

Content: Which aspects of sustainability are integrated in this study activity (use the sustainability figure)

> To which extent have examples of interdisciplinarity been integrated into the study activity?

Teaching style: Have you adapted a specific teaching style with relevance to sustainability

Ex. In class/outside/involving experts/community members/field trips – and how is it connected to sustainability?

Probing questions:
To which extent do students get activated in the study activity?
Are there opportunities for students to voice their wishes and make choices related to contents and/or teaching style?

Learning outcomes: To which extent have aspects of sustainability been integrated into the learning outcomes?

Probing question:
To which extent has it been easy to integrate sustainability aspects into the learning outcomes? (i.e. formulation of LOs; acceptance by colleagues; approval by Study Board etc.)

Assessment: To which extent are students' knowledge, skills and competences in the area of (aspects of) sustainability measured at the summative assessment?

Please tell us about all formative and/or summative types of assessment used in the study activity

Future plans for the study activity

Are you planning any changes to the existing teaching? If so: What and why? (i.e. inclusion of more/other aspects of sustainability etc.)

To which extent are such plans based on student evaluations of your study activity?

Do you have any experiences of sharing ideas with colleagues? Do you see any opportunities to do so? Do you wish to do so?

Do you have any suggestions as to how we can find out more about this study activity?

Possible student interviews?

Possible observations?

Possible interview with another colleague?

Anything else?

Thank you for your time.

Appendix 7: August 2013: Seminar invitation, programme and discussion points

To scientific staff at Faculty of Engineering and Science, AAU

On behalf of the Faculty of Engineering and Science and the three school leaders you are hereby invited to a seminar on:

PBL and Sustainability in the Faculty Study Programmes

The seminar takes place **Wednesday the 28th of August 9.00-13.00**

Aalborg: Niels Jernes Vej, room 8A – 1.12

Copenhagen: (via video-link, room ACM15 C1-2.1.025)

Esbjerg: (via video-link, room B107)

Register for the seminar here

The seminar aims at inspiring you to include sustainability aspects in your courses and projects.

The preliminary programme for the seminar is:

8.30-9.00 Coffee and sign in

9.00 Welcome

9.10-9.45 Presentation of the PBL-Sustainability project

9.45-10.00 Introduction to group discussions

10.00-12.00 Group discussions (groups will be based on school affiliation)

12.00 – Summing up group discussions

13.00 The dean will be hosting a light lunch

Programme of PBL-Sustainability staff seminar 28th of August 2013
9.00-9.10   Welcome by Dean Eskild Holm Nielsen
9.10-9.45   Presentation of the PBL-Sustainability study
9.45-11.30   Group discussions: What can I do in my teaching?
11.30-12.00   Poster presentations
12.00-12.15   UNESCO Aalborg II Centre for PBL and Sustainability in Engineering Education by Anette Kolmos
12.15-13.00   The Dean will be hosting a light lunch

Group discussion: What can I do in my teaching?

- A round of presentation: Name, department, area of specialisation (research and teaching)
- A round of sharing: Each participant describes the study module she/he wants to share
- A time keeper in each group is responsible for securing that the time is administered so that all modules are being discussed

The discussion should focus on the following two questions:

- What can I do in my teaching to integrate sustainability, wherever relevant?
- How can sustainability be made (more) visible and explicit in the study module description?

The group prepares a poster with short description(s) of one or more of the discussed modules. The poster should be a summary of the group discussion.

The posters are presented in plenary and will be included in the Good Example Catalogue as a short story.

Appendix 8: August seminar 2013: Summary of group discussions

Participants started by discussing the given question, and concluded that more programmes include sustainability than the ones described in the PBL-SUS study presentation.

Responding to the question on how to integrate sustainability in the Faculty programmes, they made the following suggestions:

- Through the PV course;
- Elective course, or free study activity in one or more semesters;
- Integrate sustainability in the projects descriptions
- Create a central place at the University to provide support, and facilitate, the integration of sustainability in programmes
- Re-design courses to include sustainability as a core element
- Be aware not to "green wash" the courses

Participants also pointed at some requirements that were needed as a way to integrate sustainability such as:

- Support and directive from the dean/rector
- Allocation of resources
- Production of a reference/ concept paper
- Promote employee ownership

SLIDES FROM PARTICIPANTS IN COPENHAGEN

Copenhagen resume of discussions	Sustainability is visible in some programs
Andres, Morten, Lene, Tania, Mushtaque, Tom	• Sustainable Biotechnology • Sustainable Design and Innovation • Sustainable Cities • Avoid green washing of other programs

How to better integrate sustainability in programs where sustainability is not the focus	Requirements for that to happen
• Include sustainability as a topic in the PV course • Establish an elective "free study activity" or 5 or 10 ECTS module on sustanability for students from different programs (like WOFIE) • Include sustainability in semester project descriptions (one or more) • Set up an office that can help module responsibles to include lectures, cases etc. (like Jacob Stolt in the area of entrepreneurship; UNESCO Center II or DIST) • Re-design courses to include sustainability as a core element (do we want to do that?)	• Decission by the Dean that AAU should put priority on sustainability in study programs • Allocate ressources • Produce a reference paper that relates sustainability to other central/similar concepts, like social responsibility, ethics, efficiency, green etc. (done by Aida?) • Employee ownership over sustainability as a central concept

Plenary discussion comments:

It is important not only to integrate sustainability as part of the teaching and learning activities but also as part of students' and staffs' everyday life at University.

2nd SADP Group (five participants)

The group focused its discussion on the two courses study regulations brought by participants from Geography and Public Health programmes.

Examining the two programmes the discussion participants identified themes/ideas in the courses that can be linked to sustainability such as public health. For example a project model about obesity could be linked to social inequality. However the participants felt that for including aspects of sustainability they had to be made visible and added to the formal courses' descriptions.

POSTER FROM SADP GROUP

Plenary discussion comments:

It is important to be aware that not everything should be called "sustainability" in order not to "green wash" courses and programmes but work towards a holistic concept of sustainability.

3rd SES Group (six participants)

The group discussion resulted in the following comments:

- Focus on learning outcomes and reflect what kind of graduates we want to educate, and where sustainability has its role/ place
- Reflect upon what is a good solution today and what the implications are for study programmes
- Integrate systems thinking approach as a requirement in the programmes (for example, there is a need for engineers to think in terms of systems because the world faces more and more complex problems)
- LCA awareness is also important (due to sustainability challenges)

- Create elective courses for sustainability
- Look into implementation strategies (for example a policies frameworks from top management; good example to make sustainability teaching more visible)
- Take the PBL approach to another level, for example to apply a systems thinking approach, or embed it by using "mega projects" across programmes and departments.
- In a system thinking approach, the first step is to think about the requirements, and above is some of the requirements.
- *"We want to educate students for the future and not the past"* - quote from Roger H. – *"when we understand the problem you can solve in a better way, and don't spend a lot of time understand it".*
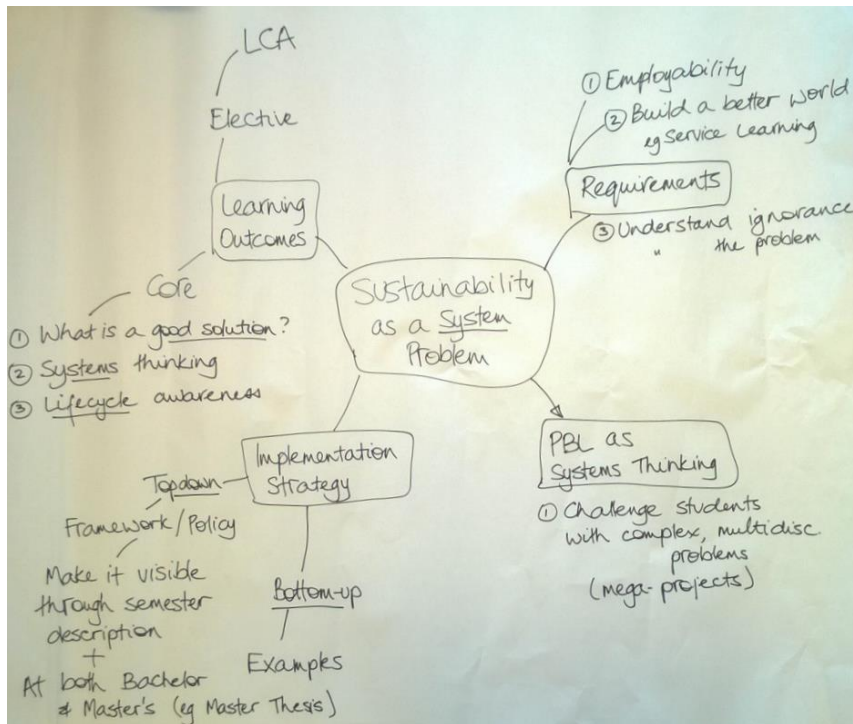
POSTER FROM SES GROUP

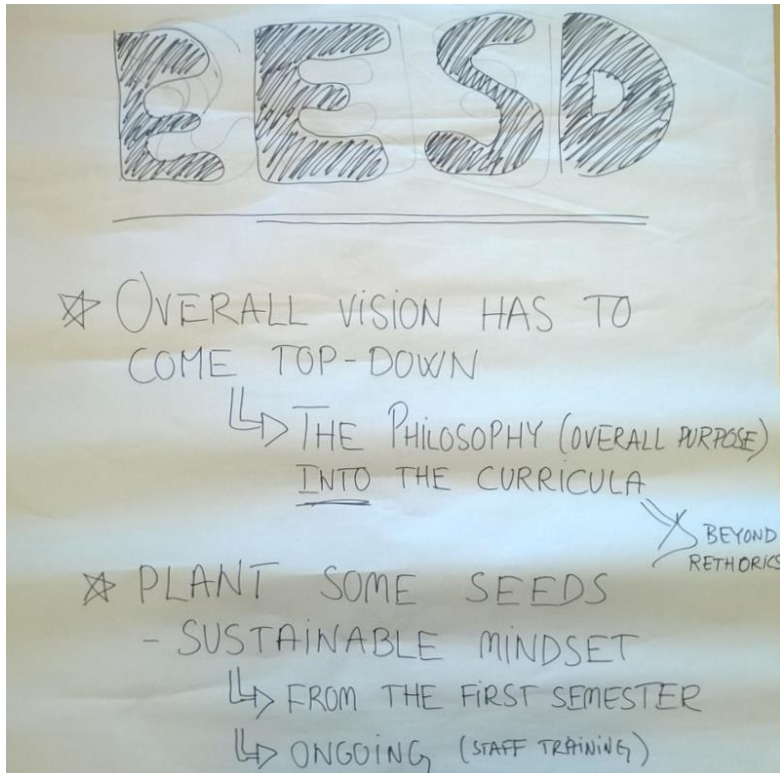**Plenary discussion remarks:**

The audience agreed that there is a need for a shared definition of sustainability, and also what the institution (and different departments/ fields) mean by sustainability, and how this can be combined with a systems thinking approach.

There is a need to develop a joint strategy and make sustainability visible, so each department, programme, research group can identify an element in the overall sustainability strategy. It was agreed that a lot has been done in the Faculty but much of it is not visible.

4th SICT Group (five participants)

This group raised two main points:

- It is important to make the overarching philosophy, and vision of the programme students are enrolled in visible and clear (this is not done in the written curricula). Through this it may be possible to provide an overall and holistic picture of the programme, including students' future roles in the outside world. An overarching vision of the programme should include sustainability. At the moment programme descriptions use a general template that focus on what is being taught. If sustainability was a part of the programme than it should part of the curriculum and in its overall profile as well.
- There is a need to start to plant the seeds for sustainability integration by: i) have a shared agreement from day one; ii) pinpoint in the curriculum where aspects of sustainability can be included, for example in the PV course; iii) another idea could be to integrate sustainability in elective projects/ courses; iv) staff training on teaching sustainability.

Plenary discussion comments:

There are many ideas that are similar. It is important to remember that sustainability should also be included in the master/kandidat programmes and include for example in the PBL introduction course.

The next pedagogical day could include sustainability as a main theme.

Final comments

- There is a need for more top down support
- Have a vision towards sustainability as part of the Faculty vision and allocate resources to develop this vision

- Sustainability needs to be understood as a holistic concept that required diverse contributions
- There is a need to reflect on the kind of graduate we want to educate, and this should act as a driver for sustainability integration.