SUSTAINABILITY NOW!

A Review of the Current State of Academic Programmes in Sustainability

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My warmest and sincerest thanks, agus go raibh míle maith agaibh, to everyone who helped, inspired, challenged and supported me throughout this most trying of processes, especially:

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Eits and Donal

Kim and Weston

My Housemates and my LUMES class

And anyone who has tolerated my utterance of the word sustainability, over the last two years!

Abstract

The emergence of the academic field explicitly concerned with sustainability has seen the establishment of many university degree programmes in sustainability. This study examines what the curricula of 54 of these programmes, 27 master's programmes and 27 bachelor's programmes. entailed in terms of mandatory and optional courses and detailed topical content. It then looks, more specifically, at the content of 22 core sustainability courses from these programmes. The aim is understand what is being taught, how it is organised and to what extent it is shared across programmes.

The vast majority of both the bachelor's and the master's programmes offered courses in the social sciences, 85% and 89% respectively, and in sustainability, as a distinct subject, both 93%, with 97% of the bachelor's programmes and 44% of the master's programmes offering courses in the natural sciences. Arts and humanities courses were offered in 56% of the bachelor's programmes and 22% of the master's programmes. The particular subjects offered within these fields, varied considerably across programmes. The core sustainability courses drew on a broad spectrum of literature, with very few authors or articles referenced in multiple programmes.

Overall this study shows that there is a large amount of variation between programmes in terms of approach, topical content and literature and other educational resources. Furthermore, two specific issues of content are raised. First is, the unpopularity of natural sciences at the master's level, possible reasons for this and its potential impacts in the light of attacks on the physical science basis of climate change. Second is the role of humanities, especially ethics, in the context of sustainability as a normative endeavour. In the light of these findings, this review closes with a reflection on curricula and the design of sustainability programmes in the context of the market, the modern university and the emerging academic field concerned with sustainability.

Keywords: sustainability education, bridging natural and social sciences, normative science, experiential learning, curriculum design, university degrees

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1. Introduction

1.1.1 Background: The Emerging Academic Field Concerned with Sustainability

There is an emerging academic field that is explicitly concerned with sustainability; it seeks to understand the dynamic interactions between nature and society (Kates et al., 2001; Clark & Dickson, 2003) in response to human produced, social and ecological crises. The emergence of this field has seen the establishment of journals, conferences and university degree programmes, in recent years. As a field in education, sustainability is young and in its formative years and yet, it emerges from the knowledge and approaches of diverse fields, with much longer histories. Attempts to define how educational programmes in sustainability can be realised in universities and what sustainability education should consist of are plentiful but we do not yet have an clear picture of the reality of sustainability education, as it is practised in universities. In this study, I aim to shed some light on this, in particular, by examining the curricula of university degree programmes in sustainability.

1.1.2 Setting the Context: Realising University Degree Programmes in Sustainability

University programmes in sustainability face the challenge of integrating the new and sometimes radical concepts, methods and approaches of the field, into traditional university structures. Concepts and approaches such as inter- and transdisciplinarity, the participatory production of scientific knowledge with the involvement of both society and academia, call for a transition to a new paradigm of university education (Martens et al., 2010), where these are supported. There has been research into dealing with the barriers to integrating sustainability into university education (Moore, 2005a, 2005b; Sibbel, 2009) and the difficulties in designing curricula for programmes in sustainability (Sherren et al., 2010). There have also been attempts to develop guidelines, for how new sustainability programmes can be integrated to existing university structures (Moore, 2005b; Sherren et al., 2010). In these studies, barriers are often related to the interdisciplinary nature of sustainability, in the context of universities structured around distinct disciplines. These analyses highlight financial constraints on university departments and the importance of market demand for encouraging the development of new programmes.

The existence of many barriers to the integration of sustainability programmes into existing

university structures suggest, that a review of existing sustainability curricula will be useful, in that it will describe the outcomes of curriculum design in the face of these barriers. Sustainability educators can make decisions about the design of future curricula, or changes to existing ones (Sherren, 2006), by reflecting on what is available and what is not, in terms of current offerings from universities.

1.1.3 Setting the Context: What Degree Programmes in Sustainability Should Look Like

Though there is some contention over their exact definition, there is agreement over some core concepts of sustainability. Inter- and transdisciplinarity; understanding the interconnectedness of social, environmental and economic systems; the importance of scale from the global to the local level; the bridging of social and natural sciences and engagement with the local context and community needs in the participatory production of scientific knowledge, are concepts that appear frequently in sustainability literature (Tilbury, 1995; Kates et al., 2001; Clark, 2003; Brundiers et al., 2010; Yarime et al., 2012).

Recently, academics have started to consider educational outcomes, by conceptualising frameworks for what competencies are desirable, for graduates of degree programmes in sustainability. Wiek et al. (2011) describe systems thinking, anticipatory, strategic, normative and interpersonal competencies as being particularly relevant to students of sustainability. Sipos et al. (2008) developed a framework, to be deployed both in the design and evaluation of educational programmes in sustainability. Their transformative sustainability learning (TSL) promotes learning with the head, the hands and the heart, or the engagement of cognitive, psycho-motor and affective learning processes. (Brundiers & Wiek, 2010) present another framework for evaluating sustainability programmes, focusing on education in the context of application to “real-world” problems. The criteria include, engagement with actual sustainability problems, the inclusion of stakeholders and their knowledge, professorial supervision and the inclusion of a facilitator for the project. Martens et al. (2010) and Yarime et al. (2012) also outline characteristics of what sustainability education ought to entail. Wiek et al. (2011) provides a synthesis of much of the literature on competencies for sustainability education.

In the light of discussion over defining what is desirable in these programmes, an extensive review of the practice of sustainability education, rather than an assessment, based on the criteria of a

particular framework or theory, may offer new insight into the state of existing sustainability education.

1.1.4 Setting the Context: The Current State of University Education in Sustainability

The current approach to the design of curricula for degree programmes, explicitly concerned with sustainability, is not well understood, even though, understanding of the difficulties in integrating programmes in universities is increasing and theories for what these programmes ought to entail are plentiful. As a step towards examining sustainability education in universities, Sherren (2005, 2006, 2008) sets about examining the curricular content of generalist environmental programmes (with some reference to sustainability) in a series of papers. She concludes that core subjects are oriented towards biological and ecological sciences, with insufficient attention to human and societal aspects of sustainability. In particular, those few programmes that made explicit reference to sustainability, lacked courses in philosophy and policy (Sherren, 2008). She also recommends more liberal (i.e. with a greater range of study, across disciplines) yet more prescribed programmes. Elsewhere Yarime et al. (2012) describe how innovative approaches to sustainability education, are being incorporated by degree programmes around the world. They offer just a few examples but there is a growing number of degrees internationally that explicitly address sustainability (this study covers 54 such programmes). With so many of these sustainability programmes now being offered, it is possible to conduct an extensive study of them, as a category in their own right.

Text Box 1: Degrees: Programmes and Courses. In this study university degrees are referred to as consisting of one "programme" of education which itself consists of a number of "courses". Courses are individual units for which credits are awarded, the sum total of credits from courses combined, are what is required to complete the programme and receive the degree.

1.1.5 Research Questions

While programmes consists of more than subject matter, like how information is imparted or constructed and what resources are available to students, as Dewey has said, "the problem of selection and organization ~ subject-matter for study and learning is essential" (Dewey, 1938 p.34).

Therefore, the design of this study is such that curriculum, meaning what is taught and how it is organised, can be examined. The overarching questions for this examination of programme curricula is: What is being taught in university degree programmes in sustainability and how is it organised. The results will be discussed in relation to my own assumptions and prominent literature on sustainability and education for sustainability. To uncover this information the review is structured around the following three questions:

- How much of the curriculum in higher level degree programmes in sustainability is mandatory or optional?
- What is the subject matter of the courses, that makes up the content of the programmes in sustainability?
- What learning objectives, concepts, literature and other information resources define what is taught in the core sustainability course, in programmes in sustainability?

Answering the first question will describe the structure of required and optional content of sustainability programmes. Mandatory and highly restricted optional courses, as revealed by the first question, will be of interest in terms of content, as they make up the most essential content of a programme. A core sustainability course is expected to be a feature of this essential content that most of these programmes have in common. The content of these is the focus of the third question.

Together, the answers to these questions will reveal whether there is a common model for these degree programmes or, if there is large variation, to what extent this is the case. They will show what subject-matter content is most popular in programmes in sustainability and if this is common to all programmes or if there is much variation. They will reveal what is being taught as sustainability in core courses, what concepts define sustainability, what literature and other resources are being used to teach this is and if there is wide agreement amongst programmes.

2. Methodology

This study is intended as a review, rather than a criteria based assessment, and so data are constructed so as to provide a plain language, jargon-free description. To ensure this, categories and criteria are described in the language used in programme web-pages and course descriptions and where necessary drawing on standard, widely used categories and criteria. The review is intended as an extensive study and so, following from Sayer's (2000) distinction between intensive and extensive methods, will provide a descriptive account. Therefore, the data are analysed using descriptive statistics.

2.1 Selecting Programmes

2.1.1 Internet Review

The internet provided the most readily available source of data on degree programmes in sustainability. Moreover, it is this information upon which many students will make the decision to apply to the programmes. The Journal for Sustainability: Science, Practice and Policy (JSSPP) has compiled a database of programmes related to sustainability. It was the most comprehensive database of its kind at the time, that I could find, with over 200 programmes listed in January 2012. Using the database allowed quick access to programme web-pages which could be accessed from the database web-page.

This database relies on programmes self-reporting. It is an English language journal, which likely biases selection to programmes from English speaking countries and some northern European countries. On the other hand, English being the international *lingua franca*, a database in English is likely to have the broadest selection of international programmes.

2.1.2 Search Criteria

The selection criteria for programmes were two-fold. Firstly, programmes with “sustainable” or “sustainability” in the title were selected. Using a word search ensures a reliable and repeatable selection procedure. However, using the word sustainability leads to selecting both programmes

concerned with sustainability as a distinct field and those that take a sustainability approach to a field such as management, engineering or agriculture. This distinction formed the second criterion and the programmes in the former category, programmes that deal with sustainability as a distinct field, were selected. Selection using these criteria probably excludes programmes that deal with sustainability as a distinct field but that do not have the word sustainable in the title. Selecting these programmes would have involved developing further selection criteria and further qualitative analysis of programme descriptions. The criteria employed yielded an adequate sample size (54).

The two most common university degrees with defined content (taught rather than research degrees) are the bachelor's and master's degree and so PhDs, graduate diplomas and certificates and minors were excluded from the study. Additionally, it was only possible to analyse programmes that had sufficient information in English, available on their website.

2.1.3 University Demographic Information

I collected certain demographic details of the universities including university name, the academic department that housed the programme and the location of the university (Table 1). This information was intended for comparing programmes in U.S. and European universities and different academic departments. This information also helps define the scope and limitations of the study. Once all data had been collected, bias towards North American universities in the data meant that, location was not used as a criteria for comparison. Similarly, there were a large number of different kinds of academic departments, which would have lead to analysing small numbers of programmes in each group, reducing generalisability. Therefore, this study compares bachelor's and master's programmes where appropriate. Prerequisites for master's programmes were noted to understand if there was specific knowledge required for entry.

Table 1: Data Collected and Data Sources

Data Type	Data Source	Data
Univeristy demographics	throughout website	⅄ university name ⅄ programme title ⅄ academic department ⅄ degree type (BSc, MA etc.) ⅄ location of university ⅄ master's prerequisites
RQ 1: Programme: structure	programme summaries	⅄ credits per course ⅄ required/not required ⅄ total credits for degree/major
RQ 2: Programme: content	Course titles and descriptions	⅄ academic field ⅄ subject
RQ 3: Course: content	syllabi	⅄ reading list ⅄ learning objectives

2.2 RQ 1 Programme Structure

There is no standard way of comparing the structures of programmes (required, optional and elective content, concentrations and specialisations and number of credits) in different universities and so what follows is an original attempt to devise such a system.

2.2.1 Required Option and Elective Content

Programme summaries contained data on whether the courses were compulsory and, in the case that they were not, the number of courses that one could choose from at that juncture. In this sense the data were quantitative. I categorised the courses inductively into four categories based on the likelihood that a student would choose that course, or the “requiredness” of the course (Table 2). Courses were on a continuum from absolutely compulsory to electives that could be chosen freely from any university department. The four categories: required, option, restricted elective and free elective, were selected to correspond to the language used by many universities in describing such courses, though the criteria were often somewhat different.

Table 2: Categories for Programme Structure

Course	Description
Required	A compulsory course that all students must take to graduate.
Option	Students can choose from a limited number of options. In the range, choose X from these X + 1 courses, to choose X from these 4X courses (see Appendix for full details).
Restricted Elective	Students can choose from a wide pool of electives. In the range from where "option" ends to any number of named electives, or an undisclosed, restricted list.
Free Elective	Students can choose from a very large number of courses in their home and/or in other departments, including courses chosen in consultation with advisers. Described as eg. free, general, upper-level electives.

2.2.2 Concentrations, Specialisations and Degree Tracks

Some sustainability programmes offered a number of different paths through the degree, with somewhat different content, these are variously referred to as concentrations, specialisations and degree tracks (I will refer to them as concentrations from here). For some programmes, there was a common set of core courses for all the concentrations. For these programmes the common core subjects were listed as required and the rest of the courses listed as option, restricted elective or free elective, according to the criteria (Table 2). Some programmes had different required subjects in each concentration. In some universities programmes with similar formats to these concentrations would have been designated separate degrees, and so to be consistent, concentrations such as these were treated as separate programmes (Figure 1). The titles of these degrees were of the form: "MSc in Sustainability with a concentration in X".

Concentrations

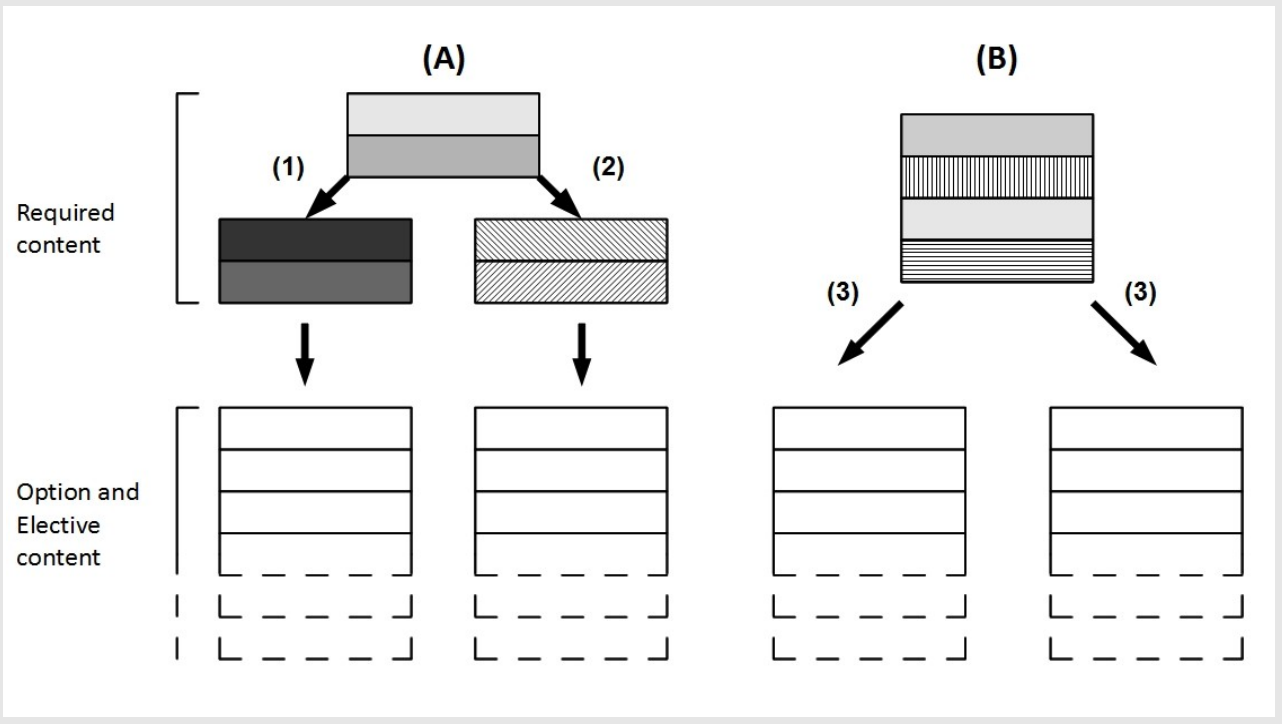

Figure 1: Concentrations: In degree (A) the two concentrations have some shared and some different required content and so are considered separate programmes in this study, programmes (1) and (2). In degree (B) the concentrations share the same required content and, though they might have different optional content, are treated as one programme, programme (3). Shading represents different courses.

2.2.3 Credits

The way in which credits were awarded for courses varied hugely from university to university but especially between countries. Because of this variability and difficulty in accessing information that could make the different systems comparable, programmes are internally consistent, rather than directly comparable in terms of hours (or any other standard measure). This means they can be compared in terms of, e.g. what percentage of the programme's credits are awarded for required, option or elective courses, but not comparable in terms of, e.g how many hours in total are dedicated to each type of course. This is the case throughout the rest of the paper.

2.3 RQ 2 Programme Content

I developed an inductive method for qualitatively categorising courses based on course titles and course descriptions. Course titles and descriptions were collected, coded (Table 3) and used to categorise the courses (Table 4). As the number and variety of restricted and free electives was vast and often unavailable, only content for required and option courses was coded.

There are a range of standard models for the classification of disciplines with very well recognised categories and sub-categories. These models rarely agree precisely on how disciplines are organised. Nevertheless I consulted many for the organisation of the categories that made up this novel system, namely "fields" and "subjects" (Australian Bureau of Statistics, 1998; Higher Education Statistics Agency, 2012; National Centre for Education Statistics, 2012) (AUS, UK, USA) though the categories I developed are different from all of these. The descriptions of the fields and subjects are intended to to be readily understood by a wide audience while reflecting the major content of the course in a short, often one word, phrase. Some sensitivity in description is lost by assigning a single field and subject to each course therefore fields are broad and courses with two subjects are, where possible, classified to a higher level, overarching subject (Table 3). Traditional classification systems, when deployed, classify interdisciplinary courses by reducing them to the parts that make them up. The method of categorisation that I developed does not reduce sustainability courses to their constituent disciplines but rather retains the description as "sustainability".

Table 3: Procedure for Coding Course Titles and Descriptions

Sequence	**Procedure** (see Appendix for examples)
1.Start with course title	For some this will make field and subject quite clear, esp. natural sciences, research methods, applied work, research
2.Find topic sentence in course description	Always check agreement with title, if doesn't agree or unclear use keyword in topic sentence
3. Identify context of keyword in topic sentence	How it is referred to/situated to distinguish between particular fields esp. for problem specific vs engineering, design and technical and business management and organsiations, business management and organisations and social sciences, (particular guidelines by field in table 4)
4.If multiple topic sentences or keywords therein:	look for greater mention or importance of one throughout course description, or overarching keyword/subject eg. Atmospheric science, geology = earth science
Or 4. .If none, or topic sentence lacks keyword:	Look for words related to keywords, eg. history of ideas, western thought etc. = philosophy; strategic frameworks, steering organisations etc. = management; production, operations, logistics etc. = industry

I categorised the courses into ten fields with each of the ten fields having further subdivisions called subjects. Six of the categories are likely to be found, in some form, in most classification

models. Two categories describe major pieces of work: research (thesis, research projects) and applied work (experiential learning courses, applied projects, internships). This distinction is made in response to Brundiers et al. (2010) who stress the importance for sustainability of “real-world” education. A further two newly induced categories describe fields and subjects specific to sustainability. One is for courses on the sustainability of a particular resource or problem and the other for courses in sustainability itself and other interdisciplinary courses (Table 4).

I reffered to Elo & Kyngäs, (2008) and Bryman (2004) for when to use deductive and inductive methods: deductive methods are used when there are established categories and inductive where the field is new and there are no broadly accepted categories. I categorised subjects deductively in all but the two new fields. Therefore, natural science broke down into physics, chemistry, biology etc., social science into sociology, economics, development and so on. Subjects for the two new fields were induced from course titles and descriptions and this was an iterative process (Table 4.). higher level subjects were only broken down when they appeared multiple times. eg. plant biology is represented by biology as there was only one instance of this.

Table 4: Categories for Classifying Courses and Guide to Inductive/Deductive Categorisation

Field	**Specific Considerations for Categorisation and how subjects were induced.**	**Subject** [B] = just in bachelor's [M] = just in master's
Research (R)	Usually straight forward, can be identified from course title or topic sentence of course description. Except distinguish from applied work as below.	• Thesis • Research Project
Applied Work (AW	Research versus applied. Applied will involve engagement with actors, organisations, communities outside of the classroom, active, beyond research to problem solving.	• Applied Project • Fieldwork • Internship
Arts and Humanities (AH)	Usually straight forward can be identified from course title or topic sentence of course descriptions. Sometimes requires looking for related words e.g. ideas and western thought for philosophy.	• Composition • Ethics • History [B] • Humanities [B] • Literature [B] • Philosophy • Religious Studies [M]
Business, Management and Organisational (BMO)	Often considered a subset of social sciences. When there is confusion between SS and BMO, BMO will refer to intentional human organisations especially businesses and management incl decision making, strategy	• Accounting • Assessment • Business Studies [M] • Decision-making • Finance • Leadership • Management • Marketing [B] • NGOs and Advocacy [B] • Organisational Studies • Participatory Processes • Sustainable Business Practices (CSR)
Engineering, Design and Technical (EDT)	Identified by keywords (right) and technical, engineering or design aspects. Differentiated from problem/resource specific by reference to these aspects alone not social, environmental, political etc.	• Buildings (architecture) • Design for Sustainability [B] • Energy Systems • Engineering • Information Technology [B] • Planning [B] • Transport
Natural Sciences (incl. mathematics, though this is a formal science) (NA)	Usually straight forward can be identified from course title or topic sentence of course description.	• Atmospheric Science • Biology • Chemistry [B] • Earth Science • Ecology • Environmental Science • Geology • Hydrology [B] • Mathematics [B] • Physical Geography [B] • Physics [B]

Field	**Specific Considerations for Categorisation and how subjects were induced.**	**Subject** [B] = just in bachelor's, [M] = just in master's
Research Methods and Modeling (RM)	Usually straight forward can be identified from course title or topic sentence of course description. Sometimes requires combining many keywords into quantitative or general research methods.	• Geographical Information Systems (GIS) • Life Cycle Analysis (LCA) • General Modeling • General Research Methods • Statistics • Other Research Methods [B] • Quantiative Methods [M]
Social Sciences (SS)	Usually straight forward can be identified from course title or topic sentence of course description. Although often required identifying most prominent or overarching subject. Especially with law and policy, economics and sociology.	• Anthropology • Communications • Conflict and Peace Studies [B] • Cultural Studies • Demography [B] • Development • Economics • Education [M] • Environmental Sociology • Justice and Equity Studies [B] • Law • Policy and Governance • Psychology [B] • Sociology + Social Theory • Urban Sociology
Sustainability and Interdisciplinary (SI)	Subjects were induced with use of the words sustainability and interdisciplinary and reference to many disciplines, especially when sustainability was the focus of the topic sentence. Often when reference was made to economic, social and ecological systems. Also systems thinking or other systems approaches to sustainability.	• Core Sustainability • Sustainable Development • Sustainability Seminar [B] • Systems Thinking • Other Sustainability and Interdisciplinary
Resource/Problem Specific and Sustainability (RS)	Subjects were induced when resources or problems appeared in course descriptions in the context of social environmental and economic aspects, impacts etc. Resource/Problem specific often share problems and topics with esp. ET, BMO and NA and are distinguished by mention of two or more of social, ecological, economic, political, technical; impacts, effects, aspects etc. Whereas ET, BMO and NA will refer to their specific realm.	• Agriculture • Climate • Ecosystems • Energy • Enterprise • Fisheries [B] • Food • Forests [M] • Health • Industry • Land [M] • Mixed Topics [M] • Pollution [M] • Rural [M] • Sustainable Resource Management • Transport [M] • Urban • Waste • Water

2.4 RQ 3 Core Sustainability Course Content

Given the significance of a core course in sustainability to a programme in sustainability, this course, where present, was examined in detail. The second round of empirical data collection involved requesting the syllabi of core sustainability courses. I contacted the instructors of the core sustainability courses and requested the syllabus, and a reading list, if this was not included in the syllabus. In order to gain an insight into the conceptualisation of sustainability being taught and what resources were being used , I focused on the learning objectives and course reading lists.

I received the 25 syllabi, which represented the core or introductory course in 36 programmes* (a response rate of 78%). A sufficient number of syllabi from those received, allowed me to examine the reading list and learning objectives (Table 5). This information, though of varying depth, came in very standard or easy to standardise form, which facilitated comparison. I made simple counts of authors and articles from the reading lists. A minority of syllabi asserted that further readings would be made available online or in class. 2 such syllabi were very small consisting of less than three texts.

Learning objectives usually contain two pieces of important information in the verb and the object (Krathwohl, 2002) (the implied subject being the student). The verb represents the cognitive process that is to be stimulated and the object reflects the knowledge content or subject matter. Knowledge content was categorised using the fields used to categorise the courses (Table 4) plus two new categories one describing “skills” (such as communication and teamwork) and a second describing “pragmatic” concerns (e.g. ability to access online resources, introduction to faculty).

Table 5: Syllabi Received

	Bachelor's	Master's
Sustainability programmes	27	27
Programmes w/ intro/core course	22	23
Intro/core courses*	19	13
Syllabi received	16	9
Programmes represented by syllabi received	19	17
Syllabi w/ reading list	16	6
Syllabi w/ learning objectives	13	6

*Some programmes in the same university shared the same introductory course. In one case, of the Master's programmes, one course was shared between 7 programmes.

3. Results

3.1 Sustainability Programmes

Of the over 200 programmes in the JSSPP database, 54 were identified as master's or bachelor's programmes that dealt with sustainability as a distinct, stand alone field of study (e.g degrees in sustainability, or sustainable development or sustainability science). 27 of these were master's programmes and 27 were bachelor's programmes. As expected from the English language database, the majority of programmes are in the U.S followed by the U.K, then other English speaking countries and northern European countries and Japan (Table 6).

Table 6: Breakdown of Sustainability Programmes by Country

Country	Bachelor's	Master's	Total
U.S.A	22	10	**32**
U.K	1	9	**10**
Netherlands	0	5	**5**
Australia	2	0	**2**
Canada	2	0	**2**
Sweden	0	2	**2**
Japan	0	1	**1**
Total	**27**	**27**	**54**

3.2 RQ 1 Programme Structure

3.2.1 Required, Option and Elective Courses

Bachelor's and master's programmes were first analysed in terms of how much of the programmes were made up of required, option, restricted elective and free elective courses (Table 2). Bachelor's and master's programmes were analysed separately (Figures 2 and 3) and subsequently compared.

Individually both bachelor's and master's programmes displayed a great variety of models. Bachelor's programmes ranged from having less than one quarter required content, to programmes that were entirely compulsory. At master's level programmes ranged from just less than half required content to entirely compulsory.

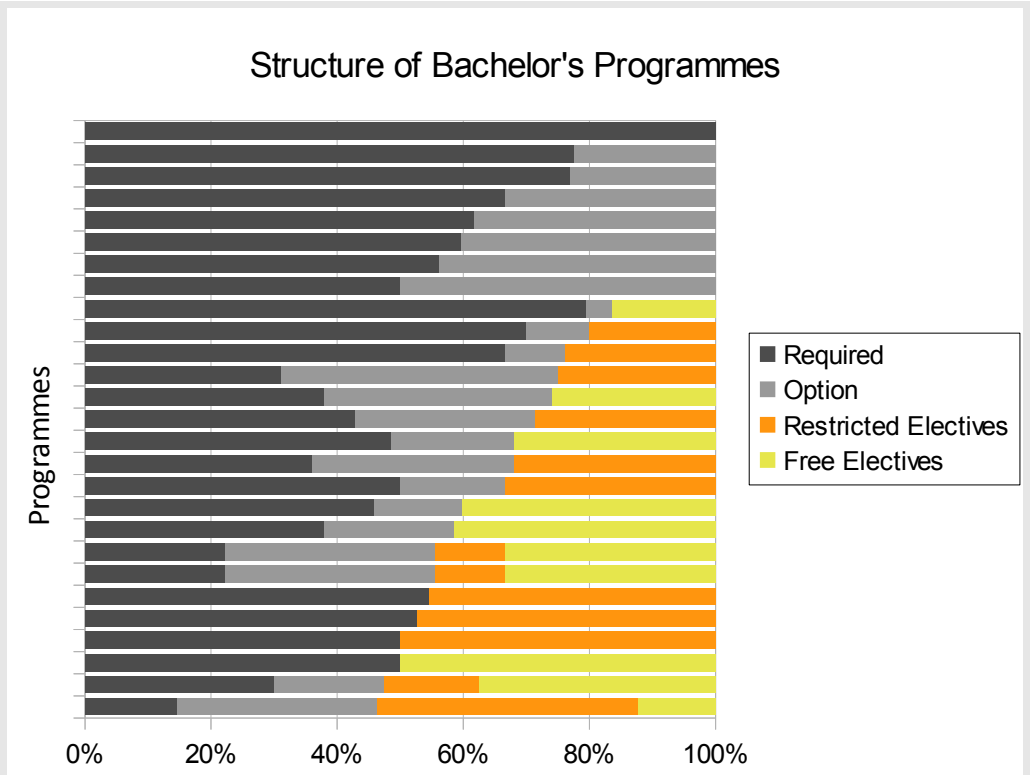

Figure 2: Structure of bachelor's programmes. Mandatory and optional content as percentage of total credits. 27 bachelor's programmes. Data from programme summaries.

When comparing the two, bachelor's programmes were, on average, more flexible, in that a greater proportion of the programmes were option and elective. On the other hand, master's level programmes had more restricted content. Less than one quarter (15%, 4 of 27) of bachelor's programmes had greater than 75% required courses, for master's programmes almost half (48%, 13 of 27) of the programmes did. Less than one third (30%, 8 of 27) of bachelor's programmes were comprised solely of required and option courses whereas for master's programmes this was the case for the majority (59%, 16 of 27).

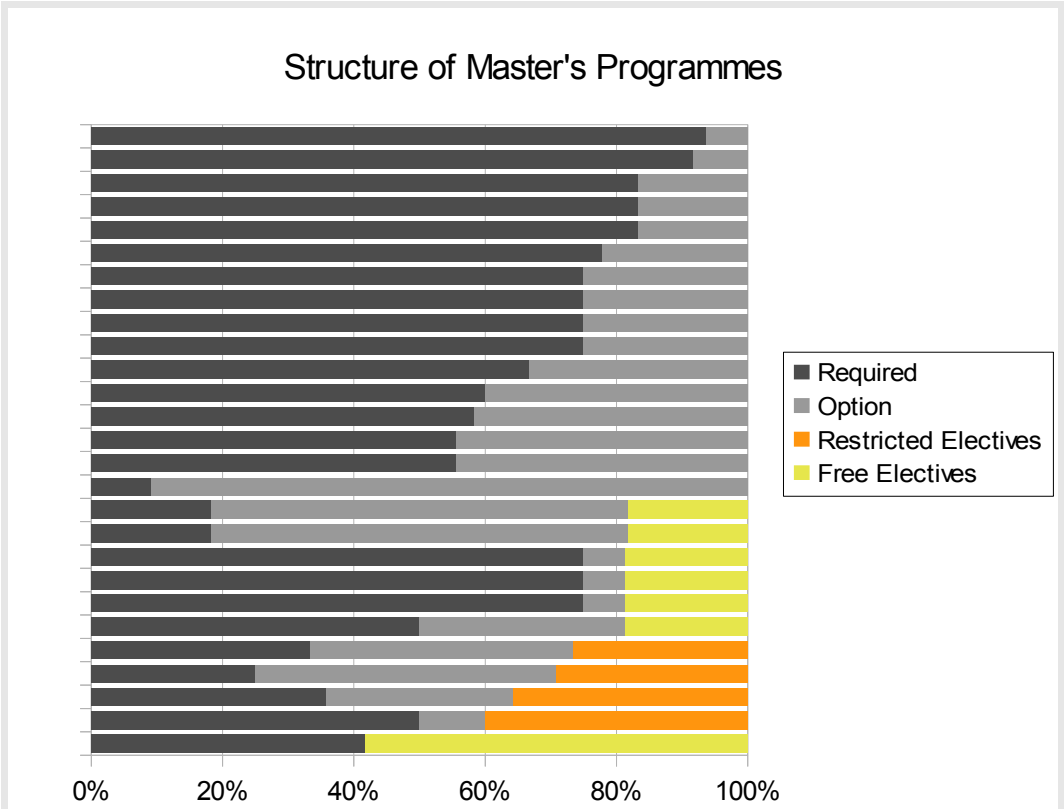

Figure 3: Structure of Master's Programmes. Mandatory and optional content as percentage of total credits. 27 master's programmes. Data from programme summaries.

For both levels a majority of programmes had greater than 50% of their content in required or option programmes. This will be important when it comes to analysing the content of the programmes in terms of fields and subjects.

3.2.2 Core Sustainability Course

Of the 54 programmes, 45 (83%) had a core sustainability course. The other nine programmes introduced sustainability through courses on a number of different perspectives on sustainability or sustainability perspectives on other areas.

3.3 RQ 2 Programme Content

Having analysed the structure of programmes in terms of mandatory and optional content (RQ 1) it is clear that a majority of programme content is in required and option courses (Figures 2 and 3).

These are also the most restricted categories and so an analysis of these courses will reveal the overall content of programmes with a high degree of fidelity. Limited information on elective courses; the large number of elective courses per programme, where present; the uncertainty produced due to the amount of choice associated with such large numbers and the time that would be needed to analyse this information, ruled out their inclusion in this section. Therefore the content of required and option courses was coded from course descriptions (Table 4).

This section will first deal with the programme content in terms of the higher level categorisation, fields and then move on to looking at the the more specific content of courses in terms of subjects (Table 4).

At this stage it is worth noting that none of the master's prerequisites specified previous study in a particular field. In general they referred to requirements such as minimum grades achieved, scores in standardised tests or a certain level of proficiency in the English language.

3.3.1 Fields

Before looking at the specific content of the programmes in terms of what different fields were present and most popular, the number of different fields that the programmes contained was analysed. On average both bachelor's and master's programmes contained courses (required and option) in more than 6 of the 10 different fields. This shows a high degree of disciplinary variety or liberalness at both levels.

The first task, in looking at the most common fields in sustainability programmes, was to examine the required courses. Required courses make up the core of a programme and must be studied by every student. This core content can be taken as, what is seen as, most vital to understanding sustainability in these programmes. The core, required content of master's and bachelor's programmes were analysed and compared (Figure 3). As the exact amount of credits taken by all students is known for required courses, it was possible to compare programmes in terms of the percentage of total required content that was assigned to each field. Though in some programmes required content may equal less than 50% and some 100%, all programmes are weighted equally here.

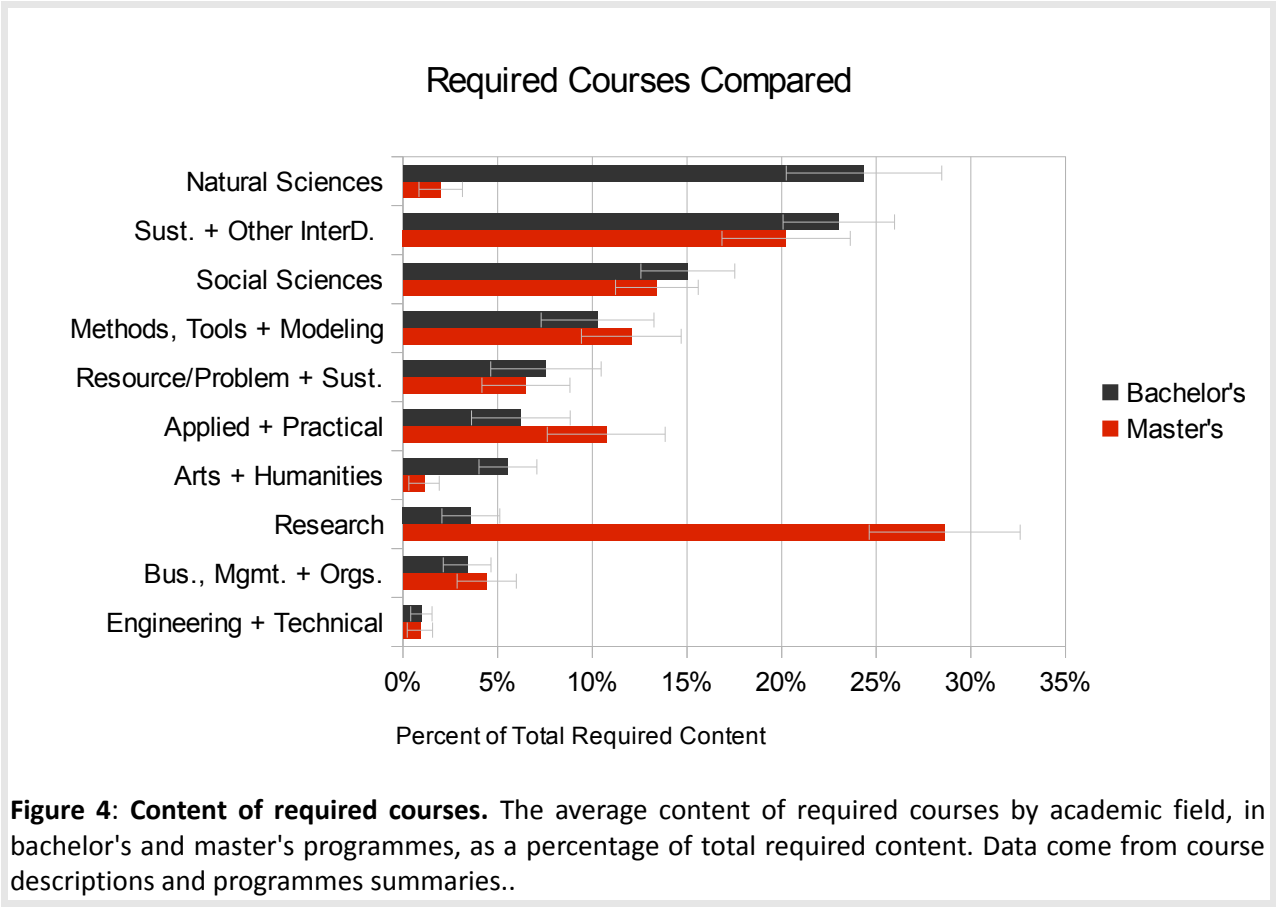

Figure 4: **Content of required courses.** The average content of required courses by academic field, in bachelor's and master's programmes, as a percentage of total required content. Data come from course descriptions and programmes summaries..

Natural sciences and sustainability were the two fields that had the greatest representation at bachelor's level. Together they amounted to almost half (24% and 23% respectively) of the average required content of bachelor's programmes. Social sciences and research methods and modeling were also significantly present at 10% and 15% of the average core requirements.

Research projects and theses, at 28% and sustainability courses, at 21%, together made up a near majority of master's programmes' required content. Social sciences (13%), research methods and modeling (12%) and applied and practical courses (11%) were also popular. Natural sciences were very unpopular only 2%, indicating that many programmes have no natural sciences as core content.

The greatest contrast between programmes at the two levels is in the fields of research and natural sciences. Whereas natural sciences make up the largest part of core content at bachelor's it is barely present (2%) in master's programme's . The opposite is true of research, to which bachelor's programmes assign 4% of required content, whereas in master's programmes it is 28%. Arts and humanities, engineering and technical and business management and organisational studies make up very small parts of both master's and bachelor's programmes' required content.

In order to get a more complete view of the total programme content, both required and option courses were analysed together. Though different students will choose different options, their choice for option courses is limited (Table 2) and so while not exact, an analysis of required and option courses gives a reasonably accurate and more extensive account of the programme contents. It is not possible to calculate, in terms of percentage, how much of a programme is dedicated to the various fields in option courses, as each student will decide on a somewhat different programme content. Therefore, a simple count of programmes that contained courses, in each field, in either required or option courses, was employed (Figure 5).

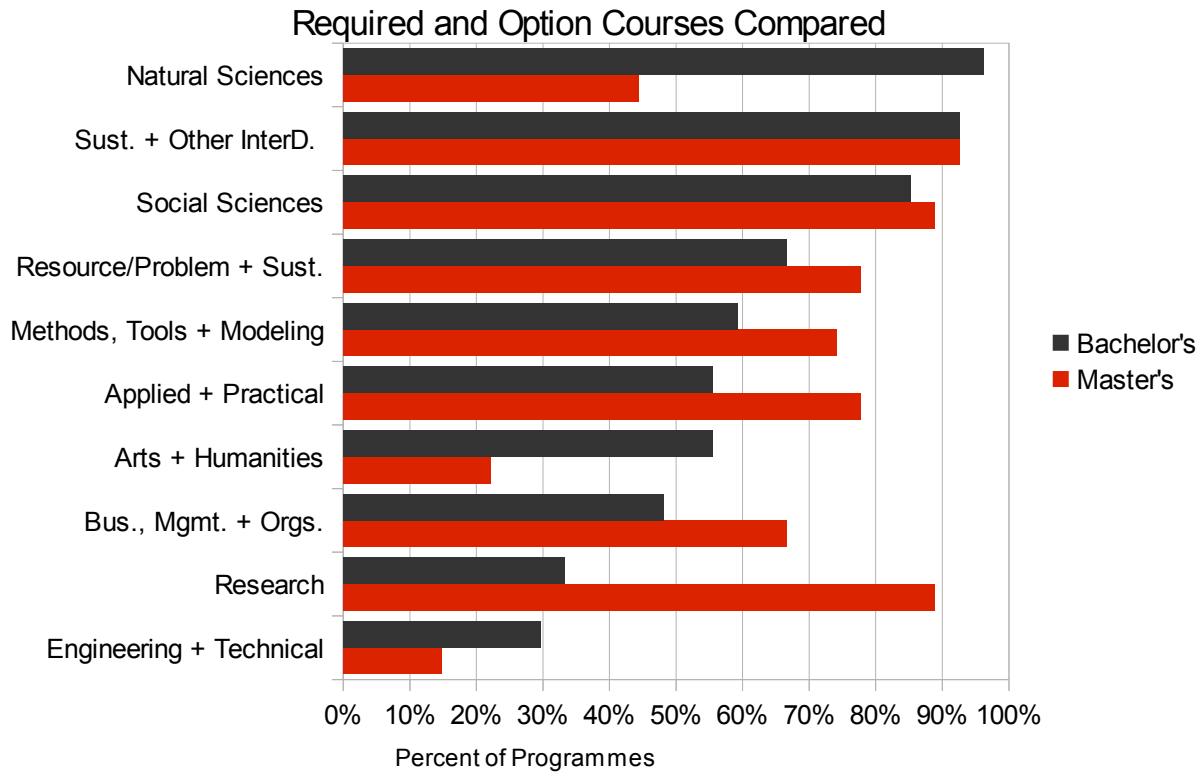

Figure 5: Content of required and option courses. The percentage of programmes offering courses in the various academic fields, in required or option courses. Data come from course descriptions and programme summaries. N=27 for both bachelor's and master's programmes.

This analysis bears out the pattern of the unpopularity of natural sciences (44%) at master's level and of research (33%) at bachelor's. The arts and humanities are offered in 22% of master's programmes which is substantially different from the 56% of bachelor's programmes that offer such a course. There is no field that all programmes at either bachelor's or master's level include in required or option courses. The greatest agreement at bachelor's level is over the inclusion of natural (97%) and social sciences (85%) and sustainability (93%), at master's level social sciences (89%), sustainability (93%) and research (89%) are the most present. There are a considerably greater number of programmes at master's (78%) than bachelor's (56%) offering applied and practical projects. Although business management and organisations made up very small parts of core curriculum they are significantly present, probably in option courses, especially in master's programmes.

3.3.2 Subjects

Certain fields were dominated by one or two subjects: sustainability and other interdisciplinary by general sustainability and introductory courses; research methods and modeling by general research methods and statistics; research by theses and research projects; arts and humanities by ethics and philosophy; applied work by applied projects and internships; business, management and organisational studies by sustainable business practices (incl. corporate social responsibility) and general courses in management and organisations. The engineering design and technical field was not significantly represented (Figures 4 and 5)

Therefore, this section will detail the specific content of programmes in terms of natural sciences, social sciences and problem specific sustainability courses. The five most common subjects in required and option courses are displayed.

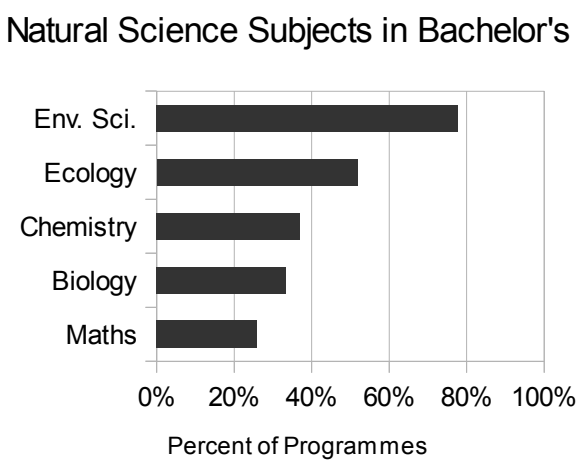

Figure 6: The five most popular natural science subjects in bachelor's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

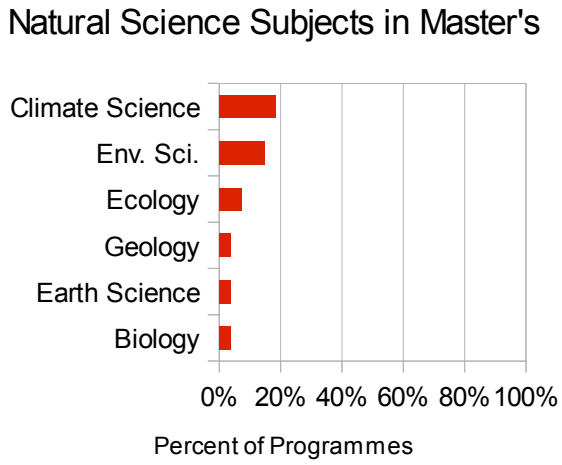

Figure 7: The five most popular natural science subjects in master's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

The most popular natural sciences (Figure 6) in bachelor's programmes are environmental science (78%) and ecology (52%). Chemistry, biology and mathematics are present in a large minority of bachelor's programmes (37%, 33% and 26%). Natural science courses are much less present in master's programmes (Figure 7). None is present in more than 20% of programmes, climate science and environmental science are the most popular (19% and 15%). All of these climate science courses are in various programmes in one university and so results are biased towards the approach of one university. Otherwise environmental science would be the most popular.

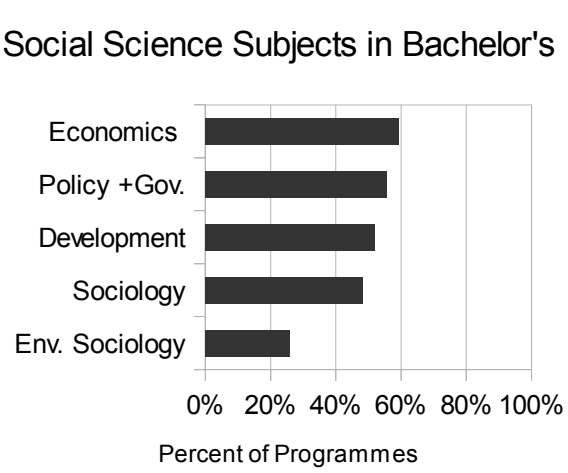

Figure 8: The five most popular natural science subjects in bachelor's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

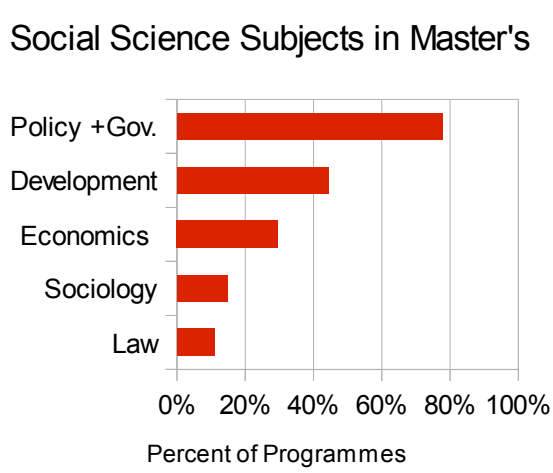

Figure 9: The five most popular social science subjects in master's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

The most popular social science subjects offered in bachelor's courses were economics (60%), governance (56%) and development (52%), sociology is offered in almost half (48%). Governance is by far the most popular of the social sciences offered in master's programmes (78%). Development is offered in almost half (44%) All the others are offered in a minority of programmes.

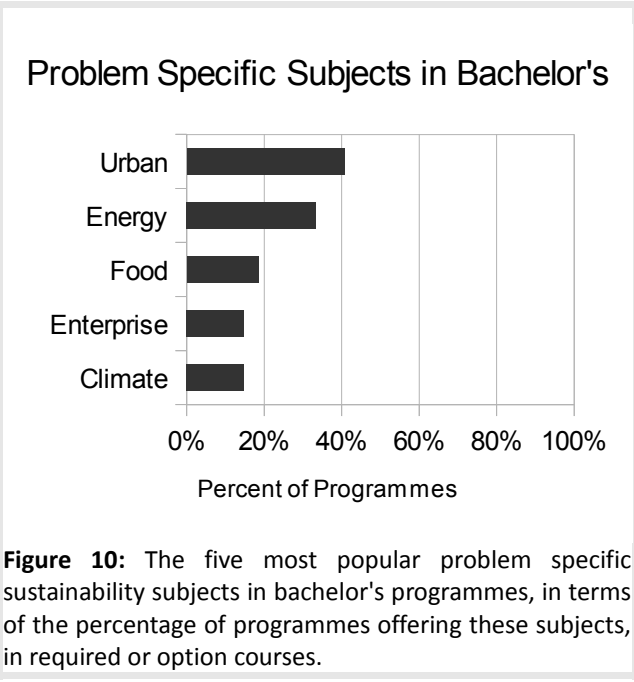

Figure 10: The five most popular problem specific sustainability subjects in bachelor's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

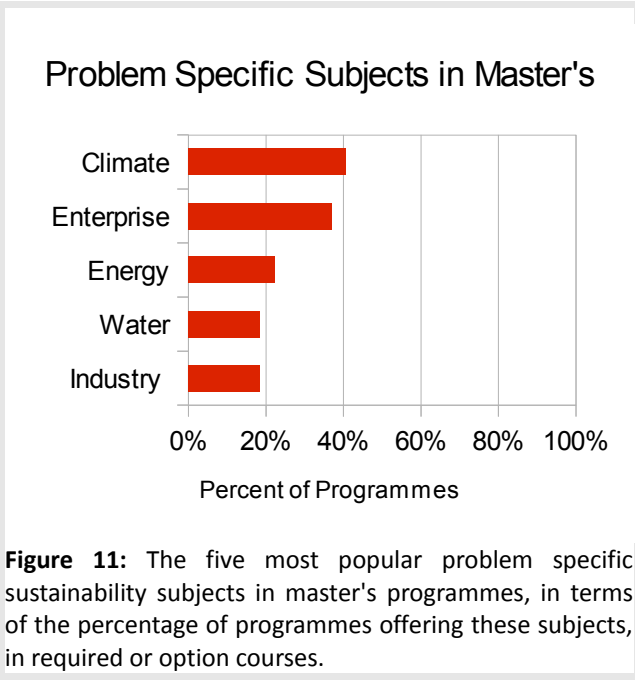

Figure 11: The five most popular problem specific sustainability subjects in master's programmes, in terms of the percentage of programmes offering these subjects, in required or option courses.

In bachelor's programmes more than twice as many programmes offer courses in urban sustainability (42%) and sustainable energy (34%) than sustainable enterprise (14%) or climate change and sustainability (14%). Food and sustainability is offered in 18% of bachelor's programmes. Conversely, in master's programmes climate change and sustainability (40%) and Enterprise (36%) are the most popular. Again the approach of one university biases these results somewhat, without the programmes in this university included climate, enterprise, energy, water and industry would be approximately equally popular (~20%).

Overall the results show a diversity of disciplines. Although 85% of bachelor's programmes offered courses in social science no subject within the social sciences is present in more than 60% of total programmes. This pattern is repeated for most of the categories analysed. Governance at master's level is the subject over which there is the most agreement. 89% of master's programmes offered a courses in social science, whereas 78% (of total programmes) offered courses in governance.

3.4 RQ 3 Core Sustainability Course Content

3.4.1 Reading Lists

At both master's and bachelor's level the field of sustainability and other interdisciplinary were very large parts of the average core content and appeared in the vast majority of programmes. As stated in the subjects section (3.3.1) this field was dominated by introduction to sustainability and

other core sustainability courses. In fact these courses were some of the most popular courses at both levels with 45, 22 bachelor's programmes and 23 master's programmes, of the 54 programmes including such a course (Table 5). An examination of the the contents of these courses would therefore reveal a lot of information on the content of the sustainability field which is itself a large portion of the average programme.

Table 7: Most Popular Articles in Core Sustainability Course Syllabi

Article	Number of Syllabi (n=22)
The Tragedy of the Commons (Hardin, 1968)	6
A Safe Operating Space for Humanity (Rockström et al., 2009)	4
Resilience and Stability of Ecological Systems (Holling, 1973)	3

Of the 25 syllabi received, 22 included reading lists (Table 5). From these the frequency of articles and text books was assessed. A large amount of variation from programme to programme was found. Although certain articles did appear multiple times, a core set of articles across many courses was not forthcoming. The three most popular articles were: C.S. Holling's foundational article on the resilience of ecological systems, (Holling, 1973) Rockström and colleagues' more recent article on planetary boundaries and tipping points: A Safe Operating Space for Humanity, (Rockström et al., 2009) and the Tragedy of the Commons by Hardin, (Hardin, 1968). Though these were the most popular articles they appeared in less than one third of the syllabi.

Table 8: Most Popular Authors in Core Sustainability Course Syllabi

Author(s)	Number of Syllabi (n=22)
Folke	4
Miller and Spoolman	3

This variation was also apparent when counting individual authors, aside from of the above articles. Folke and Miller and Spoolman together were the most popular. Similar to the articles the work of these authors appeared in less than one quarter of all syllabi.

3.4.2 Learning Objectives

Of the 25 syllabi received 19 included learning objectives (Table 5). On examination of these it was revealed that all core sustainability courses had learning objectives that referred to components of sustainability. A majority (bachelor's 54% and master's 67%) of syllabi referred to skills. Half of the syllabi at master's level included learning objectives in the social sciences whereas only 31% of syllabi from bachelor's programmes did. The other fields were represented in less than one third of syllabi with research methods and problem specific completely absent in master's syllabi and engineering design and technical absent in both.

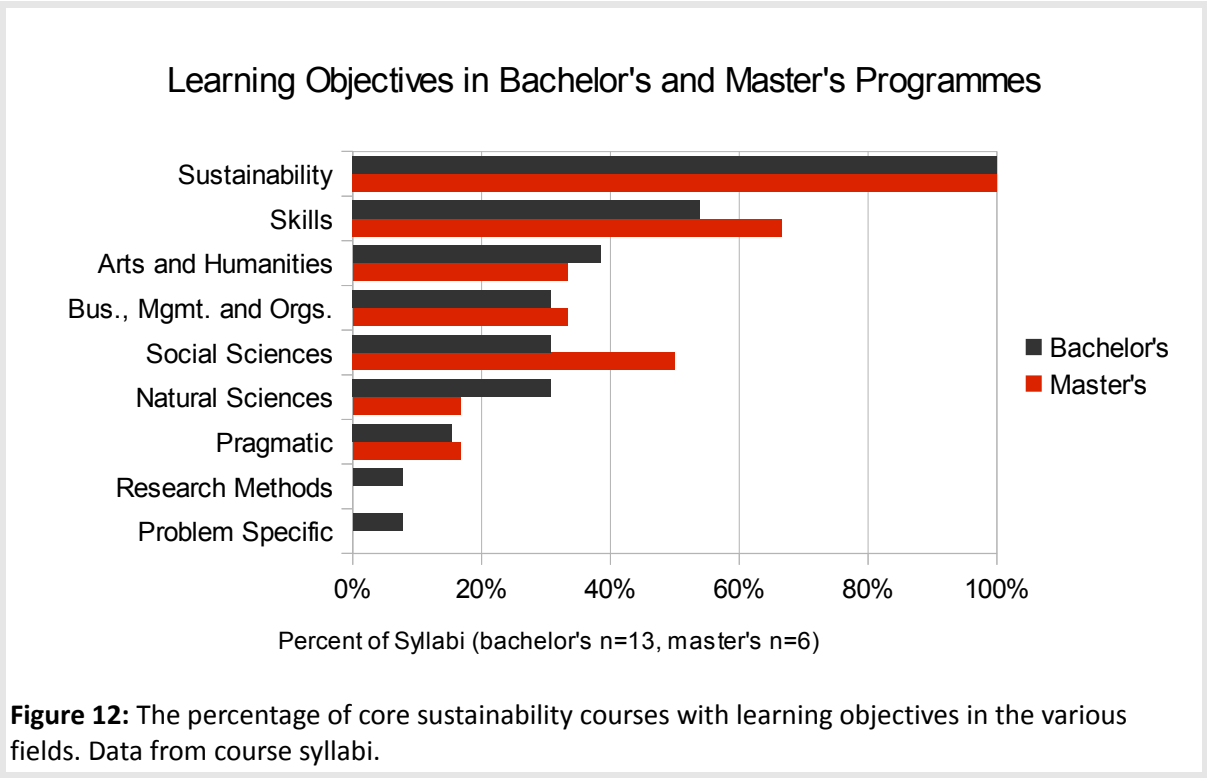

Figure 12: The percentage of core sustainability courses with learning objectives in the various fields. Data from course syllabi.

The most common of the concepts referred to in the sustainability learning objectives, though variously defined was the interaction or interconnection of human and natural or social, economic and ecological systems. A learning objective to this effect was present in 100% of master's programmes and 69% of bachelor's programmes. Other prominent concepts were scale, or global to local sustainability, and inter- or transdisciplinarity though these were referred to in a minority of programmes at both levels.

4. Discussion

4.0.1 Overview

In this discussion, I will first comment on my methodological approach to the study and potential contributions or questions arising from this. The main body of the discussion will be dedicated to reflecting on the results, to develop a synthetic picture of the current state of academic programmes in sustainability. I will do this by outlining my assumptions about the field, before the study and how they were borne out, or contradicted by, the empirical evidence. This will frame the discussion of what the results mean in relation to literature on sustainability and sustainability education and the potential impact of this beyond the classroom. I will close the discussion with some reflections, inspired and informed by the carrying out of this study, on the state of academic programmes in sustainability, in relation to the modern university, the market and the emerging field concerned with sustainability.

4.1 Methodology and Approach

The largest part of the work that went into this study was in constructing the data on programme curricula in a reliable, repeatable way and such that it reflected the actual content of the programmes. Current classification systems for disciplines were unsuitable as they reduced sustainability to a group of disciplines. The fact that the current ways of categorising academic subjects, were found to be unsuitable for describing academic programmes in sustainability, raises the question of what it means for sustainability as an academic field, that existing classifications do not recognise subjects like sustainability, sustainability science or sustainable development, as anything more than a string of their constituent disciplines. How we classify subjects is important. Hansson (2006) has gone so far as to claim that classifications that we use mirror the society that we live in. If sustainability is not recognised as a subject, and furthermore if sustainability has no widely accepted, formalised definition, that demonstrates its relationship to other subjects, without reducing it, this could pose barriers to its recognition and institutionalisation as a distinct field. The development of such a definition, which would likely involve the development of a new classification system, would be an important step in the institutionalisation of the emerging field.

4.1.1. Previous study

The design of this study is similar to studies carried out by Sherren (2005, 2006) but, in response to those articles, I made some different choices in terms of selection criteria, the type of data that was collected and the geographical scope of the study. Sherren focused on the content of core required subjects. I look at required and option courses, to gain a better understanding of the complete programmes of education, as well as taking a more detailed look at the structure of the programmes. I also review various syllabi for sustainability courses to gain a deeper insight into the conceptualisation of sustainability that is being taught. That study reviewed all programmes concerned with sustainability whereas I use the term “sustainability” as the search criteria as there were enough programmes to examine these as a distinct category, programmes that explicitly address sustainability. Sherren's study focuses on Australia whereas I searched worldwide though the majority of programmes found are in the United States.

4.1.2 Methodological Contribution

The method of categorisation developed for this study (Tables 2,3 and 4) included solutions to two difficulties encountered in comparing and categorising, the content and structure of, academic programmes in general, but specifically, programmes in sustainability. Firstly, programmes had very different design in terms of credit systems and optional and elective content. Secondly, courses needed to be categorised in a reliable, repeatable way, that didn't compromise descriptive clarity or reduce the complex and inter-related concepts of sustainability to a group of constituent sciences. These categories could be used in future studies of sustainability programmes. The overall approach could be used for any comparison of programmes from programme summaries, course titles and descriptions.

4.2 Existing Sustainability Education

This study was intended as an extensive review of the state of academic programmes in sustainability. As a student of sustainability and having read extensively on the subject, I had certain assumptions about characteristics programmes would share. At one level, assumptions are of a general kind, that could be applied to any field of education, referring to continuity and consistency between programmes. Yet sustainability is a unique field, at an early stage in its

development and so the assumptions have are somewhat more specific. They are informed by a broad base of sustainability literature. I assumed there would be consistency in curricular content across programmes and from bachelor's to masters level and that this would be of a particular character (Table 7). I also assumed there would be similar conceptualisations of sustainability across programmes and similar literature and resources would inform this. In many instances the assumptions were borne out by the study but in others, findings were to the contrary. This discussion will be based around these assumptions, their confirmation or their confounding (Table 7), and what implications these might have for the field of education, concerned with sustainability.

Table 9: Assumptions and Empirical Results of the Review

	Assumption	**Empirical Result**
Coherence of Programme Content	Programmes would have similar if somewhat diverse content: interdisciplinary, drawing on natural and social sciences, arts and humanities. and applied work.	Programmes had a diffuse variety of disciplinary content with no field or subject present in every programme, courses in natural sciences, arts and humanities and applied work were absent in many programmes
Similarity of Bachelor's and Master's programmes.	Similar in terms of disciplinary content, more research in master's programmes	As expected, except for much more natural science in bachelor's than master's programmes
Shared Goals and Concepts of Sustainability	The learning objectives and course descriptions would describe a similar conceptualisation of what sustainability is and its goals	Agreement over human-nature interactions, interconnected natural, social, economic systems, but little else
Shared Literature and Educational Resources	Variety, but also a common set of articles, authors and reports	Extremely diffuse variety, no core shared set of articles, authors or reports

4.2.1 Coherence of Programme Content

Sustainability is an emerging academic field in the early stages of development with its inception (Kates et al., 2001) just over a decade ago. Sustainability inherently draws on a broad array of

backgrounds, giving a wide possibility of approaches to designing programme content. Nevertheless, many conceptualisations of sustainability are in broad agreement over certain key ideals. According to these, sustainability as an academic field ought to have the following attributes: it draws on disciplines that span the natural and social sciences and the arts and humanities (Clark & Dickson, 2003; Tilbury, 1995), it aims to study the dynamic interaction of human and social systems (Clark & Dickson, 2003; Kates et al., 2001) it is problem driven and solution oriented (Kates et al., 2001; Clark & Dickson, 2003) and it should involve real-world problems and engagement with communities outside of academia (Brundiers & Wiek, 2010; Martens et al., 2010; Yarime et al., 2012). Should one programme include all of the aspects that define sustainability? If sustainability is defined as consisting of many aspects and a programme awards a degree in sustainability, then it is part of my assumption that it should. Therefore, assumption 1 is: that sustainability programmes would have similar interdisciplinary, if somewhat diverse, content that would include the natural and social sciences, the arts and humanities and applied or experiential projects.

The empirical findings are in mixed agreement with this assumption. Firstly in terms of broad consistency across programmes there was no single field offered in all programmes (Figure 8) and this pattern was repeated with the subjects that make up these fields (Section 3.3.2). This represents quite an extreme diversity of approaches to content. This would suggest that different programmes in sustainability are taking different approaches to curricular content and there is no core set of fields or subjects that are recognised generally as essential to sustainability.

Nevertheless, there were a number of fields in which there was a high level of agreement, especially in bachelor's programmes. A large majority of bachelor's programmes offered courses, either required or option, in the natural and social sciences and a small majority offered them in the arts and humanities. The vast majority of programmes also offered an interdisciplinary sustainability course, that set out to define the concepts and challenges of sustainability. At the master's level the results were more mixed. A large majority of courses offered social sciences and the core sustainability course but natural sciences and the arts and humanities were only present in a minority of required and option content.

The absence of the arts and humanities in many programmes at both levels stands in contrast to suggestions for what sustainability entails in the literature (Tilbury, 1995; Wiek et al., 2011). Sustainability is a normative, value-laden endeavour in which the world is often described in terms

of how it ought to be, for example, for human survival (Rockström et al., 2009). Important for the development of normative competencies (Wiek et al., 2011) is attention to the moral and ethical debates that are the life force of much of the arts and humanities. They are important for assessing unsustainable systems, collectively creating visions for future models of sustainability (Wiek et al., 2011) and how we interact with different cultures and value systems. Understanding personal and others' values received attention in only the minority of the learning objectives of core sustainability courses. Perhaps it is too much to expect entire courses of philosophy, literature and ethics, especially in the time-restricted master's degree (though there are instances where this occurs); however, the centrality to sustainability of this normative component would suggest the inclusion of education on ethics and values, in courses dedicated to defining and conceptualising sustainability.

The field I have called practical and applied work describes entire courses that are dedicated to an applied or practical project (including internships). I assumed that these would be a common feature of sustainability programmes, based on the emphasis in the literature on community engagement and real-world education (Brundiers & Wiek, 2010; Martens et al., 2010; Yarime et al., 2012). In the majority of programmes at both levels this was the case, though at the bachelor's level, the majority was small. Course descriptions reveal that applied and practical experience is occasionally gained as part of standard courses, with a specific topical focus. Brundiers et al (2010) present examples of this from one university (although this programme also includes a capstone internship or applied project). There are a number of ways this applied experience could be realised in sustainability programmes. One could imagine entire programmes of applied work, in different topical areas, or programmes in which every course has some applied experience or where the major piece of work, that was traditionally a thesis, is replaced by applied or practical experience. There is a balance to be struck between traditional classroom learning, focused on the development of critical and creative thinking skills, and the application of this knowledge in real-world situations. This balance should be decided, not only, based on what mix is most beneficial to the knowledge and skills of the student but on how the work carried out can be most effective in addressing the problem the project is concerned with. This way the legitimacy of the education depends not only on the students abilities after graduation but, to a certain extent, on the work done while being educated. It follows that to fulfill the goals of sustainability this work should be carried out in service to civil society and the environment as well as in industrial internships.

4.2.2 Similarity of Bachelor's and Master's Programmes

I expected that, despite the master's being a more advanced and shorter degree with more research and less coursework, the topical or disciplinary content would be very similar between master's and bachelor's degrees. Again, for this assumption, the results are mixed.

On the one hand, bachelor's and master's programmes have a similar amount of required content dedicated to eight of the fields, including social sciences, research methods, sustainability and interdisciplinary courses. As expected master's programmes have a great deal more research (Figure 7). This pattern is repeated when the number of programmes with required or option courses in these fields is examined (Figure 8) Furthermore bachelor's and master's programmes both, on average, address six of the ten fields (Section 3.3.1) though the identity of these fields varied. They are similar in their level of diversity but not in the subject matter that make this up. This is important, in that it reflects the amount of diversity that can be achieved, in the shorter space of time allotted for master's programmes.

Though there are some minor discrepancies in the eight fields that have similar presence in bachelor's and master's programmes, there is only one truly outstanding difference. That is the very small presence of natural science in masters programmes' core curriculum, and the low number of programmes that even offer such a course. Not only is this remarkable because of the difference between the two degrees, but because of its incongruence with the idea of sustainability as including both natural and social sciences (Clark & Dickson, 2003; Tilbury, 1995). None of these master's programmes specify prerequisites (Section 3.3) that include previous study of natural sciences for admittance. So, there is real potential for students to complete a degree in sustainability without ever having taken a course in natural science. The learning objective in master's sustainability courses also reveal little or no attention to the natural sciences whereas they are somewhat present in bachelor's.

The focus of sustainability is on understand dynamic interactions between nature and society (Clark & Dickson, 2003; Kates et al., 2001). All sustainability challenges, such as climate change, have a natural science reality and basis. In a time when the scientific foundations of the single most important sustainability challenge, climate change, are called into question (McCright & Dunlap, 2011; Oreskes, 2010), it behooves graduates of sustainability programmes to understand,

and if needs be, defend the science behind the problem. Without some education in natural sciences it is unclear whether all graduates of these programmes would be able to do this effectively.

So why such a difference between master's and bachelor's programmes on this issue? It could be related to the format of the master's programme: natural sciences might be included elsewhere, for example, in problem specific courses. It could be that natural science courses are seen as more difficult and yield lower grades, which makes them unpopular. It might be a pedagogical issue: there might be difficulties in teaching natural sciences to students of diverse backgrounds or it could be that departments lack faculty to teach them. Another possibility is that it is related to the position of the master's degree, in relation to employment and the market. Many people pursue a master's degree to further their career or improve their salary (Glazer-Raymo, 2005), it is possible that the demands from industry on master's programmes are chasing out the natural sciences.

One potential for the teaching of natural sciences, at the master's level, is that it is taught in resource or problem specific courses. Problem specific sustainability courses are offered by 78% of master's programmes which, according to their course descriptions, often include natural science aspects related to this problem, such as water, climate, or food. Sustainability aims to be problem-focused and solution-oriented and so these courses seem appropriate; however, if they are the only courses where natural sciences are being taught in many master's programmes it raises questions about how to integrate natural sciences into the sustainability curriculum. One view might say that it is enough that students study the particular natural science basis to specific problems. Others might argue that students ought to receive a grounding in environmental, ecological and climate sciences, separate from the social context. This appears to be the approach, in many of the master's programmes, with respect to the social sciences, where they are dealt with in independent courses. There is a decision to be made, about whether sustainability graduates, are to be social scientists with some limited knowledge of the natural underpinnings of a few sustainability challenges or, they are to understand deeply, the approaches, methodology and epistemology associated with natural and social science. At the moment it seems that in many cases the former is true for the master's level whereas the latter is for bachelor's programmes.

4.2.3 Shared Goals and Concepts of Sustainability

The concepts that define sustainability, as laid out by Kates et al. (2001) or Clark and Dickson (2003), have been repeated and cited throughout the literature on sustainability. Given the widespread repetition of certain goals, such as understanding the interaction between ecological, economic and social systems, understanding issues of scale, an inter- or transdisciplinary, context specific, participatory approach to science, I assumed that the conceptualisations of sustainability that degree programmes promoted would both be in line with these and shared across programmes. A very large majority of programmes offered a core sustainability course that focused on defining and conceptualising sustainability and its goals. However, many of the syllabi of these courses were not detailed enough to fully define the particular understanding of sustainability being employed. While there was widespread agreement about the importance of understanding human-nature interactions or the relationship between society, economy and ecology, syllabi also referred to a diverse variety of objectives.

4.2.4 Shared Literature and Educational Resources

In contrast to the previous section where there was a some degree of consistency between course syllabi learning objectives, there were very few pieces of literature assigned to reading lists in core sustainability courses in multiple programmes. Though not what was assumed, it is not clear why this is the case, or whether it is a positive or negative finding. On one hand, the body of sustainability-specific literature is growing with the recent establishment of journals such as JSSPP and Sustainability Science. On the other hand, sustainability is still quite a new field that intentionally draws on a wide range of backgrounds and resources. The variety was not only present in the titles of academic articles and textbooks assigned, but in the various media used as education resources as well, including videos, popular non-fiction, and websites.

Together, this and the last section, reflect a kind of paradox in sustainability education. There appears to be agreement on fundamental concepts of sustainability and yet the approach taken to explore them, theories used to teach them, and disciplines drawn on to support them vary widely between programmes. Perhaps it is related to the stage of development of the field; at the moment there is agreement on the essentials and as time moves on, curricula will converge. Or, perhaps, the goals and fundamental concepts are all that will be shared; the literature and curricula will vary from course to course and programme to programme. If the latter is the case

one would hope that this variation from programme to programme would not reflect uncertainty in the conceptualisation of sustainability, but rather attention to the specific requirements of a programme, in the context of a particular time, with the needs of a particular body of students in mind.

4.3 Reflections

What does all this mean for sustainability programmes in the broader context of the the modern university, the market and the emerging field concerned with sustainability? Firstly, in relation to the emergence of the field, the study has highlighted some concerns over the content of sustainability curricula, particularly in relation to natural sciences and ethics. It is not clear why these receive less attention, whether it is a result of pedagogical, financial or organisational barriers. Perhaps it is too much to expect the people who design curricula, from a variety of disciplinary backgrounds, to include everything that sustainability aims to, and at the same time, for universities around the world to converge on a standard conceptualisation of sustainability. This study has shown great diversity in the approaches of different universities. Maybe such diversity can be harnessed to overcome the difficulties faced in designing programmes in sustainability and at the same time advance the field.

Resources other than professors and literature: current students, professors from other programmes, communities outside the university and industry have a wealth and diversity of knowledge on the various and changing aspects of sustainability. Their inclusion in programme design can contribute to curriculum and move the field forward, by helping professors and departments overcome disciplinary biases and facilitate other kinds of learning in applied and experiential projects.

Furthermore the inclusion of such actors in programmes design could be part of extending the legitimacy of universities and particularly programmes in sustainability beyond the economy, where it has come to reside in recent years (Gumport, 2000). The production of scientific knowledge is becoming an entrepreneurial endeavour, for profit (Etzkowitz, 2001; Etzkowitz et al., 2000). Yarime et al., (2012) suggest that an academic revolution is on the horizon whereby the legitimacy of the universities will not just be founded in the service to the economy but to society

and the environment too. Achieving this transition, as with much of sustainability, will be both in co-evolution with and opposition to the forces of the market. Consumer demand now has significant power, both in defining what is required of graduates and, hence, what the curricula of programmes in sustainability entail. These are not necessarily in line with social and environmental needs, as industrial organisations do not necessarily share these needs. Extending the network of actors with influence over programme design can both broaden the base of legitimacy for universities to include the social and environmental systems and strengthen the curriculum of programmes in sustainability, that otherwise run the risk of definition by the market.

5. Conclusions and Further Research

Sustainability as an academic field is a young one and yet it draws on the experience, knowledge and approaches of a broad diversity of long-existing disciplines. What education in this field should impart, in terms of skills and abilities, is still in the process of being defined. Such a broad based field, in an early stage of development, naturally faces barriers to its full realisation in universities. This study has looked at the curricula of 54 of these programmes, to see how the complicated context of this emerging field, has played out in terms of what is taught and how it is organised.

While a certain amount of diversity was expected, many of my assumptions about the coherence of content across programmes and in bachelor's and master's programmes were not borne out. Master's programmes had far less natural science than bachelor's which is contrary to the assumption that content would draw on natural and social sciences as well as the arts an humanities. In a time when the physical, scientific basis of climate change is coming under attack, natural science education will be necessary for sustainability graduates to defend against climate skepticism. The arts and humanities were not as popular as expected. In the context of sustainability as a normative endeavour more education in philosophy and ethics would benefit graduates who will have to make value-laden decisions and interact with different belief systems than their own. On the whole I found that the diversity of approaches was a more striking feature of the programmes than coherence, this was in terms of topical content, conceptualisations of sustainability and the literature used to teach it.

Perhaps it was unrealistic to expect coherence in a field so early in its development and one that draws on so many backgrounds. Perhaps the ten years since its inception is too short a time to expect convergence and perhaps convergence is not what is required. Whatever the story, the definition of the field concerned with sustainability will continue to play out over its second decade. It is important to recognise that, this will not just be in the production of academic literature but also in the process of designing programme curricula, a process that involves the balancing of many, sometimes opposing forces and ought to involve the input of a diverse many to make up for the gaps in the knowledge of the few.

Further Research

Throughout the discussion certain questions for further research have come to mind, such as: How precisely are natural sciences to be incorporated with social sciences and other fields in programmes of education that last one to two years and involve students from various backgrounds? What are the barriers to natural sciences at master's level, are there any? Should, and how can a diversity of actors, including from civil society, industry and current students be engaged in the process of developing curriculum for programmes or individual courses? How can a taxonomy of scientific subjects that includes interdisciplinary and possibly even transdisciplinary subjects such as sustainability be constructed, in a non reductionist way.

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Appendix

An example of how the data were collected in a matrix and analysed.

	Institution Name	LUMES	Arizona State	ASU	University of Limb	scomb U	University of Ramapo Coll	Northern Ariz	1 Antioch Uni	2 Murdoch U	
	Website	http://www.lu	http://school	http://school	http://www.u	http://sustair	http://sgs.us	http://www.r	http://nau.ed	http://www.a	http://www.r
	In AASHE database?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?
	Location	Lund, Sweden	Tempe, AZ, U	Tempe, AZ, U	Arlington, TX,	Nashville, TN	Tampa, FL, U	Mahwah, NJ,	Flagstaff, AZ,	Keene, NH, U	Perth, Austra
	Type of Degree	MSc	MA	Msc	Msc	Msc	MA	MA	MA	Msc	MA
	Name of Degree	Environmenta	MA in Sustair	Msc in Sustai	Master of Sci	Master of Sci	Master of Art	Master of Art	MA in Sustair	Msc in Envirc	MA in Ecolog
	Institutional Structure	Faculty-free c	Institute for S	Institute for S	School of Urb	Institute for S	School of Glo	Graduate Stu	College of So	Dept Environ	School of Soc
	Type of University	Public	Public	Public	Public	Private	Public	Public	Public	Private	Public
	Length of degree (years)	2	2	2	1	1	2	2	2	2	2 1?
	Units required (semester equivalen	120	33	33	36	30	33	36	36	42	48
	Term System	Bologna	Block								?
	Students currently enrolled	87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Year program started	1997	2007	2007	2010	n/a	n/a		n/a		n/a
	Electives (not in "Coursework") tak	0	6	6	0	0	6	0	21	15	14
	Concentration Areas						Water, Entrepreneurship*				average of 4-
	Sustainability Courses	Sust Sci					Interdisciplin	Sustainability Studio/ lectu		n/a	
	Sustainability Tutor (contact)	Barry Ness						A Vasishth			
	Online Syllabus							http://phobos.ramapo.edu/~vasishth/SUST_660-Sylla			
	Applied/ Thesis info							Capstone De	Thesis Only		
P	Applied Project (Experiential)	7.5	-3	-3		3		4			
P	Internship				3	3	6	4		6	
P	Internship 2					-3					
P	Fieldwork										
AH	Ethics/Phiosophy						-6		3		-4
AH	Religious Studies					-3					
AH	Writing/Speaking				3						
AW	Project 1				6		-3	8		3	-8
AW	Thesis	30	-6	-6					6		-12
BM	Accounting and Finance				6						
BM	Assesment									-3	
BM	Assesment										
BM	Business						-6				
BM	Decision Making (incl. Tools)		-3	-3							
BM	Leadership									-3	
BM	Management					3	-6				
BM	Management 1										
BM	Organisational						-3			3	
BM	Participation										
BM	Sustainabity and Business						-3				
ET	Buildings					-3					
ET	Energy Sytems					-3					
ET	Engineering										
ET	Transportation										
NA	Biology										
NA	Climate Science										
NA	Earth Science									3	
NA	Ecology									3	
NA	Geology										
NA	Environmental Problems/Environmental Science		-3	-3							
RM	General Research Methods	15			3			4			-4
RM	GIS				3						
RM	Modelling										
RM	Quantitative Methods and Tools (systems dynam		3	3	3						
RM	Statistics										
SI	Other Interdisciplinary/Sustainabilit	7.5						4	6		4
SI	Special Topics in Sust					-3					
SI	(Intro) Sustainability		3	3			3				4
SI	Sustainability 2										
SI	Sustainability Science	7.5									
SI	Sustainability Science										
SI	Sustainable Deveopment										
SI	Systems Thinking										
SO	Anthropology						-3				
SO	Cultural Studies										
SO	Communications				3						
SO	Development	7.5	-3	-3							-4
SO	Development										
SO	Economics							4			
SO	Economics		-3	-3							
SO	Education										
SO	Human geog ecol		-3	-3	3						
SO	Law						-3				
SO	Policy/Governance	7.5	-3	-3	3		-3			3	4
SO	Policy 2										
SO	Society	7.5				3		4		-3	
SO	Urban Society/Economy										-4
TP	Agriculture										
TP	Climate									-3	
TP	Ecosystems		-3	-3							
TP	Energy	-7.5	-3	-3							
TP	Enterprise		-3	-3		6	-3				
TP	Food		-3	-3		-3					
TP	Forests										
TP	Health	7.5					-3				
TP	Industry (Ecology)	-7.5	-3	-3							
TP	Land										
TP	Mixed Topics					3					
TP	Pollution										
TP	Rural	-7.5									
TP	Sustainable Resource Management					3	-3	4			
TP	Transport	-7.5									
TP	Urban	-7.5	-3	-3							
TP	Urban 3										-4
TP	Waste/Recycling										

Examples of Coding (Table 3)

1. Coded from Title in Agreement with Course Description.

EN 101 Intro to Environmental Science

Today's environmental problems have scientific, social and political aspects to them. This course, which is strongly suggested for majors and is suitable for non-majors, will focus on the scientific aspects, but will not ignore the other two. The student will be introduced to the geology, biology, physics and chemistry behind the problems and to the social and political difficulties inherent in dealing with them. Through a combination of lectures, case histories, in-class discussions and observation of the environmental decision making process at work, it is hoped that the student will gain an understanding of the complex nature of environmental problems and of the choices that must be made in solving them.

Categorised as: NATURAL SCIENCE, ENVIRONMETNAL SCIENCE

2. Coded from Topic Sentence in Course Description where title is unclear.

SUST 350 SERVICE AND SUSTAINABILITY

Individually designed internships and/or service-learning experiences. Students will be matched with a local organization/institution that corresponds to their personal/academic interests and career goals, where they will engage with real-world sustainability problems and solutions. As a capstone to the course, students will produce an extensive report based on their work and reflect on their experience.

Categorised as: APPLIED WORK, INTERNSHIP

3. Coded Similar Keywords in different context

Sustainability and Enterprise (3)

The course will examine the evolving interface between sustainability and human enterprise. The class will first explore and review key fundamental concepts in the sustainability arena, including economic and scientific drivers and select historical and structural aspects that create the current context for the enterprise and sustainability interface found today. The class will then delve into more specific case studies of attempts by current businesses to become "greener" and "more sustainable"; exploring challenges and opportunities that are commonly found as well as how decisions are often made in today's business settings and by whom. Alternative enterprise models and examples of businesses that are using the current context to redefine the sustainability and enterprise interface will be explored and discussed. Given the emergent nature of this effort, timely and real-world examples from current events will be utilized when possible. Finally, participants will explore and apply an integrated approach to sustainability and enterprise. Popular texts, original research articles and current events will make up the basis of course readings.

Categorised as: PROBLEM SPECIFIC SUSTAINABILITY, ENTERPRISE
Why? Problematisation of the concept of enterprise in relation to sustainability.

and

SUST 344: SUSTAINABLE BUSINESS PRACTICES (3)

This course will introduce the concepts of sustainable business practices and corporate social responsibility. Sustainable Business is a new paradigm shift from today's status quo management style of maximizing

profit at any cost. Traditional economic indicators have relied on gross domestic production and purchasing; however, these measures do not incorporate the costs to the environment and society. Newer indicators try to include these externalities to more accurately represent the economic health of a society. Sustainable business aims to restore and maintain environmental quality and develop social equity, while pursuing long term profitability. Prerequisites: Sophomore status or permission of instructor. Offered as Needed. (UG)
Categorised as: BUS. MGMT. ORGS., SUSTAINABLE BUSINESS PRACTICES
Why? Problematisation of sustainability in relation to business.

4. Coded from multiple keywords

SUST 340 POLICY, LAW, ETHICS

An investigation into the **political**, legal, and ethical dimensions of sustainability in the U.S. and around the world, using case studies in public **policy**, environmental law, and community activism. Topics addressed include the impact of **policies** and laws upon communities, especially in urban areas, and the relevance of environmental **policy** and ethics to the development of sustainable agriculture, transportation, energy, and housing systems. Students will gain an understanding of the **political** terrain, the significant ethical debates, and the legal boundaries surrounding sustainability by critically evaluating **policy** questions in a sequence of critical writing projects.

Categorised as: SOCIAL SCIENCE, POLICY GOVERNANCE
Why? Policy, politics mentioned most and overarching concept

5. Coded from related words

210 Calculus I
Survey of analytic geometry, limits, continuity, and curve sketching. Also includes derivative rules and application as well as an introduction of the integral.

Categorised as: NATURAL SCIENCE (incl. mathematics): MATHS

Further Details of Categorisation of Option Courses (Table 2)

The basic criteria are that students choose in the range, choose X from these X + 1 courses, to choose X from these 4X courses. However as the number of courses to choose from increases the possible number of combinations of courses that can be selected from these also grows, though the ratio is the same. To reflect this, and its impact on the uncertainty of the content of the overall programme, the criteria were adjusted. As the pool of courses to be chosen from increases the proportion of courses that can be chosen, in order for the course to considered option, also increases. Therefore, the criteria come in intervals whereby, students choose X from 4X courses where $4X < 15$, X from these 3X courses where $3X < 20$ and X from these 2X courses where $2X > 20$.

It was not always as straight forward as choosing a given number of courses from one set group. There were options where if A was the case then students would choose a certain number of courses and if B was the case then choose students would chose a greater number of courses. In these situations, if the number of courses to be chosen from were the same then categorise courses as if B is the case. If the number of courses to be chosen from is different and one case gives restricted and the other gives option, then assume B (i.e. the case where the greater number of courses are to be chosen).

These are somewhat complicated criteria but they reflect the variety of structures of optional content in different programmes.