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QUESTE-SI

D 5 / D 1.5: Meta-Referential Validated

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1 Introduction

This report is based on Deliverable 4 “Draft Meta Referential” and updated after all project participants have formulated their observations. It is thus validated by the stakeholders and discussed at various occasions. The report will be disseminated and a system to update it through an on-line process will be installed on the web site (online reference documents).

There are several starting points, which need to be taken into account:

1. Considering the breadth of the question and the variety of initiatives that may be developed, there is no place for a unique referential, or simply summing up prescriptive measures to be taken even in specific fields of study.
2. QUESTE-SI cannot be really considered as:
   - a ranking system (even if good practices are in play)
   - a way to grant a new label (although it may encourage pro-active institutions)
   - a way to set up a quality management system (as there is a little possibility of a well defined reference framework).
   - Overall, there are too many differences in the context of institutions or courses to clearly define a "best way".
3. Initiatives of any kind should be encouraged if they address the (desired) rationale of long-term management of resources, and an integrated view of technical and social dimensions.
4. In line with this analysis, the project will aim to mainly propose general guidelines, which may take the form of a general grid to locate progression.

An issue as large as social responsibility (expressed through sustainable development) is too overwhelming to be entirely dealt with in the framework of one project. More to the point, such an issue must be approached in strategic terms and at the policy/decision-making levels of an organisation. To be credible, social responsibility and sustainability should be embedded within the institution (not to rule out strategies that originate at departmental level). Thus, QUESTE-SI turned to a strategic action and fulfilment as an evaluation principle.

QUESTE-SI model was built upon a strategic action cycle, similar to that used in the earlier QUESTE quality assurance endeavours. This would comprehend initial conception, formulation of strategic objectives and planning, implementation, on-going management, and evaluation. Each phase should be rated and points should be scored for tangible action based on well-conceived plans. As presented the self-assessment process will require the demonstration of thoughtful decisions, sensible if not excellent practices, and convincing arguments for the fulfilment of sustainability objectives.

Sustainability is approached from four levels or dimensions: the institution and faculty, education and curriculum, student development, and research and innovation in cooperation with industry (and peer institutions). In addition, it is presented in seven topical target areas as outcomes for sustainability education. Additionally the evaluation should be made more flexible in terms of disciplines and programme outcomes, and at the same time leave a way open to strategies that run from the middle or bottom up.

As such, what in the project is normally called “criteria” are the seven challenges, i.e. the forward-looking engineering school should recognise and have strategies in place for these

aspects of sustainability. The “performance indicators” are steps in the conception, formulation, planning, and implementation of strategies in one or more of the seven areas. As ratings are given, this produces a map of activity or the lack of it.

The scheme had several important characteristics from the outset. There is no form of accreditation involved, as that would impose pass/fail standards when there should be a developmental emphasis. Moreover, many of the desired outcomes for students and faculty are attitudinal and intellectual, rather than purely technical. Additionally the meta-referential draft was turned into a form more suitable for publication, which is available as online reference documents and is used as part of a self-evaluation package.

2 Main Features of a Meta-Referential for Engineering Education

2.1 Why a Meta-referential Approach?

- Traditional referential frameworks may take the form of a linear display of objectives, which become the basis for an evaluation process or for making judgments as part of a quality management process.
- Beyond their clear usefulness, they reveal certain weaknesses when a qualitative issue cannot be reduced to simple cognitive terms and analytic formulations – notably, when a broader, more holistic vision is needed in making judgments.
- This is the case when the task is to clearly formulate the issue to be addressed, to make decisions in an uncertain context, or to adapt to totally new situations.
- This is particularly true when attention must be given to more global and individual aspects, such as
    - The context of the educational project (who, what, why, how, for what purpose?)
    - The elements of student attitudes, motivation, and self- sufficiency
    - At the institutional level
        1. A clear sense of the institutional identity and labour market position, targeted profiles, and corresponding job opportunities.
        2. The periodic assessment and upgrading of educational options
- The development of personal judgement and capacity to take decisions

2.2 What Does a Meta-Referential Bring?

The meta-referential directs attention to key factors that are often left in the background

- Institutional commitment of the institution to values that are based on a vision of the benefit to society of engineering expertise.
- An institutional strategy of differentiation from other universities, built upon specific and well-considered choices.
- The need to explain the context in which graduates will make their contribution to society and the planet.
- A follow up of the student body, within the studies or even in social life, to develop an actual motivation and ambition.

2.3 The Relationship Between Engineering Education Topics and Sustainability

Given a growing concern for social responsibility, sensible choices must be made. An analysis of current experiences and the relevant ISO standards will help to define the scope of our ambitions.

They should clearly cover:

- **Management of the environment** in a broad sense; energy, is addressed as a separate issue (Cf. the upcoming ISO 50001 on energy management).
- All that is being done or planned to **limit the emission of greenhouse gases** (in production of energy, alternative sources, design of buildings, low carbon vehicles, rational use of energy (cf. the upcoming ISO 50001 on energy management) and to ensure the **availability and rational use of raw materials.**
- **Health and safety issues** inside the productive organisation (corporate firm) with an extension to welfare.
- **Consumer protection** at a broad sense (transparency, health and safety issues).
- **Corporate ethics** (fair attitudes).
- **Social responsibility** and impact on communities.

This outline does not integrate all aspects of the ISO 26000 norms, such as human rights, legacy, etc.

2.4 Various Levels of Action to Consider

According to the example outlined above, actions may be developed at various levels:

- Institutional development of models consisting of values and corresponding actions.
- Efforts to foster a student awareness and vision of real world perspectives
- Identification of new skills and occupational profiles
- Need analyses for the development of new methodologies; critical analysis of current technologies and their impact

2.5 What Can Be Expected?

- In most countries engineering institutions are subject to quality assurance procedures, which focus on the key learning objectives and outcomes, while giving little attention to societal concerns. The interest in sustainability is all too often an individual rather than group attribute. Such an interest must be encouraged.
- The meta-referential proposed by the QUESTE-SI project has been prepared and backed by prestigious European institutions. It has the potential to motivate institutions to take concrete initiatives.
- A strong argument is the growing awareness and interest of students in sustainability. A potential effect of a label is that institutions may enhance their market position in the view of students and employers.

3 The Definition of a Meta-Referential

3.1 The Added Value of Meta-referentials

3.1.1 Referentials as Useful Descriptions of the Educational Process

Since the advent of the ABET Criteria 2000, it has become more common to see engineering program objectives expressed as competencies, to which specific learning outcomes are attached. Student progress is verified by the completion of tasks that combine to form the intended outcomes. In effect, the tasks serve as performance indicators or criteria. Constituted as lists of learning objectives and outcomes, frameworks of reference are useful tools for the implementation of quality systems or accreditation procedures. They propose, with variable levels of depth, an overall standard, its component outcomes, and relevant items for assessment.

In most cases learning outcomes refer separately to

- Basic and applied knowledge (what has to be learned and applied)
- Methods (how to act in reference to a certain profile of activities: design, construction, plant management) whose acquisition is mainly based on projects
- Transferable skills (communication, teamwork, etc.) mostly tied to collective and social dimensions.

In most accreditation reference frameworks, there is a simple mention of the need to foster an awareness of social issues, sometimes with a short quotation about sustainable development. This does not constitute a standard, which might be assessed, so this mention of sustainability remains a rather open wish.

3.2 The Meta-referential As a Broader Frame of Understanding

There are good reasons to broaden the scope of traditional referentials through the use of Meta frameworks, which take into account important new dimensions, which are scarcely recognized in the classical frameworks of reference, e.g.,

- The importance of contextualization and the quality of vision
    - Answering the questions: why is acquisition of knowledge and skills necessary and useful: what for, what is the world made of?
- The role of the institution
    - As a source, foundation, and example of values, notably a vision of engineering
    - For the strategic definition of engineering education (targeted profiles)
    - In the development of initiatives to foster student personal development
    - As a working model of what it teaches
- Student involvement in the direction of his or her studies and future career

A solution is to integrate these elements in a meta-model, which may be adapted to specific situations. The opportunity to integrate these dimensions is underlined by several initiatives in the field of sustainability, such as GRLI or the ISO 26000 norm. It appears that:

- Vision and foresight in decision-making are more important than technical expertise for the management of actions

- A full awareness of the actual context of decisions is an obligation.
- The reality of initiatives relies mainly on the motivation and disciplined effort of individuals.

3.3 The Structure of a Meta-referential

A meta-referential may be understood as a "Russian dolls framework", where the program objectives are "embedded" in collateral actions at the institutional level or targeted at the student body. See Fig. 1.

It puts a new emphasis on the cultural identity of the institution (values, world understanding, language) and the individual engagement of students (which is in this case a real challenge).

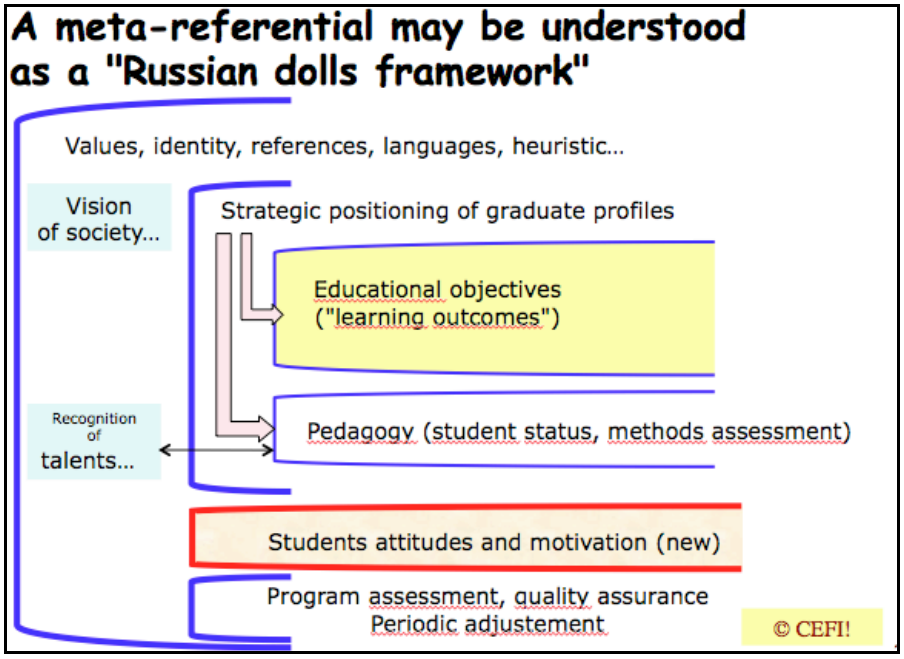

Fig.1: "Russian dolls framework"

3.4 A Synoptic View of Engineering Education

Another way to understand the ambition of a meta-referential is to consider engineering education as a three-circle process (see Fig. 2)

- A cognitive process (in the broad sense of the term) which is dedicated to the acquisition of learning outcomes (formation step)
- An education of mind and development of an actual motivation, which may better be considered at the educational level (education step)
- An institutional role, providing adequate options and playing a crucial platform role (cultural step).

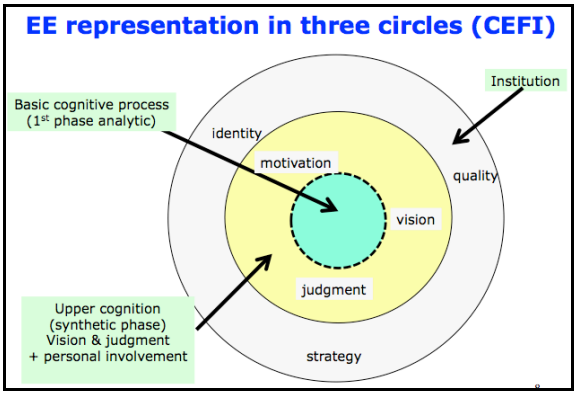

Fig. 2: Engineering Education As a Three-circle Process

4 Initial Elements

4.1 Adaptation of Existing General Principles to the Case of Sustainability

A thoughtful reflection on existing experiences shows that the case for sustainability is rather specific.

- There is a need to introduce new subjects, but these changes are not the priority.
- There must be an emphasis on institutional examples (cultural dimension, importance of embedded values).
- There must be an active involvement of students as they prepare for their future role of decision-makers.

Thus, four main levels of action emerge:

- Purely educational dimension: what must be introduced to, or strengthened in engineering curricula?
    - Context awareness (priorities, resources, constraints)
    - Required scientific or technical knowledge or know-how
    - New methodologies (e.g. impact studies, multidisciplinary approaches)
    - New transverse skills (e.g. crisis communication, risk management…)
    - Matching of pedagogical practices with learning objectives (placements, projects, stages, etc.)
    - New or expanding professional profiles (e.g., ecological- environmental-resource management engineers)
- Institution as a model
    - Management of the institution to demonstrate the reality of a sustainability policy (elements of strategy, identity, values, etc.)
    - Good practices (energy efficiency, environmental protection, waste management, etc.)
    - Research activities (strategic direction in the choice of topics)
- Targeting the student body for efforts to secure their involvement in sustainability

  - Through activities inside the institution
  - Through external involvement

An interesting approach is to apply existing activities to well identified challenges, such as :

- Life cycle analysis
- Development of alternative energy sources with smaller carbon-footprint
- Energy conservation (cities): efficient use of raw materials and recycling
- Transportation policies, eco-building practices
- Risk prevention
- Social participation in policy choices
- Knowledge society and long life learning
- Eco-systems and biodiversity

4.2 Challenges Where Engineering Education Should Be More Reactive

There are good reasons to expand on the points covered by the meta-referential. According to the outline a sensible choice could be to cover:

- Environmental management in a broad sense (with energy addressed as a separate issue)
  - Pollution prevention
  - Waste treatment
- All that is being done or planned to limit the emission of greenhouse gases
  - Production of energy, alternative sources,
  - Design of buildings, transportation issues
  - Energy saving, low consumption vehicles, etc.
  - Recuperation
- Life-cycle product management
  - Sustainable design
  - Sustainable production
  - Recycling
- Management of natural resources
  - Raw materials, ore
  - Ecosystems preservation, biodiversity
- Health and safety issues inside the productive organisation (corporate firm) with an extension to welfare (risk protection)
- Consumer protection in broad terms (transparency, health and safety issues)
- Corporate ethics (business practices, equity, fairness) and social responsibility (education, citizen participation, demography, migration, social protection) and common respect issues

This outline does not integrate all the points included in the last ISO 26000 iteration, such as human rights, legacy, etc.

5 Precise Definition of Criteria

The general grid to fulfil is presented below.

Part 1: Educational issues

Levels	**Challenges to take up** (may be extended)						
	Environment, pollution, waste management	**Energies recycling**	**Eco-building**	**Life-cycle conception** **Recycling**	**Natural and water resources**	**Eco-systems** **-Bio-diversity**	**Health and safety** **Risk**
1.1 Basic knowledge of sustainable development	Issues: understand the concept of sustainability mainly through challenges to be addressed, understand the sustainability challenges specific to a professional field (priorities), become aware of the role of engineer in the fabric of an interconnected world, become aware of the connections between the course of study and sustainability, understand the contribution of sustainable thinking and decision-making to sustainable development						
1.2 Specific scientific or technical knowledge or methodologies, tools and techniques for sustainable solutions	Issues: development of technical skills, transverse skills, and expertise necessary to implement sustainable solutions and to address sustainability challenges in a professional field Distinction between: • Sustainability themes to integrate in existing education modules • New modules for all students						
1.3 New speciality	Issues: setting up new programs or educational profiles in a specific field in relation to the skills needed to address sustainability challenges Distinction to make between: - optional modules - new speciality						
1.4 Student assessment	Appropriate assessments will be needed for student learning in matters of sustainable development						
1.5 Pedagogy	Various Issues: development of personal characteristics; development of sustainable attitudes and behaviours through active learning, provision of a range of practical experiences with an integrated problem solving approach						

Part 2: The Institution as a model

	Challenges to take up						
	Environment, pollution, waste management	**Energies recycling**	**Eco-building**	**Life-cycle conception** **Recycling**	**Natural and water resources**	**Eco-systems** **-Bio-diversity**	**Health and safety** **Risk**

2.1 Vision and policy (values)	Vision on sustainable development in general and/or on certain aspects, expressed in a strategic policy.
2.2 Research activities	New research activities and partnerships to address the different challenges to take up
2.3 Life long learning opportunities	Follow up of the graduates
2.4 Networking	Contacts with external organisations as a source of knowledge and expertise about sustainability Contacts with other engineering institutions to build a common vision on sustainable education in engineering Charter
2.5 Good practices	Good practices with a demonstrated value: as a model or as an educational tool (labs for chemists)

Part 3: Students: opportunities and involvement

	Challenges to take up						
	Environment, pollution, waste management	**Energies recycling**	**Eco-building**	**Life-cycle conception** **Recycling**	**Natural and water resources**	**Eco-systems** **Bio-diversity**	**Health and safety** **Risk**
3.1 Opportunities for involvement in sustainable activities and in social and humanitarian activities							
3.2 Opportunities to be involved in decisions about content and curriculum…							
3.3 Involvement in sustainable activities and in social and humanitarian activities							
3.4 Involvement in decisions about contents, curriculum…							

Project work is to define criteria in each of these cells, each time it appears sensible.

- Example of the dimension [Pedagogy]
  - Wide range of practical experience with an integrated problem solving style
- Example of the dimension [research activities linked to sustainability]

- Sustainability issues addressed by research activities (very much, rather much, noticeable, not significant)
- Impact on education (very much, rather much, noticeable, not significant)

5.1 QUESTE Progression

Following approval of these general guidelines, this huge matrix should be used as a framework for concrete criteria in specific fields:

- Energy
- IT
- Transverse abilities

5.2 Global Structure of the Work to Be Done

The structure is presented in the form of PowerPoint slides in Fig. 3 below.

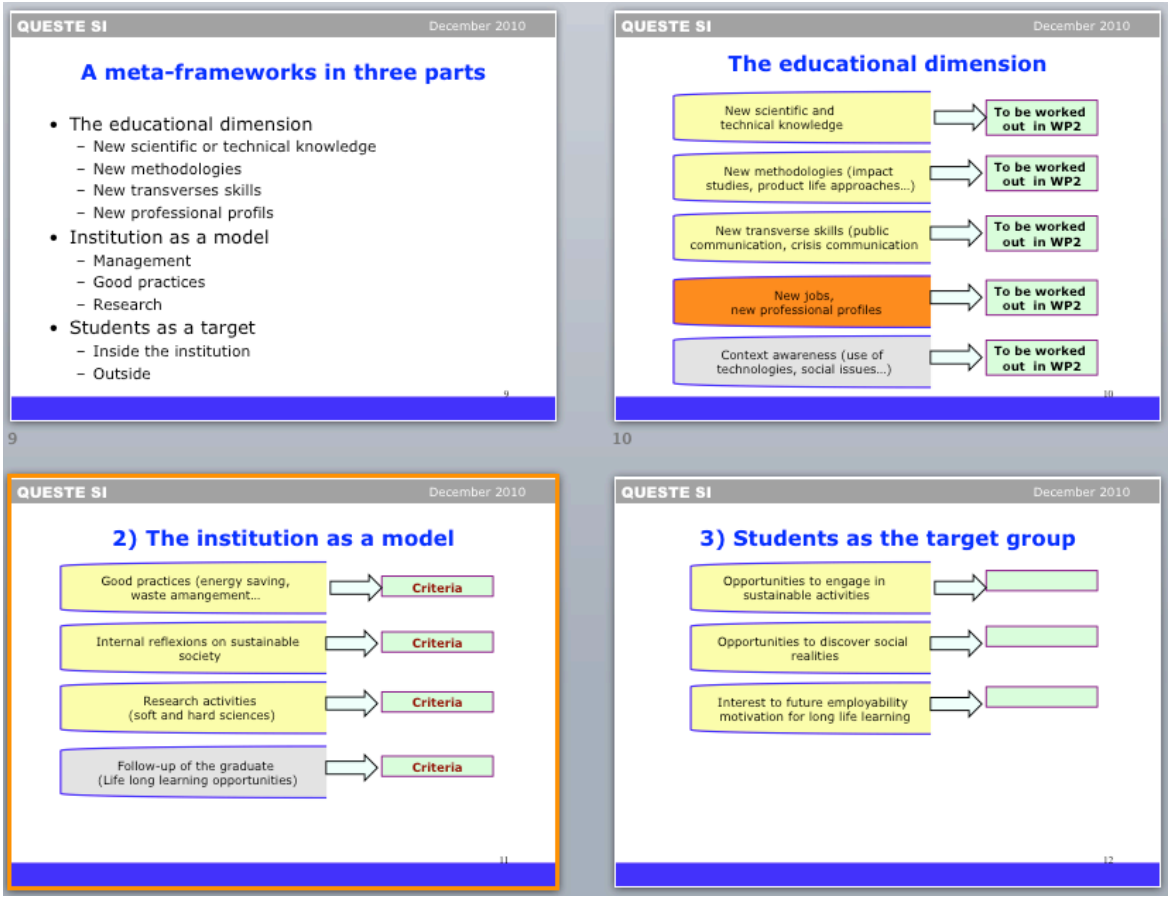

Fig. 3: Structure of the Work

6 Defining Provisional Criteria

6.1 Management of the Environment

The purely educational dimension:

- Scientific or technical knowledge
    - Water treatment
    - Eco-systems
- Methodologies, tools, techniques (e.g. impact studies, multidisciplinary approaches)
    - Life cycle analysis
    - Eco-design (products, buildings, process)
- New transverse skills (e.g. crisis communication, risk management, etc.)
- New professional profiles
- Context awareness:
    - Knowledge of ISO 14000 standards and other sustainability related international standards

Institution as a model

- How local management demonstrates attention to environmental management (element of strategy, identity, values, etc.)
- Good practices (energy efficiency, environmental protection, waste management, etc.)
- Research activities
    - Subjects related to environmental and sustainability issues

Student body as a target

- Activities inside the institution
    - Participation in cleaning and conservation campaigns
- Outside involvement: involvement in NGOs, community or humanitarian activities
- Awareness of ecological systems

6.2 Energy and Raw Material Management

The purely educational dimension:

- New scientific or technical knowledge or know-how
- New methodologies (e.g. impact studies, multidisciplinary approaches)
    - Life cycle analysis
- New transverse skills (e.g. crisis communication, risk management, etc.)
- New professional profiles
- Context awareness:
    - Attention to ISO standards (14000 series, 50001 on energy management)
    - Climate change debates
    - Precise assessment of natural resources
    - Data on energy resources

Institution as a model

- How local management demonstrates the attention to sustainability (element of strategy, identity, values, etc.)
- Good practices
    - Plan for energy efficiency
- Research activities
    - Subjects related to environmental issues

Student body as a target

- Activities inside the institution
    - Encouragement to use public transportation, waste management
- Outside involvements

6.3 Health and Safety Issues

The pure educational dimension:

- New scientific or technical knowledge or know-how
- New methodologies (e.g. impact studies, multidisciplinary approaches, life cycle analysis
- New transverse skills (e.g. crisis communication, risk management, etc.)
- New professional profiles
- Context awareness:
    - Attention to ISO 14000 standards
    - Climate change debates

Institution as a model

- How local management demonstrates the attention to sustainability (elements of strategy, identity, values, etc.)
- Good practices
    - Plan for energy efficiency
- Research activities
    - Subjects related to environmental issues

Student body as a target

- Activities inside the institution
    - Encouragement to use public transportation
- Outside involvements

6.4 Consumer Protection

The pure educational dimension:

- New methodologies (e.g. impact studies, multidisciplinary approaches, survey methodology)
- New transverse skills (e.g. communication, organization of action groups, etc.)
- New professional profiles
- Context awareness:
    - Awareness of existing regulations (REACH)

Institution as a model

- How local management demonstrates its attention to consumer protection (element of strategy, identity, values, etc.)
- Good practices
- Research activities

Student body as a target

- Activities inside the institution
- Outside involvements

6.5 Social Responsibility and Corporate Ethics

The pure educational dimension:

- New methodologies (e.g. impact studies, multidisciplinary approaches; understanding of sociological elements)
- New transverse skills (e.g. crisis communication, team & group functions, etc.)
- Context awareness
    - Gender issues
    - Ethical Charts of engineering associations (What and why?)

Institution or Organization as a model

- How local management demonstrates its attention to Social responsibility and corporate ethics (element of strategy, identity, values, etc.)
- Good practices
- Research activities

Student body as a target

- Activities inside the institution
- Outside involvements
    - Participation in social and community activities

7 Use of Sustainability in in a Global Assessment Process

Three main options may be considered for the use of specific referentials (a topic that will be addressed more precisely in WP2 and in the advancement of the project). The first could be to limit the process to a relative count of the initiatives taken by an institution within a given

frame of reference (one point for each cell where an action has been engaged). The second option may be to rate each initiative (on a five level scale) and to calculate an average rating. A third approach could be to impose a threshold for each item that would allow defining a label.

7.1 What Does a Raw Counting of Initiatives Bring?

One purpose of a reference framework is to allow mapping of all possible actions and to build a database of actions connected to sustainability.

Such a count will provide a rough estimate of the efforts made by an individual institution. It may also help to distinguish various types of policies, some more curricula oriented, some more student- oriented, and some more based on a model that may offer an interesting typology.

7.2 Concept of a Rating System

Starting from the raw inventory of actions, the next step might be the introduction of a rating scale based on the depth of actions taken (for example, from one data point to comparative data on the mastery of subject matter).

It would be then very simple to define either a global rating, or perhaps a four-point scale, related to the four main forms of action (short-term educational issues, long term educational issues, institution sustainable management, and efforts to involve students.

In this approach the emphasis would be more on the intensity of the initiatives, whereas the initial counting would reflect extension of the initiatives (with uneasy choice to make between the two views).

7.3 The Basis for a Label

As soon as a rating system is defined, the way will be open to define rules for the award of a label, possibly as a combination of extent, as determined by counting, and a very basic rating of impact.