Organisational learning and integration of sustainability in engineering education

Aida Guerra
Assistant Professor
Aalborg Centre for Problem Based Learning in Engineering Science and
Sustainability under the auspices of UNESCO, Aalborg University
Aalborg, Denmark
E-mail: ag@plan.aau.dk

Jette Egelund Holgaard[1]
Associate Professor
Aalborg Centre for Problem Based Learning in Engineering Science and
Sustainability under the auspices of UNESCO, Aalborg University
Aalborg, Denmark
E-mail: jeh@plan.aau.dk

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INTRODUCTION

Sterling [1] advocates for four levels of institutional responses towards sustainability that are aligned with different levels of change, where: i) no response characterises no change; ii) weak response characterises accommodation? and add-on strategies; iii) strong response characterises reformation and integration strategies; and iv) very strong response characterises transformation, rebuilding and redesign strategies.

In 2004, just before entering the UN Decade of Education for Sustainable Development (ESD) 2005-2014, Sterling could conclude that most organisations were stuck at second and/or third level of change lacking a whole system transformation [1]. At the end of the decade Lozano et al [2] made a study based on a literature review of 60 peer-reviewed papers and a survey answered by 84 respondents from 70 institutions world wide to investigate the commitment and implementation of sustainability in higher education institutions (HEI) [2]. This study showed that "*Most HEIs are making some efforts to contribute to SD. However, this research confirms that, in general, the implementation of SD in HEIs has been compartmentalised and not holistically integrated throughout the organisation*" [2:14].

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[1] Corresponding author

This indicates that the organisational learning in HEIs to integrate SD is indeed a challenge.

Organisational learning (OL) can be defined as a process through which organisations are capable to adapt themselves to the surrounding environment. An organisation's learning capability depends on its members' ability to learn and transform current mental models and values, resulting in new forms of action [3]. This is related to what is defined as single loop learning [4, 5] which happens whenever an error is detected and corrected without questioning or altering the underlying values of the system – instead the purpose is to comply with these values, or the governing variables [4]. as Argyris name them. The governing variables are "*preferred states that individuals strive to "satisfice" when they are acting.*" [4:9]. Examples of governing conditions could be the level of respect and trust on ethical and technical issues [5:160], Double loop learning on the other hand takes place when the governing variables are examined and altered [4,5]. Other authors e.g. Swieringa and Wierdsma [6] have added yet another distinction and introduced triple loop learning, which is so nicely summarised by Tosey et al [7:294] "*Following Argyris and Schön's schema logically, since double-loop learning involves correction of governing variables, it would appear that triple-loop learning should be concerned with the change in whatever governs those governing variables*". The concept of triple-loop learning adds a critical and normative perspective by not only stressing the importance of examining and altering but also by questioning the governmental variables.

OL is thereby characterised as a continuous process whereas demands from external surroundings trigger reflection regarding current mental models and practices whereas a gap between "how things are" and "how things ought to be" within an organisation is recognized by its members [3][8]. Dixon [9] has characterised OL as accumulated cyclic processes of acquisition, integration of information in existent structures and collective interpretation leading to new initiatives, actions and experiments. In this paper we will argue that a mapping of the elements in such OL cycle can provide an overview of the OL process, which can inform the discussion of OL in HEIs from a double-loop and triple-loop perspective – the first step however is to relate the OL cycle to ESD.

1   METHODOLOGY

The specific relation between OL and education for sustainability research is an emergent area. Authors claim that OL is a suitable framework to enhance integration of sustainability in universities [3][7] but to transform the theoretical considerations from OL theory to ESD practise there is a lack of examples of how OL can help ESD integration in practise. This paper addresses this problem by investigating the following research question:

In which ways do experiences with integrating sustainability in engineering education relate to the organisational learning process?

The study takes a qualitative approach and uses expert-interviews as the primary method for data collection to be able to get in-depth and yet comprehensive insights from different integration processes of ESD. The study involves seven sustainability experts who carry out research on education for sustainable development and are involved in processes of change and integration of ESD. The interviewees are from

different institutions and from different countries. The interviews are supplemented with documents and research papers characterising the integration process of ESD at the different institutions.

The data collected is analysed using the Dixon's [4] OL cycle. which is composed by four main processes: i) **acquisition** and generation of information; ii) **integration** of information into organisational context and structures; iii) collective **interpretation** of information; iv) responsible **action**.

2 FINDINGS

2.1 Generating a knowledge base for ESD

Regarding the acquisition and generation of information, the results from the expert interviews show that members are acquiring information continuously and from different sources namely supervision of PhD studies related with sustainability, involvement in engineering education organisations (e.g. The Royal Academy of Engineering), entering research units on sustainability and auditing sustainability projects.

A research approach to knowledge acquisition has not only been a way to generate knowledge, but it has also been a way to acquire recognition of the acquired sustainability knowledge within the engineering culture. E2 exemplifies:

"*There are attitude issues which I think have become less… there might have been a saying that this was a very momentary and fashionable topic that would not last more than a couple of years… it is very difficult to generalise, and I do not want to do that but some colleagues inevitably feel that a lot of the material we might cover is a bit fluffy, a bit vague, others are very, very supportive, and I think we have the whole spectrum of attitudes among colleagues... And although we are changing the research strategy … Up until recently sustainable development was one of the key research themes of the department of engineering and just having written down to say: this is an important activity, I think has been hugely valuable for us*."

Another approach has been focused on employability (E7) to knowledge acquisition, making workshops for industry partners to clarify the need for sustainable knowledge in relation to specific disciplines.

Whereas a third approach is to create knowledge networks of people engaged in ESD that can come together on the Internet or in other ways to share experiences with ESD (E5). Expert 5 furthermore argues for a more experiential mode in the acquisition of knowledge. She states that even though some engineering professors are interested in teaching sustainability they lack practical experiences as they have grown up in a more traditional academic environment. Therefore universities, if they are serious in terms of ESD, should offer faculty members the opportunity to experience the integration of sustainability in real life situations.

2.2 Ways to integrate information

There are also different opportunities for **integration** of information into the organisational context. The results point to staff development programmes, creation of committees involving students, lecturers, as well as staff gatherings e.g. at

seminars to share knowledge and experiences from ESD practise. The results also point to on-line platforms and reports as means to disseminate information within the organisation.

Even though these examples of integration activities exist, Expert 6 stresses that it is indeed a challenge to spread information across the campus. Besides spreading information there is also the challenge of reaching the necessary depth of sustainability knowledge to be integrated. E7 takes the position of seeing sustainability as a set of requirements in a system design engineering approach and then sustainability becomes something concrete by providing three types of requirements related to economic, social and environmental sustainability:

"If every engineer understood that this was a part of the thinking and a part of the thinking framework, they would not just worry about whether it would be strong enough and think: then we have done well. Much people see sustainability as some kind of extra thing we have to do. And yes it is extra in a sense that there is a little bit more extra awareness that you need, but it actually integrates at the centre of the design process. It is not an extra step of the design process".

Expert 4 expresses that there is a great need to integrate a deeper understanding of sustainability among staff:

"In some cases it is very much a buzz word, and a buzz-word sometimes is empty because there is nothing behind it. People do not understand what is behind the buzz-word, so they say I like sustainability, I am all for it and I would like to teach it, but if they do not understand what is behind it, it is just hollow"."

The question here is not only how much an engineer should know about sustainability in order to work interdisciplinarily and design sustainable products, it is also a question about the profile needed in order to teach sustainable development for future engineers. Expert 2 argues for a multi-disciplinary approach, where the engineering community at large have to educate staff and students for sustainability:

What I think is very interesting is that we have always taken the view that sustainable development is multi-disciplinary and we have to talk with other specialists whether they be particular social scientists or environmental scientists and so on. And for the reason that the department is increasingly recognising that it has to work in a more multi-disciplinary way.

2.3 Collecting interpretation strategies

Staff development programmes, committees involving students, and gatherings as seminars and workshops also hold the possibility for **collective interpretation**.

Several of the experts stress the importance of creating what Dixon [4] call a shared meaning structure. In one example (E2) a project has been established to bring staff members together to discuss how sustainability could be brought into the different departments, courses and lectures in an active co-creation process. In another case (E1) such co-creating strategy is also used in the pedagogical approach as more traditional lecturing is combined with project work, bringing together people within and across departments.

One expert (E4) exemplifies this co-creation process among students in groups formed across schools and programmes. Students are not only from engineering but also from other faculties like liberal arts or social sciences, and they are faced with exercises where they have to build a common understanding and conceptual ground.

However, the challenges of working interdisciplinarily have to be recognised and offered attention in order to benefit from the potential synergies. Expert 4 emphasises that there is a remaining resistance from the engineering community to integrate ESD in the programmes, which partly is due to some misunderstandings from both worlds of the engineering and social science communities. Expert 6 exemplifies what can happen when different mindsets meets, in this case about relations among staff:

"In the discussion there was an anthropologist, a social scientist, a biologist and two chemical engineers… we started a discussion and out of the blue, the biologist and the chemical engineers, we clustered to discuss things and we went very fast on this. But when we came together again, the anthropologist and the social science guy they processed information in a totally different way. I am not meaning that they are wrong… it was just totally different. You have to face that and keep down your arrogance of hubris … You have to be careful – it is a multi-cultural system."

This example points to the tendency to seek corroboration. As noted by Glaserfeld [10] individuals need the corroboration of others to establish the inter-subjective viability of ways of thinking and acting. However, Glaserfeld also indicates that the degree of corroboration is a matter of interpretation [10:121] *"Others may be telling (or we may believe) that they think as we do, but what they say or do shows us, as interchange goes on, that this cannot be the case. Although the words they use are the same as ours, the network of concepts they seem to have in mind is incompatible with the ones we have built up."* This underlines the need of initiating collective interpretation processes.

Expert 1 calls for a more collaborative culture but indicates that the kind of hubris mentioned in the previous quote create barriers:

"There is a lot of suspicion. We have been working for so long and we can feel that there are many colleagues still that say that this is all a lot of bullshit … all these social scientists they are just too stupid to do something like real science and things like that."

As noted by Hård and Jamison [11], hubris is a central theme in the history of technology and science.

2.4 Action for ESD

The last stage of the learning process regards **action** when members have authorization to impact others (if top-down approach) or act by own initiative (if bottom-up approach). At this level, the results show the diversity of the actions taking place. Examples are creation of elective programmes and courses; establishment of

champions in the engineering area; specialised inter-disciplinary ESD projects; use of innovative learning approaches such as boat week, studios, living libraries, etc. In terms of inter-organisational networks there are also examples of industry taking an active role in ESD, e.g. by educating undergraduate students about how industry is dealing with sustainability.

Expert recommendations for future actions include more systematic integration of lectures and project work in the bachelor as well as master levels, focus on real life problems and situations, emphasis on more inter- and trans-disciplinary educational activities and encouragement of students to become change agents. These recommendations relate to the governing variables of the institutions, and in more concrete terms the success criteria that will guide the actions.

But also, there is a tendency to challenge the governing variables with a new type of thinking. This tendency is exemplified by the following quote (E5):

"The more ecological thinking and system thinking can be brought to universities, the better is the direction that we will be heading, and I think that without questioning the direction of universities … not just more education is better. It depends on the type of education. It is not just 'more is better', it is about being more critical about what we mean by education and what it's goals are and who is involved, and what kind of information, what kind of knowledge, is involved and what is being generated. I think these are some of the mature questions of our time."

Expert 5 thereby hints to the strategic level, and by reference to Orr [12] and his call for considerations to what education is for, she implicitly calls for triple-loop learning activities.

2.5 Facilitating the organisational learning process

One of the experts stresses the need for alignment between top-down requirements and support at institutional as well as governmental level and the bottom-up initiatives taken by a number of enthusiastic academic members (E2). One way to foster this alignment has been to set up sustainability committees with representatives from all levels of the organisation, including lecturers and students.

What triggers the process depends on the context as Expert 3 stresses and explains in the following way:

"Ideally I want everybody involved. Of course that does not happen and we go back to the context. In some countries, and in some particular universities, like for example private universities, top level can decide what to do because that is the way it is. It works more or less as a company. In other universities, a public or state university, the study body has a lot of power. So if the students begin to ask for that then the university is going to change"

The top-down triggers seem to be related not only with the visions of directors and leaders but also with external factors such as accreditation bodies and professional practice. They thereby start the organisational process by integrating and diffusing ESD knowledge, providing a frame for interpretations and possible actions. On the

other hand, the bottom-up triggers are related with interests of individual staff who start by introducing aspects of sustainability in their own courses. In this case, the organisational learning process begins with a patchwork of practices based on local interpretations and knowledge acquisitions, whereas the diffusion of knowledge and construction of a more shared meaning structure becomes central. If bottom-up strategies stay local, and top-down strategies stay detached from practise, learning will not reach the organisational level.

3 CONCLUSION

This study accumulates expert advice and examples of activities for the integration of ESD in an OL perspective. The concrete activities can be related to the different phases of the OL process, as illustrated in figure 1.
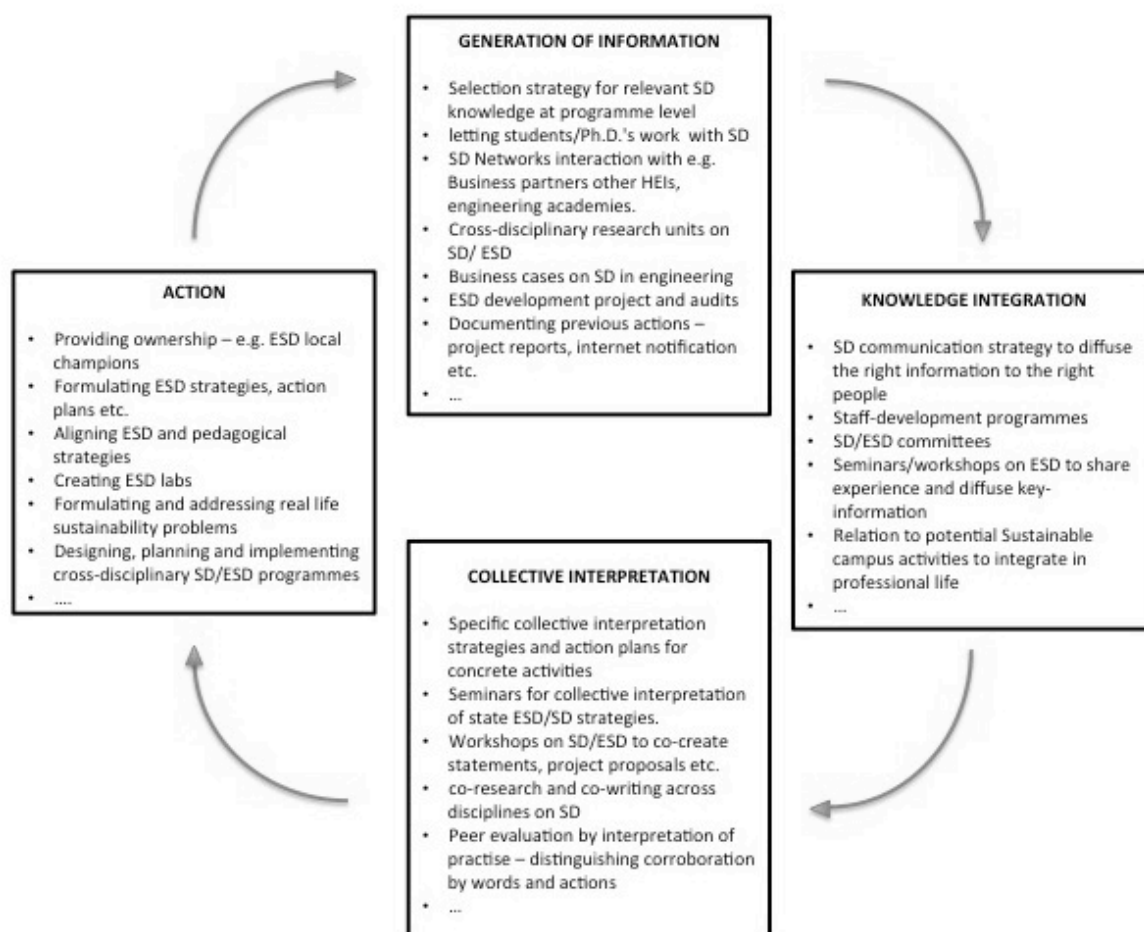
Fig. 1: Examples of ESD elements in the organisational learning cycle

The activities mapped can be seen as accumulated examples across HEIs, and as such figure 1 is by no means representing what one HEIs is doing – but instead what a higher institution could do, and how a mapping of these activities in an OL perspective can give an overview and possibilities for alignment. What could be called OL blind spots can also be revealed – e.g. if the collective interpretation processes are short-cutted.

The mapping of activities in figure 1 presents a single-loop perspective. There is no consideration to the governmental variables for EESD at institutional level. It presents what we could do. By getting the overview of organisational activities an alignment process taking into consideration the refining of what we do (single loop), the on-going appropriation of what we want (double loop) and the questioning of where we are going (triple-loop learning) in terms of ESD is enhanced.

The finding shows that the acquisition process can be rather sophisticated, e.g. by including in-house research and inter-organisational networking. Integration of sustainability is facilitated by top-down and/or bottom-up initiatives in the organisation, and thereby it is not a matter of one OL process but many organisations' learning processes, which are to be aligned. The organisational learning process provides a structure for clarifying the strategies and activities in parallel cycles and not the least, it raises attention to the challenge of creating collective meaning structures.

Although the frontrunner experts can point to diverse possibilities for integration, it is also clear that the transition through the different stages of an OL process is not absent of barriers, for example in relation to cross-departmental collaboration, resistance to change, and distribution of information to all corners of the organisation. This together with the overall challenge, to align the OL in the bottom-up and top-down approach, underlines the complexity of the challenge of integrating sustainability in engineering education.

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