Abstracting and Engaging: Two Modes of Systems Thinking Education

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This paper presents two modes of systems thinking education to help make sense of previous and future experiences in this field as well as in soft operational research in general. Using Abbott's ideas on professional knowledge I present these modes as based on either (1) abstracting or (2) engaging. The former emphasises the value of systems thinking in helping people understand abstractions to deal with complex situations. The latter focuses on using abstractions to facilitate students' engagement with complex situations in areas outside operational research including sustainability and project management. I present each mode based on my experience in a higher education setting in the UK, and I highlight key elements and possibilities for these modes that could inform future developments in systems thinking and operational research education.

Key words: systems thinking; soft operational research; education; professional knowledge; abstracting; engaging

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Introduction
Systems thinking, a body of knowledge that initially emerged in biological investigations has spread to other areas like physics, psychology, cybernetics, information technology, community development, and management. Currently it is considered by many as a form of “soft operational research” (soft OR) and often it is better known as “problem structuring methods” or PSMs, both of which are used to deal with complex (e.g., messy) situations (Eden and Ackermann 2006, Rosenhead and Mingers 2001). Many of the methods used in soft operational research and PSMs employ systems models or the idea of the enquiry process as a system (Checkland 1981). Systems thinking can also involve the use of several methodologies to guide thinking and practice (Jackson 2003, Mingers 2003, Mingers and Gill 1997, Midgley 2000, Cabrera et al. 2008).

Regardless of the different labels used (systems thinking, PSMs or soft OR), systems thinking ideas are now incorporated in courses in business education as well as in specialised journals including the Journal of the UK Operational Research Society and conferences (for instance the European Conference on Operational Research). These efforts share a basic premise of advocating an alternative mode of thinking to that of a “mechanistic” one in order to address complex (messy) problems in organisations. However, popularity could be a two-edged sword. On the one hand, it could mean that systems thinking, like OR in the past, is better seen as a way to help other disciplines (i.e., management) expand into new domains (Corbett and Wassenhove 1993). On the other, popularity could also mean a sign of relevance and usefulness for systems thinking that should be taken forward. In any case, it is worth looking at how education in systems thinking is being developed, and how such types of education can be improved.

In this paper I discuss a context and experiences of systems thinking education in the form of two modes, which are (1) one that emphasises abstracting of concepts, ideas of, and methodologies for systems thinking; and (2) one that emphasises engaging with specific situations. The first mode is based on a strategy to offer systems thinking as an alternative way of thinking about problems. As such, it focuses on enabling students to appreciate and reason about a situation as a system, leading them also to choose one or several systems-based methodologies to act on a specific problem they want to address. This mode of education has contributed to differentiate systems thinking as a body of knowledge within and outside soft OR.

However, abstracting does not necessarily involve a strong degree of interaction between students and
other people involved or affected by the problem. I became concerned about the relevance for students and potential impacts of this mode of education. I therefore shifted to a mode of engaging, which involves students tackling relevant problems in their own surroundings by using systems thinking ideas and methodologies. This second mode helped students gain knowledge, skills, and abilities to reflect on the outcomes that they achieved but required a more structured process of engagement to help students to master what they were learning.

From my experience as an educator, I consider that these two modes are complementary so that new abstractions can be developed and grounded in practice through engagement. The interdependence between these modes helps a great deal in the development of new educational possibilities in systems thinking and soft OR education.

The paper is organised as follows. I use the ideas of Abbott (1988) on the sociology of professional knowledge to briefly reflect on systems thinking as a body of knowledge that has a number of opportunities and challenges. I use these ideas to present and detail two modes of systems thinking education that I then discuss in detail using my experience as an educator in this field. I assess the strengths and weaknesses of these modes and conclude by putting forward a number of future possibilities for systems thinking and soft OR education.

Systems Thinking in the Context of Professional Knowledge

Systems thinking and problem structuring methods are bodies of knowledge within soft operational research that include concepts, ideas, and methodologies for problem solving in organisations (Rosenhead 2006, Rosenhead and Mingers 2001). Both of them are distinguishable from more traditional or “hard” operational research given that they can help researchers and practitioners to define the problem to be addressed prior to tackling it. Several problem structuring methods and techniques define and represent the problem to be addressed as a “system.” They can also help individuals consider their enquiry process as a learning system (Checkland 1981).

Systems thinking prides itself in using methods and techniques to represent and solve a problem in an informed manner. This means that the use of methods and techniques can be organised in methodologies so that users see a coherent process to follow and a purpose to be attained. Moreover, the use of systems thinking methodologies, methods, or techniques is guided by a number of commitments: a commitment to critical awareness of taken for granted assumptions in a situation and the conditions that gave rise to them; a commitment to human emancipation from any constraint that could limit the achievement of individuals’ potential; and a commitment to employ coherently a variety of methodologies, methods, and techniques according to their strengths to tackle a problem (Midgley 1996).

As bodies of knowledge, both PSMs and systems thinking are often “caught in” between the worlds of academia and professional practice. They are not disciplines or professions on their own; rather, their development takes place in OR departments or groups as well as systems thinking research centres. In countries like the UK, both of these are being ascribed to management or technology departments in universities. This is the case for instance of the Centre for Systems Studies, which is ascribed to the Business School of the University of Hull, and of the systems group that is part of the Faculty of Technology at the Open University. In the world of practice, we see a growing number of training courses for practitioners in the use of systems thinking or PSMs. Examples include courses run by the UK Operational Research Society on using soft systems methodology (SSM) and structuring complex problems (UK Operational Research Society 2011). These courses attract the interest of those individuals interested in exploring alternative ways to manage problems and situations. To this audience we as educators say that we “do” soft operational research, management science, or complex project management rather than systems thinking. Appropriate labels seem to gain the attention of the professional world as well as of other academics.

Existing efforts in systems thinking education can now be considered in the context of the professions that systems thinking currently serves. According to the sociologist (Abbott 1988), a profession is a set of activities that requires an adequate level of expertise to address and solve a specific set of problems. It is only through time and by gaining recognition of its relevance and uniqueness that a set of activities can gain the status of a profession. A profession can then lay claims to a set of problems and their solutions. Abbott (1988) argues that professions constitute a dynamic system in society where professions that hold relevant knowledge emerge, interact, or compete with each other (almost territorially) for jurisdiction on or ownership of specific problems. In this process professions can develop further, contract, or disappear.

According to Abbott (1988), a profession involves activities of (a) diagnosing a set of problems; (b) treating them; and (c) inferring or linking diagnoses with a range of treatments and their expected outcomes. These terms will be used throughout the paper given that they can constitute the core of professional
knowledge in both academia and practice. The role of academics in contributing to identify new diagnoses, treatments, and inferences is fundamental for a profession. Abbott says:

The ability of a profession to sustain its jurisdictions lies partly in the power and prestige of its academic knowledge. Academic professionals demonstrate the rigor, the clarity, and the scientifically logical character of professional work, thereby legitimating that work in the context of larger values. In most modern professions these have been the values of rationality, logic and science...[academic knowledge] may reveal underlying regularities that can ultimately reshape practical knowledge altogether...[however, it] exists in a peculiarly disassembled state that prevents its use. (Abbott 1988, pp. 53–55, italics and brackets added.)

Abbott’s statement makes it explicit how academic knowledge contributes to maintain a profession by reorganising existing classifications of diagnoses, treatments, and inferences, so as to make them more complete, useful, and accessible to professionals. This also means that academic activities (including education) have a two-sided effect. On the one hand, academics are in a unique position to develop new ideas and explore their potential use in new domains of practice. On the other, by making their knowledge available and useful to professionals or students they also reveal the achievements and limits of their activity and indirectly those of the professions they support. This can make a profession vulnerable to “attack” by others. Academics and educators need to continuously regenerate and renew knowledge while contributing to protect their professions’ jurisdictions.

Under the above perspective, systems thinking can be considered a body of knowledge that can help people understand and deal with complex phenomena. This body is now regarded as distinctively different from but complementary to that of hard or mechanical (goal-oriented) thinking (Kapra 1997). From a number of systems-based methodologies (treatments) (Ackoff 1981, Mason and Mitroff 1981, Checkland 1981) we also now have ways to diagnose complex problems as “messes” (Ackoff 1981), as well as to infer which of those methodologies could help professionals deal with them (Mingers 2003, Jackson 2003, Jackson and Keys 1984, Midgley 2000, Meadows et al. 1972). These inferences also provide theoretical rigor to the choice of particular systems methodologies to deal with situations. These efforts show that systems thinking—in both academia and practice—has contributed to the work of professionals who claim jurisdiction on complex problems. Among the professions supported by systems thinking we now have OR and management.

In systems thinking, new theories and ideas are being explored, studied, and incorporated. People developing research in systems thinking have made some further inferences to unveil certain regularities, strengths, and weaknesses that systems methodologies could have in practice (Jackson 2003); others look at incorporating ideas of complexity theory into systems thinking (Cabrera et al. 2008). Others apply existing abstractions to project management (Checkland and Winter 2006), information systems (Clarke 2007, Checkland and Holwell 1998, Wilson 1984), and the development of the information society (Córdoba 2009). Additional efforts in the field include short textbooks (Checkland and Poulter 2006, Wilson 2002) that aim to make the use of systems methodologies more accessible to different audiences of students and practitioners. These developments signal important contributions of systems thinking to professions in the public and private sector.

By doing the above, systems thinkers seem to be working on providing new diagnoses, inferences, and treatments, as well as making existing ones more “portable” and to the service of academics, students, and practitioners. Following Abbott (1988), the activities of systems thinkers can have a number of challenges that could also be considered opportunities:

1. making existing developments more accessible to different audiences, and
2. consolidating and extending knowledge of complex situations in other areas of interest.

How we can address these challenges by focusing on making systems thinking education more useful to its different audiences is the focus of this paper. As educators and instructors, we need to continue to facilitate students’ access to and learning of systems thinking based diagnoses, treatments, and inferences whilst enabling them to engage into and learn from other and possibly more “real world” complex situations. In this way these experiences can also help educators to generate new knowledge about systems thinking. Building on my own experience as a systems thinking educator, in the next section I present two modes of teaching systems thinking. These modes bear similarities and differences with other efforts in the field. The presentation also follows my personal journey and the intention is not to provide specific detail of curricula but to focus on key activities and elements that I used to interact with my students in my courses. Following this presentation I reflect on these modes in relation to the above challenges and conclude by suggesting a number of possibilities for the future.

### Two Modes of Systems Thinking Education

In line with Abbott’s ideas, a first mode was that of sustaining jurisdiction over a set of specific problems
(complex, messy) by abstracting and disseminating existing knowledge of systems thinking. Using some previous material from an existing course (Jackson 2003) as well as from my own PhD research, I re-designed and ran a one-term compulsory course of four months, with a weekly three-hour session for students taking a masters’ degree in systems thinking. The degree was administered by the business school of the University of Hull in the UK. Between 2003 and 2006, the emphasis of this course was on the presentation of a number of abstractions in systems thinking: ideas, concepts, and methodologies to help in diagnosis and treatments of messy management situations as well as on further inferences connecting these two (for instance using several methodologies at the same time).

The aim of the course was to encourage students to adopt an alternative way to mechanistic, short-term, or reductionist thinking in dealing with organisational problems. The course began by challenging traditional ways of thinking as being focused on symptoms rather than causes and often generating far from desirable consequences. I presented problems as ill structured ones or messes (sets of interconnected elements) (Ackoff 1981). Students were encouraged to embrace rather than reduce messes and to work on the causes rather than the symptoms of problems. To represent messes I associated systems as sets of connected parts whose interaction could generate something other than individual outputs. Interdependences and interconnections between parts, features of adaptation and holism were declared as systems properties that could be observed in natural or social phenomena.

The course continued by presenting the main tenets of general systems theory (GST) (Von Bertalanffy 1968) followed by practical exercises in which students mapped the properties of systems to different phenomena. Together with students we looked at the history of OR and systems thinking to highlight their common interest in using methods and techniques for systems analysis and systems engineering (Flood and Jackson 1991, Churchman 1970). In this historical exploration, I also showed to students the influence of general systems ideas in society, in particular how organisations can also be conceived of as systems to continuously meet the needs of employees, customers, and other stakeholders and adapting to demands of their markets or regions of operation.

To continue exploring relationships between the idea of a system and organisations, I presented a number of metaphors of organisations as machines, brains, organisms, and cultures (Morgan 1997). These allowed students to understand in more depth how the influence of certain elements (i.e., structure, communication practices, reward systems, collective values, etc.) would impact on the performance of an organisation as a whole. Different forms of organisation (i.e., those based on functional hierarchies, autonomous and networked teams or communities) were compared to metaphors. Students then identified a number of relevant issues in an organisational situation that in their view could be addressed to improve conditions and possibilities for the organisation, its employees, and other stakeholders.

Following up on a historical analysis of systems thinking, I presented a first “turn” in systems thinking that took place when a distinction was made between hard and soft systems thinking, the former focusing on efficiency related goals seeking, the latter on value enquiry, accommodation, and critique (Checkland 1981). This distinction enabled students to see how the idea of a system could be used for different purposes when dealing with complex situations. I then offered a number of systems-based methodologies to students so that they could assess the orientation of these methodologies toward hard or soft goals. Several methodologies were described with their features and composing methods and techniques. Practical exercises to use them on a particular situation (i.e., working to improve a prison system) were set up for students to engage with and experience systems methodology use. Methodologies included soft systems methodology (SSM) (Checkland 1981, Checkland and Poulter 2006), interactive planning (IP) (Ackoff 1981), and strategic assumption surfacing and testing (SAST) (Mason and Mitroff 1981). I presented methodologies as tools to help people make sense of their current and desired situation using systems models and properties in the process of learning about it. During the practical exercises I also offered guidelines on how to build conceptual systems models according to certain criteria of what such models are. For instance conceptual systems models should have a number of human activities to accomplish what is stated in a definition of what the system do. Models should also have ongoing purposes or missions, measures of performance, a decision-taking process, components that are themselves systems and that interact within and outside the bigger systems, and resources (material, people) that are at the disposal of the decision-taking process (Checkland 1981).

Discussions in class about the problems encountered when comparing conceptual models with what happens in real practice led students to identify conflicts of interest or purpose between different actors involved in carrying out the systems activities. For instance a prison can be regarded as a system to punish or to rehabilitate people. Activities and therefore resources required to meet each of these two purposes could be different and often in opposition to each other. I used this and other types of insights to
present students a second “turn” in systems thinking. This turn was characterised by the introduction of critical social theory in the process of enquiry on situations (Mingers 1980, 1984, 1992; Ulrich 1983; Jackson 1985), in order to address more in depth questions related to how to improve a complex situation. This turn was also presented with examples of today’s organisations, many of which have followed traditional managerial practices and that have generated far from desirable consequences like environmental degradation, psychological alienation, feelings of disempowerment, and exclusion in individuals (Alvesson and Willmott 1996, Ackoff 1981).

From a second turn in systems thinking, I presented as an abstraction the inclusion of social theories and sociological paradigms in the enquiry process with the idea that knowledge is not neutral and therefore basic assumptions about different ways of generating it needed careful consideration. I then revisited the main tenets of systems methodologies explored previously and used abstractions from both social theory and systems thinking to assess methodologies’ strengths and weaknesses. In particular I offered the abstractions of classification of social paradigms (Burrell and Morgan 1979) and the system of systems methodologies (SOSM) (Jackson and Keys 1984). Following Abbott’s terminology on professions and as a way of inference in systems thinking, I linked the use of organisational metaphors to the choice of systems methodology to guide action, so that issues that were considered relevant to explore in a messy situation could be tackled with an appropriate methodology according to the methodologies’ strengths and weaknesses (Jackson 2003).

I also presented critically oriented systems-based approaches that in the systems thinking literature make more explicit commitment to the issue of emancipation mentioned previously. These approaches included boundary critique (Churchman 1968, 1970; Ulrich 1983, Midgley 2000) and critical systems heuristics or CSH (Ulrich 1983). I set up a number of practical exercises for students to have another look at situations already explored (i.e., the prison system). These particular approaches encourage people to consider the human values that influence the choice of what is considered relevant to tackle as well as on who is considered a relevant stakeholder in the enquiry process. Reflection on values and how they affect the choice of boundaries of the “system” under study was proposed to students to complement their choices of systems methodologies to address a particular situation.

In the final part of the course, I presented further developments on exploring the philosophical assumptions of systems methodologies (Mingers 2003) as well as extensions of current inferences to facilitate choice to multimethodology (Mingers and Brocklesby 1996, Jackson 1999). I also looked at applications of systems thinking in areas like the information society (Córdoba 2002), which also suggest new avenues of exploration in systems thinking research and practice.

Formative course assessment included student groups exploring a situation with the use of organisational metaphors and presenting their choice and use of methodologies to address issues that they considered relevant. Feedback was given to guide students on the core principles and tenets of methodologies as well as frameworks of choice so that their inferences about diagnosing a situation and prescribing a course of action (treatment) with a methodology could be improved. This type of formative assessment linked to a final summative course assessment, which consisted of an individual assignment and/or exam in which students were to justify and document their choices of exploring a situation with a number of metaphors and using a systems methodology to tackle it. The assignment required students reporting on their choices and on their insights about a methodology’s strengths and weaknesses in practice.

A summary of the features of this mode of education is presented in Table 1.

### From Abstracting to Engaging

The above abstracting mode of systems thinking education enabled students to appreciate different systems ideas and methodologies to help them deal with complex situations. Key abstractions came from developments in both systems thinking and social theory. Dissemination of these abstractions has become popular and integrated in curricula in management departments and systems thinking research centres. This has contributed to create more “portable” and “simple to use” versions of systems thinking education, which in turn, have contributed

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<tr>
<th>Area of jurisdiction</th>
<th>Complex problems and decision making</th>
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<td>Key course elements</td>
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<td>• Reductionist thinking</td>
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<td>• Systems concepts</td>
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<td>• Social theories</td>
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<td>• Metaphors</td>
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<td>• Hard, soft, critical systems thinking approach</td>
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<td>• Systems methodologies</td>
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<td>• Frameworks for methodology use</td>
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<td>• The future of systems thinking</td>
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<tr>
<td>Course assessment</td>
<td>Formative: feedback on group work related to a choice of issues in a situation and systems methodology use to tackle them.</td>
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<td>Summative: individual assignment and/or exam to show competence in the choice and use of methodologies; reflections on strengths and weaknesses of methodologies.</td>
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**Table 1** The Abstracting Mode of Systems Thinking Education
to make it more relevant in traditional business and management oriented subjects. An example of how systems thinking has spread in these subject is Fry’s 2008 development of MBA courses, where problem solving techniques inspired by systems ideas are used to engage students in supply chain management problems.

In my own educational setting though, external changes shifted the focus of management education to the practical relevance of what was being taught. In the last few years a high degree of importance has been conceded to collaborative work with professionals in industry, giving students more opportunities to engage in “real” learning situations (Tushman et al. 2007, Bartunek 2007, Mintzberg 2004). With new demands and pressures, my course on systems thinking became noncompulsory and reduced in hours (from three to two per week). I had to transform it in order to make it more appealing to different areas of management education as well as other academic departments. For me, as an educator, the situation generated a wake up call and an opportunity. Speaking about the need for continuous revision of academic knowledge, Abbott says (1988, pp. 51–52)

…either too little or too much use of inference [in professions] will ultimately weaken jurisdiction…a profession that is purely esoteric has trouble demonstrating the cultural legitimacy basis for that [attributed] efficacy. (Brackets and italics added.)

Looking at alternative ways of delivering our systems thinking course, I became conscious of the importance of the surroundings or contexts in which management students (including those interested in systems thinking) were being immersed (Kay and Foster 1999) as well as of improving my own understanding of how the existing abstractions that linked complex problem diagnoses with systems methodology choice were effectively used in practice (Keys 2006). According to Bawden (2005), the presentation of systems methodologies and associated abstractions in systems education can become a mere tick in the box to be fulfilled by both instructors and students within existing educational settings. Lots of content can be transmitted without generating any significant impact in students’ awareness of the potentialities of thinking beyond and outside the box. Students could miss the opportunity to become part of wider systems of concern, in particular those systems belonging to their immediate and geographical context of learning. Educators could also miss the chance to use that engagement to transform educational systems and practices, many of which are out of date and in need of demonstrating how they can really help addressing societal problems (Banathy 1992).

It became important for me as an educator to facilitate students’ engagement in action with problems of their own context, and to learn from their and my experience in the process. In the domain of PSMs, Keys (2006) raises the importance of enabling students to develop expertise by tackling problems outside their comfort zones and learning from others who are more experienced. People should be allowed to use their own PSMs and techniques in conjunction with official methodologies, to change their (system) models as they see fit and to go beyond textbook descriptions, in other words to try things for themselves. Students could also learn from experts’ experiences about dealing with tough or atypical systems interventions in the field as well as the choices that were made throughout. Keys also suggests that reflection and self-reflection opportunities are to be offered in the process: “if novice users are to learn more than simply how to apply existing PSMs, if they are to become genuinely expert, they also have to learn a basis for reflection and self-development” (2006, p. 828).

The Engaging Mode of Systems Thinking Education

The above and other insights provided me with ideas to shift from an abstracting to an engaging and collaborative mode of systems thinking education. I first considered that this mode should enable students to generate knowledge to be relevant to a particular context of application (Nowotny et al. 2003). Instead of a body of knowledge with its own identity (and in continuous claim to jurisdiction to complex problems) as previously proposed, in an engaging mode of education systems thinking was now to be presented as a strategy for learning about relevant areas. These areas included sustainability, project management, or corporate social responsibility.

As described previously (Córdoba and Farquharson 2008, Córdoba and Campbell 2008, Porter and Córdoba 2009), an engaging type of educational course on systems thinking followed a similar structure/content to the previous one. However emphasis on presenting abstractions and linking them to gaining systems methodological competence was shifted to the process of engagement itself. Engagement was put forward to students as a systemic effort that involved students’ continuous interaction with their immediate environment(s). A focus on engagement required in some cases renaming the course to more appealing names including business ethics, (complex) decision making, or complex project management with systems thinking. Because of the nature of some new audiences we also had to shorten the course content so as to tailor it to them (researchers, practitioners, or other groups of management students).

In the new instances of delivery we emphasised the importance of thinking outside the box and of doing
something about a situation that was considered as relevant and complex (messy). In some cases I helped students to define the situation they wanted to tackle. Situations included

- the sustainability of a city, including the city where their university was based;
- an imminent change situation (a merge between organisations, a legally bound change or reform), or a situation after a change (for example the post-apartheid period in South Africa);
- businesses relocating to other countries;
- project failures; and
- information systems failures.

During the course, I used ideas on general systems theory to conceive of student groups as systems (Córdoba and Piki 2012). I emphasised that a group could be considered as a system whose interacting parts (students) could also generate synergies. For their projects, students were assembled in teams of no more than four. In each group I ensured that there was a diversity of individual profiles according to the results of questionnaires administered to each student in order to assess their preferences and orientations when working in teams as proposed by Belbin (1981, 1996). Conceiving of groups as systems enabled us to get students’ attention to how their traditional modes of thinking and working together could be contributing to experiencing failures when dealing with complex situations. It was necessary for students to continuously reflect on how they were communicating and interacting with each other as well as with the rest of the cohort, how they were responding to feedback, and how they were using their individual and group related skills to meet the requirements of the course (Córdoba and Piki 2012).

As Kay and Foster (1999) argue, “the successful practice of systems thinking requires knowledge at both the systems level and the discipline level” (p. 171), so that students are able to synthesise knowledge from both levels. In our attempt to implement this insight and for certain topics (project management, information systems design), the content of lectures included basic knowledge on project management, “good” computer systems design (with principles of feedback, adequate mapping of actions in the real world with actions on the screen, and coordination) (Norman 1999, Winograd and Flores 1987) and approaches to facilitate participative information systems design using systems thinking (Wilson 2002). For other topics though, we found it challenging to offer both systems thinking and topic-specific content. In this case for example, we invited a guest lecturer to give us some basic insights on sustainability.

Alongside presenting the basic tenets of one or two systems methodologies (chosen by us according to our level of expertise) in lectures we set up two other types of activity. First, we used the guidelines of the World Cafe’ approach (World Cafe’ 2010). This exercise allows people to converse about relevant questions (defined previously by a “host” or tutor in this case), whilst at the same time contributing to generating new ideas on how to address them. People could then travel through different groups by contributing to and getting ideas from them. Out of the emerging conversations during this exercise and together with students we identified a number of questions and themes to be addressed later. Second, we had informal conversations with students outside class and through business meetings (15-minute meetings with each group in which they mapped issues and connections among them). Using these activities I collected students’ ideas, comments, and connections between them in order to build a picture of the mess we were all getting in (see Figure 1). This picture had some relation, but it was not drawn by following the guidelines of a rich picture of SSM (Checkland 1981). Together with students I drew connections between existing issues and actions to tackle them. Students could also visit the room where the picture was being drawn at any time to comment on or add things to it.

After a few weeks from the start of group projects, I presented the picture back to the cohort of students in class. We continued the discussion in order to add or talk about connections between the picture elements. The aim of this was twofold: to convey the messiness of the situation, and to highlight the importance of an effort by all members of the cohort to better understand and if possible deal locally with the complexity of the topic of sustainability.

Regarding sustainability I brought forth a perspective of a city as a system using the work of Ravetz (2002) in order to help students make connections between issues, policies, and actions, so that they could think of potential impacts of addressing some of them in both mechanistic or systemic (integrated, interdependent) ways. With the help of local council websites, student groups then chose to investigate two particular areas of city management in which a city of their choice was doing something about its sustainability. In their group projects students had to build a “system of concern” composed by at least two themes being addressed by local government policies or plans for action. They were encouraged to consider two related themes and whose systemic management could then contribute to sustainability (economic, social, environmental) (UNCED 1992). As reported in most UK cities’ government websites, we found that these themes ranged from transportation to education, from community and health to safety, from children to the elderly, or from wildlife and ecosystems preservation to economic development. Using these websites, students could then venture.
to learn about specific themes and make connections between themes and possible actions to address them. For their choice of issues to tackle, students needed to get empirical evidence to support their claims about themes and connections. Evidence included but was not limited to statistics, Web-based documents or first hand information obtained from speaking to government, citizen, and company representatives.

Once the basic tenets of some systems methodologies were covered, I lectured on systems multi-methodology and methodological pluralism. As the focus of the course was on enabling students to engage with each other and with a situation at hand, I stressed the possibility of combining methodologies in a whole system of enquiry (Midgley 1997, Mingers 2003). I also set up practical exercises in which I helped students to build messes, rich pictures, conceptual models, and future scenarios with information about the situations of their choice. I did not explicitly focus on ensuring rigor in building systems models or in using several methodologies at the same time. Rather, my concern was that of stressing the message that systems-based methodologies, methods, and techniques should be assembled to address questions that were emerging from what students perceived as being relevant in their situations (Midgley 1997).

In my new course on systems thinking, formative assessment continued in the form of group-based presentations to the whole cohort of students. Presentations helped groups to report on progress as well as to receive feedback. Groups could also use systems tools (e.g., pictures, models) to better convey their understanding of situations to themselves and to others and to communicate and negotiate with stakeholders (Collins and Kearins 2004). As Bradbury (2003) and Reason (2007) suggest, students can also use these or other methods to enliven their own personal diaries of engagement, their reflections, and insights on the engagement process. If these reflections showed an explicit interest by students to get to the bottom of issues, or deal with politics in a situation, I directed them to explore in more detail critical perspectives to manage organisations (Willmott 1997). I also encouraged students to try to identify institutional constraints or specific ways of working for different actors involved that could make it challenging to produce comprehensive and actionable plans for improvement. In defining these plans students could also bear in mind the cultural feasibility and the systemic desirability of any possible action (Checkland 1981).

Feedback in presentations or business meetings included me pushing student groups to their edge of chaos if I considered that they were following working patterns that, in my view, were far from desirable (i.e., getting into dead ends, individuals not speaking to each other) (Murray 2003). The idea was to encourage students to engage with each other and with the situation at hand. This proved helpful for groups and enabled them to move forward in their exploratory...
and problem solving tasks. Again, I used the idea of a group as a system in continuous adaptation in order to facilitate students’ understanding of their own role and contributions to their group outcomes as well as to those of the entire cohort.

In later versions of this course, I encouraged further reflection with the use of electronic blogs and videos,¹ which I found useful to allow students to communicate in different ways, and to explore together their understandings and perspectives of systems thinking (Churchman 1974). Both types of resources allowed students to express themselves in a different way; in this regard we found the insights of Leeds and Maurer (2009) useful in relation to the use of digital technologies in business education. They argue that these technologies allow students to better prepare and structure their communications and use alternative means to do so. I found that blogs helped overseas students to take away the pressure from peers. Blogs also allowed instructors to provide immediate feedback on the content of students’ ideas and also on their (English) writing capabilities.

If required, summative assessment of the course focused on students’ reflective and individual attempts to balance theoretical, methodological, and practical insights coming from their group-based activity. I asked students to write a comprehensive individual report of their engagement with the chosen situation and topics, their use of methodologies, and their group experience. I assessed the degree of richness and depth with which a situation was described in terms of issues and connections; the justification for the choice of a systems methodology (it could be a combination of existing ones); insights coming from its use; and the reflections about students as individuals, group members, and future managers who could be facing similar situations in the future.

A summary of the engaging mode of systems thinking education is presented in Table 2.

Reflections
I now reflect on key insights from our experiences on the two modes of systems thinking education that we have presented. I also reflect on how their improvement could improve OR education in general.

¹ A practical experience in one of our systems thinking courses involved students in preparing a small play based on Churchman’s Perspectives of the Systems Approach (1974). A student acted as the presenter and introduced the play, followed by the paper dialogue by other students. I videoed the play and provided an introduction and conclusion to the video, which was posted in YouTube³ for all students to see and share with their friends and colleagues. Most students found this a very useful and playful experience. We could also assess students’ understanding of systems thinking as a vehicle to enable debate and definition of problems.

<table>
<thead>
<tr>
<th>Area of jurisdiction</th>
<th>Relevant complex problems for the audience (e.g., sustainability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key course elements</td>
<td>• Specific topic (e.g., sustainability, project failures, skills development)</td>
</tr>
<tr>
<td></td>
<td>• Student groups as “systems” and group projects to engage with “real” (complex) situations.</td>
</tr>
<tr>
<td></td>
<td>• Optional: Hard, soft, critical systems thinking approach</td>
</tr>
<tr>
<td></td>
<td>• One or two systems methodologies (e.g., soft systems methodology, interactive planning, critical systems heuristics)</td>
</tr>
<tr>
<td></td>
<td>• Practitioners lecture(s)</td>
</tr>
<tr>
<td></td>
<td>• Optional: use of videos and blogs</td>
</tr>
<tr>
<td>Course assessment</td>
<td>Formative: business meetings, informal talks, the “World Café” exercise, group presentations to narrate their engagement with situations. Summative (when required): individual and reflective report on process of engagement with a set of problems to be studied and intervened; improvements to a situation using systems methodologies; reflections on own role in the engagement process (individually and in groups).</td>
</tr>
</tbody>
</table>

In my view, the **abstracting** mode of systems thinking education has been an appropriate response to requirements of students and the professions they aspire to (management, technology, OR). With my initial course I have provided a way of facilitating dissemination of existing knowledge in systems thinking through a number of concepts, methodologies, and inferences. I believe this contributes to improve the ability of operational researchers and managers to deal with complex situations and thus to make systems thinking education relevant to these groups.

Students’ feedback from courses in the abstracting mode indicates that they appreciate the “nontraditional” side of things, to know that there are alternatives to mechanistic thinking, and to develop a perspective on what the future may hold for them. These insights lead me to conclude that there is a solid base from which systems thinking education can develop further. With this solid base, we have been able to incorporate new abstractions coming from our own research and that of others, for instance new approaches to help planning information systems (Córdoba and Midgley 2006).

In the abstracting mode, students’ feedback also suggests that they sometimes find it difficult to digest all abstractions that have been conveyed to them: the notion of system, its properties, methodologies, improvement, commitments, emancipation, and the like. This difficulty reinforced my concern about how to make systems thinking education more relevant and engaging, which required greater selectivity in the knowledge elements that we use in our courses.
As an alternative, the *engaging* mode has allowed students and educators to explore new areas in meaningful ways. This mode has enabled me to make systems thinking abstractions more useful to students, so they could use them more easily in practice so they can understand more clearly the insights that these abstractions could yield. I believe this has also contributed to a feeling of empowerment in students so they could go “out there” and try things for themselves. Their experience in group projects has also allowed them to better understand how to work more effectively with each other and to identify difficulties in communication, division of tasks, and in motivating themselves and others. By working on real situations, students cold see more clearly how culture, social norms, politics, diversity of viewpoints, and work ethics influence how change is defined and implemented in and across organisations.

However, when it comes to structuring proposals for improving situations, I have encountered a similar challenge to that of Fry (2008) when he says: “It appears that students are more fearful of offering a suggestion [for improvement] that could be proven wrong than offering no specific recommendations at all” (p. 71, brackets added). As an educator, what I have considered an opportunity to gain and apply knowledge in both systems thinking and a particular area (i.e., sustainability) seems to be viewed as an insurmountable challenge by some students. With deadlines for group presentations and individual reports approaching, many students decided to resort to me for guidance about the right problems and the right systems methodology (or set of methods) to deal with them. Only in a few cases have I seen that students have become confident enough to make and justify their own decisions regarding these aspects.

This insight leads me to review the strategy to involve students in both modes of education and to consider the importance of structuring our courses to offer clear and adequate levels of knowledge and expertise. In line with the suggestions of Kay and Foster (1999) and Keys (2006) and using the insights obtained so far, I now put forward two different levels in each mode of education: novice and expert levels.

An expert level of *engaging* should encourage students to push their own boundaries about the problems they define, the judgements they make in the process of enquiry, and the right systems methodology (or set of methods) to deal with them. Only in a few cases have I seen that students have become confident enough to make and justify their own decisions regarding these aspects.

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A *novice* level of *abstracting* mode would offer students a basic degree of knowledge on systems (possibly by showing systems models and guidance to build them), their properties, and applications in certain areas. The stock of knowledge in areas like the learning organisation (Senge 1999), limits to growth (Meadows et al. 1972), and supply chain management (Fry 2008) could be used to convey the main properties of systems and to get students’ initial attention and interest (Kay and Foster 1999). A *novice* level of *engaging* could follow from this and would seek to provide some degree of experiential learning in these or other areas, possibly with the use of a systems methodology or model and with a short period of time for reflection and application.

At an *expert* level of *abstracting*, students can progress to reasoning about and applying more sophisticated abstractions (for instance multimethodology), and/or reflecting on how they initially engaged into tackling real situations. In an *expert* level of *engaging*, students could pursue a more independent agenda, which could include defining their own problems of interest, gaining discipline-based knowledge (with the help of discipline experts), and being mentored in their processes of engagement that could involve systems methodologies. Mentoring activities could also help students to appreciate the role of individual decisions through their process of enquiry. An expert level of engagement should encourage students to push their own boundaries about the problems they define, the judgements they make in the process of tackling them, and the methodologies they use (Keys 2006).

Between these levels and modes of teaching I also see it as important to enable their continuous interaction. As new modes of engaging are developed at an *expert* level, new abstractions or methodologies for learning can inform novice experiences and strategies. Conversely, if education at a *novice* level attracts the interest of different audiences then those willing to become experts can be gradually supported in their transition to more complex forms of abstracting and engaging. Like educators who aim to progress in our understanding and use of systems thinking, so could those who consider themselves novices contribute to make systems thinking education more accessible and visible.

As I see it, these insights could also inform educational developments in OR. Both forms of abstracting and engaging could be used in other areas including hard OR and at different levels. As this is a proposal that needs further refinement and integration into relevant courses, I see that the door is open to continue.
developing new connections between these and other modes of systems thinking education, and to make it more relevant, useful, and accessible to a variety of audiences. I hope that this paper has made a valuable contribution to consolidate existing efforts in education and to advance them for the benefit of systems thinking and OR in general.

Conclusion
In this paper I have provide a context and discussion for two modes of education in systems thinking: (1) abstracting and (2) engaging. In defining these modes I have considered how systems thinking as a body of knowledge has elements of diagnosing, treating, and inferring on complex problems and thus serving several professions including OR. Both modes offer key elements of learning that I have found useful in helping students to appreciate and deal with such problems and situations.

A mode of abstracting emphasizes the presentation of ways of viewing complex problems as messes and reasons how systems methodologies can help in tackling them. A mode of engaging facilitates putting into practice some of these abstract elements and uses the idea of student groups as systems to support their engagement with their immediate contexts. My insights from reflecting on the use of these two modes lead me to appreciate how systems thinking can offer its available knowledge whilst helping our students and ourselves to deal with relevant issues in their and our lives. Together with students we have gained key insights on how education in these modes has generated possibilities and challenges. As a result, I have also proposed levels (novice, expert) within each mode to improve support to students.

My belief is that our task as educators is now to motivate students to learn more about systems thinking, and with this to become more independent and responsible learners. As I see it this task can continue by further developing strategies to support students’ transitions between these modes of education. Further research on how to make systems thinking more relevant, useful, and interesting to different audiences and professional communities is needed.

References