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Understanding the environment: a systems approach

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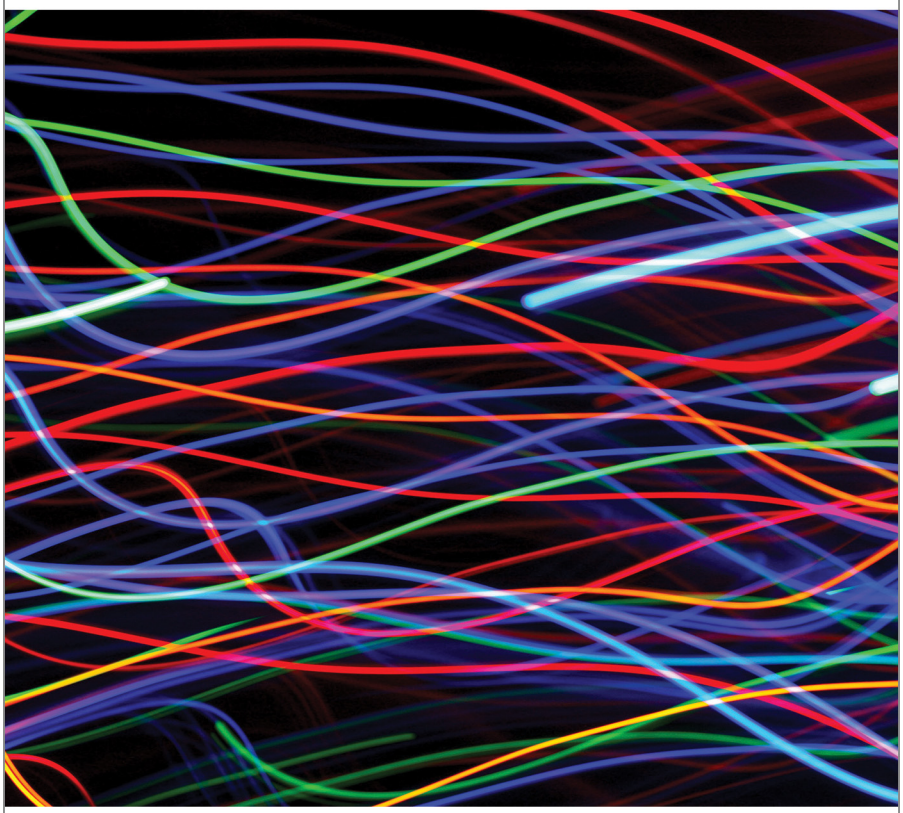

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About this free course

This free course provides a sample of level 2 study in Environment & Development
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Head of Intellectual Property, The Open University
Designed and edited by The Open University

Contents

Introduction to the 'systems' theme

Systems, such as the internet and ecosystems, are characterised by a set of components interacting to produce a common outcome. A system will usually persist over time if the emergent outcomes (the overall pattern that emerges from the interactions of the system's components) are beneficial to its components. Crucially, a system also has to maintain the integrity of the greater systems within which it is nested. However, this is not always the case, and some systems display behaviour that undermines their long-term viability. This course will allow you to develop knowledge and skills in exploring and understanding complex and dynamic systems, with a focus on natural systems and how humanity can live within these sustainably and equitably

In this free course, you will be presented with a range of 'wicked' challenges facing human society at the moment, including climate change and peak oil (I will explain my use of the term 'wicked' in Section 2.4 below). Your task will be to explore the systemic nature of these challenges using the action learning approach outlined below. You might already have some strong ideas about what 'causes' these issues, but, as you engage with this course, you will be encouraged to cast your net wider and explore the multiple interconnections between a range of issues, including resource consumption, population growth, pollution, poverty, and loss of biodiversity. You will also have the opportunity to consider how these interact with different levels of social organisation, from personal behaviour to global governance. The contention of this course is that the major challenges bearing down on natural systems (including the social systems nested within them) can only be constructively tackled once we begin to see the bigger picture.

So, your task within this course is to acquire the skills, techniques and concepts to 'see' complex issues using a range of systemic models and develop these through a process of collaborative learning. This course is all about building your capacity to understand complex situations using systems thinking and practice. If you are in any doubt about the purpose of each section, I would encourage you to review the section's aims and learning outcomes (described at the beginning and end of each section respectively). Overall this course will explicitly aim to deliver the following range of learning outcomes.

This OpenLearn course provides a sample of level 2 study in Environment & Development

Learning Outcomes

After studying this course, you should be able to:

- implement an action learning framework for exploring complex situations
- recognise that the way we engage with the world is through partial models of reality, and that these models are limited by different cognitive styles and ‘thinking traps’
- understand the need to collaboratively incorporate a blend of cognitive styles and multiple intelligences as the basis for effective systems practice and thinking
- appreciate how different modes of communication (verbal, visual and mathematical) affect the way we represent our mental models
- develop verbal, visual and mathematical models that explore both social and natural impacts, and reflect on the use of such models to inform thoughts and actions.

1 This course's fundamental concepts: feedback, models and learning

In the following paragraphs I will present the fundamental concepts that underpin this course. Don't worry if many of the terms are unfamiliar to you – the purpose of this section is mainly to give you a synthesis of what is to come. This section is therefore a reference point to which all of the various resources and activities presented in this course connect.

1.1 Feedback

A central concept of systems thinking is 'mutual causality': that A gives rise to B and, in turn, B gives rise to A. You cannot have one without the other. In the crudest of examples, we eat the environment and we are eaten by it. A and B are an indivisible whole and the dynamics of each cannot be understood in isolation.

There are two basic dynamic relationships between A and B in a system, although actual behaviour can be a complex combination of the two: (i) positive feedback, i.e. when a change in one results in a similar change in the other; and (ii) negative feedback, i.e. when a change in one results in an opposite change in the other.

You can see positive feedback in many common human interactions. For example, an argument can rapidly escalate when A reacts badly to B, who likewise reacts in the same way to A, and so on in a worsening spiral. Negative feedback is when A's violent reaction is dampened by B's conciliatory response. It's a little confusing in this context that positive feedback can be a negative thing and vice-versa, but when it comes to feedback in systems, 'positive' and 'negative' refer to patterns of dynamic change rather than value judgements.

1.2 Intuition and visual modelling

One of the techniques on which I focus early in the course is working with intuition. There is a limit to our ability to keep track of systemic relationships, especially when they are dynamic and therefore change unpredictably over time. Most people quickly develop a feeling of being overwhelmed when trying to analyse increasing amounts of detail pertaining to a complex situation. But humans have a subconscious way of processing this complexity through intuition, which draws more strongly on some of the non-verbal modes of intelligence we have available to us. In other words, we can constructively engage with complexity without having to consciously reason through it. Instead, we need to learn to use a range of techniques which allow us to subconsciously integrate a vast range of potential relationships in order to identify the key feedback processes in operation within a complex situation. Unfortunately, our modern society's emphasis on rational and mechanical interpretations have downplayed this wonderful intuitive ability to integrate and process complexity. Systems thinking reinstates intuition as a significant skill in understanding complexity through, for example, the use of visual modelling. Thus,

the first two sections of this course will focus on the essential task of building up your intuitive skills and visual modes of modelling and communicating.

1.3 Analysis and mathematical modelling

Like the Chinese philosophy of Yin and Yang, the opposing practices of intuition and analysis can actually complement each other when exploring complex situations, but only if used within an appropriate framework. The initial exploratory phase of engagement with complexity does indeed benefit from an intuitive approach. However, once feedback relationships have been identified that present a plausible explanation for the behaviour of a complex system, it is often useful to 'test' some of these relationships with a more quantitative and analytical approach. The second half of this course will therefore focus on a particular technique, system dynamics modelling, which builds bridges between visual, verbal and mathematical representations of complexity. This course does not require any mathematical prerequisites and you will be introduced to the unpredictable behaviour of systems through a graphical representation of extremely simple mathematical simulations.

1.4 Action learning

Many complex situations we face today are 'wicked'. This term not only has a colloquial meaning, but is also used to capture the particular characteristics of many complex situations. A wicked problem is characterised by an issue that manifests itself only as you try to engage and change it, and in doing so, the problem in turn changes: there is no definite solution that you could aim at; no case history to draw upon; no obviously right or wrong approach to take; and there is no way to anticipate the full consequences of your actions. The best way to tackle a wicked problem is to constantly learn about the changing situation and adapt one's goals, plans and actions accordingly. 'Learning by doing', or action learning, has therefore been the response to dealing with the complex and unpredictable nature of wicked problems.

Action learning is essentially a process that uses positive and negative feedback to either reinforce or change our mental models. The concept of learning as a feedback process is actually a very simple one: we identify a goal we wish to achieve, we develop plans in order to achieve the goal; we act according to those plans; we observe the outcome of our actions and evaluate these against our original goal. If the observations match our intended goal, then our mental models determining future behaviour are reinforced; if the observations don't, then we change our mental models in a way that we hope would make better plans and actions in the future. Most 'scientific' problem-solving approaches propose templates which need to be 'repeatable' in different contexts. However, wicked problems are rarely solved by these standard templates. The best that we can hope for is to apply an action learning process, while at the same time making sure that we record the steps that we have taken so that others can understand our thoughts and behaviours. To ease your engagement with this process (and the recording task which I would like you to put into practice during your engagement with the complex situations presented in this course), I have broken the action learning process down into four distinct phases: planning; acting; observing; and evaluating.

1.4.1 Planning

This involves identifying and clarifying your objective, and developing a plan of action to achieve whichever objective you have set yourself. The plan should clearly state the objectives (Why am I doing this?), expected outputs (What do I want to get as a result?), activities (How am I going to do it and when?), measures of progress and success (How do I know I have done it?), assumptions (What do I need in order to do it?), and responsibilities (Who is going to help me do it?). An objective does not have to necessarily result in a final product, but can also be the successful execution of a process, or establishing a situation which can then continue. As an example, imagine a toy train – an objective could be either to 'arrive at the station', or 'to be running continuously around the track'. There is the risk that sometimes people will associate the word 'objective' with its etymological root 'object' and imagine that goals/objectives have to be fixed situations or results. Achieving a specified process is also a valid objective.

1.4.2 Acting

As opposed to the planning phase, which is essentially a modelling exercise where you develop a goal, outline steps to take, and predict the outcomes, the acting phase is where you actually go and do something that has the potential to change the situation towards achieving your objective. 'Action' can easily be confused with other phases of the learning cycle. For example, don't we do something when we are developing a plan? Action is ultimately about attempting to make a real improvement in the complex situation and/or in the way you perceive the complex situation – and it should be measured in terms of having produced some change in the complex situation and/or in yourself that was not demonstrably there before.

1.4.3 Observing

This phase focuses on the collection and recording of information that will tell you about the impacts of your action. Although the constraints of verbal communication mean that this phase of the action learning has to be presented after the 'acting' phase, it is in fact a step that occurs at the same time (indeed, any phase can be carried out simultaneously, but I would recommend that when communicating your action learning to others, it is crucial that you divide the process into these distinct steps). In this observation phase, you need to monitor how the complex situation, or the way you perceive it, changed as a result of your action. Of course it is impossible to collect data on all potential measures of performance, especially in situations where your resources are limiting and logistics are difficult. This task will primarily depend on the 'model' of the situation and the resulting actions that you developed during your planning phase. In other words, the predictions (models) you made during the planning phase, of the impacts you will have during your actions, will have determined which data you will observe. However, especially in complex situations, it pays to keep an open mind on unexpected consequences of your actions – things that you did not foresee would happen. Our preconceived expectations sometimes make us blind to unforeseen consequences. The observation phase also includes observing yourself carrying out the plan (you might find that while the desired objective appears to occur, the end does not justify the means) – and you can observe not just the logical 'result' of the situation but also your reactions to it, or the reactions of others.

1.4.4 Evaluating

Evaluation is about using monitoring and other information collected to make judgements about whether your goal and associated plan was achieved or not. In other words, you will need to compare your original prediction of what you were going to do and what your final result would be with what actually happened. This should automatically feed into the next iteration of the learning process; providing evaluations which will feed into changes and improvements to the overall process i.e. the new plan might include a different, more realistic, goal, and/or different approaches for acting, observing and the next round of evaluation. While the evaluating phase often happens to be the final stage of the learning process, it is of most value as a springboard to subsequent iterations through the learning process. It is at this stage that a decision is made on whether the successful implementation of the first iteration through the learning process will require a more convergent and analytical approach, or whether inconclusive progress will still necessitate a predominantly divergent and intuitive approach.

From this point onwards, I would expect you to try and implement the action learning process as you engage with this course. Although many of the activities within this course will not explicitly ask you to use the action learning process outlined above as a guiding framework, I would recommend that you practise using this rather formal expression of the process even when I do not remind you to use it. There are rarely simple and repeatable solutions to understanding complexity – this course proposes that using and communicating your own action learning approach is the only realistic course of action.

1.5 'Many hands make light work'

The action learning process I've just described is not, in itself, very helpful if it is applied at only the personal level). Indeed, this has been the great tragedy of reductionist science to date, in that its rigid application, through increasing specialisation and isolation of people, has often resulted in simplistic (and sometimes incorrect) explanations of complex cause and effect relationships. Such simplistic explanations have often underplayed apparently contrasting ideas and evidence, when in fact their inclusion within a developing theory would contribute towards a more realistic and nuanced understanding. Within this course you will encounter a range of thinking traps, but probably the two most insidious are 'superstitious learning' and 'groupthink'. For example, just after the Second World War, the American psychologist Burrhus Skinner published research on pigeons demonstrating that the animals soon developed behavioural rituals before being fed – the pigeons apparently associated what were random behaviours with the appearance of food, so quickly 'learnt' that certain behaviours would 'result' in rewards. Although the research is still contested, it is a great reminder of the dangers in making simplistic associations between causes and effects in isolation from other perspectives, especially when there are a range of feedback relationships in operation and potential delays between causes and effects. Things become even more dangerous when superstitious learning is reinforced by groupthink, where individuals go along with the opinion of dominant individuals within a group – a trait we have evolved as social animals in order to maintain group cohesiveness – when, once again, appreciating a greater diversity of perspectives may provide a more comprehensive understanding of a complex situation. In this case, the problem lies in the uncritical faith in authoritative and trustworthy individuals and their simplistic associations.

One could therefore argue that one of the principal reasons for the rapid adaptability of the human species is not down to individual learning, but the ability to learn socially. As members of a social species, we can compare and contrast our learning with that of others, and do this across a range of disciplines and scales: organisational (individuals to groups to communities to cultures to humanity as a whole); over time (short- to long-term causes and effects); and over space (local to global). It is therefore imperative not to leave the 'learning' to a small subset of specialised professionals or to trust the dominant opinion, especially if these arise out of an educational system which prevents people from critically engaging with issues across a range of disciplines and scales. I would therefore strongly encourage you to work collaboratively throughout the learning experiences in this course.

2 How to study this course

2.1 Study time

This is a series of six OpenLearn course. This is the order in which they should be studied:

1. *Understanding the environment: Thinking styles and models*
2. *Understanding the environment: Learning and communication*
3. *Understanding the environment: Problems with the way we think*
4. *Understanding the environment: Flows and feedback*
5. *Understanding the environment: Complexity and chaos*
6. *Understanding the environment: Co-evolution*

You will need approximately 16 hours of study per week in order to complete each course (this is only a rough guide – you may find that your study time varies slightly from these durations). At the beginning of each course, there are recommendations about how you should divide your time between readings, doing the activities and participating in any discussions. Engagement, in discussions, whether face-to-face or online, is very important for achieving the learning outcomes of this course, and is therefore included in the time earmarked for study.

2.2 Course study components

In order to achieve its aims, this course relies on several fundamental learning components, each with a distinct purpose but all mutually interacting to deliver the learning outcomes for the course. The components are:

1. the course study guide (which you are currently reading);
2. the activities;
3. the readings;
4. the Diagramming Resource.

My aim here is to illustrate how these components relate to each other in this particular course.

The simplest component is this course's Study Guide which you are reading! This guide serves as a link between Blocks 1 and 2; introduces you to the course theme; and is designed to inform you of the learning opportunities you will have while studying this course.

2.2.1 Activities

This course engages you in the action learning process through carrying out substantial activities. The activities are divided into six sections according to the themes established in the readings. Each activity section provides a guide on how to engage with the various exercises and builds on the material in the readings and Diagramming Resource.

If you are lucky enough to have developed an active reading style where you create a mental dialogue with the written text (i.e. stopping every so often to question the content through correspondence with personal experience) then reading may be an appropriate learning technique. On the other hand, it is recognised that, for a lot of people, reading large volumes of text does not actually result in much learning:

> Most people's eyes glaze over if you talk to them about 'learning' or 'learning organisations.' Little wonder – for, in everyday use, learning has come to be synonymous with 'taking in information.' 'Yes, I learned all about that at the course yesterday.' Yet, taking in information is only distantly related to real learning. It would be nonsensical to say, 'I just read a great book about bicycle riding – I've now learned that
>
> Senge, 1990)

In order to engender 'real learning', there is a major emphasis on you carrying out substantial activities in this course. The idea is to encourage you to do lots of practical things that involve your own personal experiences, and to provide you with a space to keep a record of your learning and experience. You will be encouraged to develop your ability to develop plans of action, put these into practice and, finally, observe and evaluate the impact of your actions.

Each online study section will present you with a major challenge that you will need to explore. The learning aims of each section establish your study goals and the outline summarises the range of activities, readings and tools that you will be engaging with in order to address the challenge. You are strongly encouraged to keep a record of your learning experiences as you work through the activities, in your learning journal.

2.2.2 Readings

The readings are a collection of 35 essays which significantly expand on the systems concepts introduced in this study guide. The essays are divided according to six themes: thinking styles and models; learning and communication; problems with the way we think; flows and feedback; complexity and chaos; and co-evolution. Each essay focuses on several related concepts which are listed as keywords at the beginning and highlighted within the text. You will need to become familiar with these concepts when you engage with the activities.

In general, I have tried to flag which readings need to be read before engaging with each of the online activities, but you might well find that you need to revisit bits of text as you engage with each activity. My ambition is to give you as much flexibility as possible to direct your own study within the course. So I see no harm in you reading some of the essays some time before you need to engage with the associated activities.

2.2.3 Diagramming Resource

This resource is provided elsewhere on OpenLearn as an online reference for the diagramming work that you will undertake during your study of this course. If you have the time, feel free to read the resource from start to finish. However, this course will only require you to be familiar with a few diagramming techniques, such as rich pictures, multiple cause diagrams and sign graphs.

Conclusion

This free course provided an introduction to studying Environment & Development. It took you through a series of exercises designed to develop your approach to study and learning at a distance, and helped to improve your confidence as an independent learner.

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Acknowledgements

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