DESIGNING INTERDISCIPLINARY EDUCATION

a practical handbook <mark>f</mark>or university teachers

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Amsterdam University Press Designing Interdisciplinary Education

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How do you define interdisciplinarity? What is a good interdisciplinary programme design? How do you assess whether a student has integrated insights from more than one discipline? How do you challenge students to step across disciplinary borders? As programme director, curriculum developer, teacher-trainer and teacher, we face these questions regularly in our work with students and in discussions with our colleagues in interdisciplinary education. Over the years we have gathered information on how to design and carry out interdisciplinary education. This information was scattered across hand-outs for courses, workshops, project plans and trainings for teachers and students. What we were lacking was a practical overview providing suggestions, best practices and theoretical insights relating to the design of interdisciplinary education.

The Institute of Interdisciplinary Studies at the University of Amsterdam contributed significantly to this handbook. For close to 20 years, ideas on teaching and learning within an interdisciplinary education approach were tested and implemented at this Institute. Apart from our own experience, this handbook is supported by wide-ranging literature in the field, and we very much appreciate the insightful discussions we have had with a great number of colleagues at universities both in and outside the Netherlands, known for their work in teaching and designing interdisciplinary courses and programmes. We are grateful for the contributions and examples from other interdisciplinary initiatives at the University of Amsterdam, Utrecht University, the University of Wageningen, the University of Leuphana, the University of Manchester, Imperial College London, University College London, the US-based Association for Interdisciplinary Studies, and many others. We are most thankful to the following reviewers who provided us with helpful critique: William H. Newell, Roosmarijn Bakker, Elisabeth Hauke, Ria van der Lecq and Steph Menken. Furthermore, we would like to thank Noor Christoph for allowing us to make use of her work on unravelling interdisciplinary understanding in chapter 3.

Writing this handbook has reminded us that working with colleagues from various backgrounds and synthesising their insights can be both challenging and rewarding. It underlined in our minds how interdisciplinarity lies at the heart of academic practice.

1 Introduction

'If you are a student, try to be a teacher; if you are a teacher, try to be a student!'

Mehmet Murat Ildan

1.1 Moving towards more complexity

Complex problems lie at the heart of interdisciplinary studies. There are four basic prerequisites for a system to be called complex as opposed to just being complicated:

- 1 the presence of diverse 'agents' (i.e. atoms, football hooligans or organisations),
- 2 these agents are interconnected and their behaviour and actions are interdependent (they form a network),
- 3 this collection of agents tends to self-organise (as a result of feedback and feed-forward loops between agents), and
- 4 the agents must be able to change (in the local or global environment) or to learn (Menken & Keestra, 2016).

One example of a complex system is the order of a city, with the organisation of its infrastructure, its countless daily flows of goods, and people living their daily lives. The city functions even though there is no central planner (Page, 2010).

A complex system is unpredictable and often behaves in non-linear ways, such as system effects that are disproportionate to their causes, or sudden large shifts in the system's pattern of behaviour (Newell, 2007). This creates complex problems such as stock market crashes, sudden collapses of ancient societies, epileptic seizures, the civil uprisings that erupted during the so-called Arab Spring, and lakes that shift from a clear to a turbid state (Menken & Keestra, 2016).

As the connectedness of our world increases, at least at the social, economic and political levels, more complex problems are generated. Around 10,000 years ago, people lived in groups that were relatively isolated from each other, and they depended only on their own community (Menken & Keestra, 2016). Today, however, there are global markets that connect companies and consumers from all over the world, and these markets self-organise and are interdependent and adaptable to change. In other words, problems arising from these global markets can be classified as complex. As technology further increases interconnectedness and globalisation, more complex problems due to this globalisation can be detected.

So on the one hand, technological advancements can contribute to the complexity of the problems we are facing but on the other hand, technical advancements allow scientists to understand the underlying forces, interactions and non-linearities that together constitute complex phenomena (Van Santen, Khoe & Vermeer, 2010). For example, recent advancements in methods to study the human brain have allowed for the development of new theories such as neural network theory and have given us greater insight into various clinical conditions (Menken & Keestra, 2016). Generative technologies such as magnetic resonance imaging gave birth to new possibilities and have widened the scope of (interdisciplinary) research.

1.2 Why interdisciplinary education?

Complex problems cut right across disciplines. According to the National Academies of Sciences, Engineering and Medicine, climate change, for example, cannot be understood comprehensively 'without considering the influence of the oceans, rivers, sea ice, atmospheric constituents, solar radiation, transport processes, land use, land cover and other anthropogenic practices and feedback mechanisms that link this "system of subsystems" across scales of space and time.' (National Academy of Sciences, 2004). To reach a more comprehensive explanation of complex, real-life problems, insights from several disciplines have to be reconciled and combined, e.g., one needs an interdisciplinary approach. For example, scholars and scientists have put forward various answers to the question of what makes a typical Jeroen Bosch painting. Since 2010, an international, interdisciplinary group of scholars has been scrutinising Bosch's works using modern, standardised methods such as infrared reflectography and ultra-high-resolution digital macro photography (Ilsink & Koldewijk, 2016). Thanks to the collaboration of photographers, art historians, technical art historians, software engineers and research conservators, some paintings that were attributed to the Dutch painter could be taken off this list, bringing the team closer to a more comprehensive answer to their research question. Moreover, by studying the 'underdrawings' of the paintings with X-rays, infrared and UV cameras, the researchers gained a better insight into the creative process that led Bosch to paint his masterpieces.

These contemporary problems call for new professionals. Many have pleaded for more academics that can engage in the translation, synthesis and integration of theories, methods and results from fields that may sometimes seem unrelated. Professors and chancellors of various colleges and universities have argued for education that helps students become integrative thinkers who can see connections in seemingly disparate fields of study and draw on a wide range of knowledge to develop new solutions and make decisions (Association of American Colleges, 2007) What some recommend is 'an education that intentionally fosters, across multiple fields of study, wide-ranging knowledge of science, cultures, and society' and an active commitment to 'the demonstrated ability to apply learning to complex problems and challenges'. Professors and chancellors also underscore the need to teach students how to integrate and apply their learning across multiple levels of schooling and across disparate fields of study. In another report, Improving the quality of teaching and learning in Europe's higher education institutions, the authors argue that graduates will face a world that is transformed by technology and that those who can sort through and deal with information overload have a competitive advantage (McAleese, 2013). In effect, they also plead for an interdisciplinary approach to deal with the complexity of future society.

It is our experience that students are often interested in these complex problems. Students opt in large numbers for interdisciplinary programmes and courses where complex problems are studied, such as a Bachelor's in Future Planet Studies and a Master's in Brain and Cognitive Sciences. Students not only show great interest in the contemporary problems that are studied in these programmes but are also motivated to contribute to the solutions to these global challenges. Now, more than ever, higher education is challenged to educate students to see beyond the limits of their own discipline and to come up with innovative integrated solutions to our contemporary problems.

1.3 Why this handbook

This handbook, Designing Interdisciplinary Education, offers guidance and practical advice for university teachers and curriculum leaders who aim to successfully develop, implement and sustain an interdisciplinary approach to their teaching at the classroom, course or programme level.

We hope this handbook will serve as a foothold for new educational initiatives – programmes, minors, courses or extra-curricular activities – where interdisciplinary skills are cherished and developed. This can be a delicate task, as most universities are not (yet) aligned with the demand for interdisciplinary education. Many aspects and structures within our institutions are rooted in disciplinary practices that have successfully evolved over the years. Our institutions are, in a way, conservators of century-old practices and methods, which are usually accompanied by certain attitudes and cultures. In this sense, tradition is a powerful force within academia and can sometimes get in the way when trying to implement an interdisciplinary approach in higher education. Breaking from the existing 'silo approach' within universities is not a simple task, but we hope that the insights shared in this book will make it somewhat easier.

As we stress the need for interdisciplinary education in this handbook, one may form the opinion that we view discipline-based teaching as less relevant. This is definitely not the case. Discipline-based education provides students with a set of standards – an established way of framing problems, key theories and methods. An interdisciplinary approach builds on this disciplinary knowledge. In our view, it is not a case of either/or but of both/and. Ideally, interdisciplinary education supplements disciplinary teaching so that students can see the point of learning about disciplines when they learn how insights from those disciplines can contribute, through interdisciplinary studies, to understanding real-world problems, issues and phenomena (Newell, 2006). This way, interdisciplinarity is not only a bridge between different disciplines but also a means of uniting universities with the world outside academia.

There are few resources for designing courses and programmes that foster interdisciplinary thinking in students (Morrison, 2015; Spelt et al., 2015). While acknowledging that further exploration and empirical research on interdisciplinary teaching and learning in educational practice is needed, we hope this handbook provides a useful starting point in developing an approach that cultivates students' interdisciplinary mindset.

Besides the theoretical aspects of curriculum development, we also explore the more 'messy' side, namely, the daily practice of curriculum change. In our experience, despite all the preparation, designing a curriculum never follows the initial intended path because of the presence of diverse 'agents' and their interconnectedness and interdependent actions, the tendency of small networks to self-organise, and the ability to change and learn in the process. Designing a curriculum is complex, and by providing insights into the difficult situations other education designers have encountered, we hope to provide some tools to deal with similar circumstances.

1.4 An overview of the content

Since most university teachers in interdisciplinary education are experienced in teaching discipline-centred classes or courses, we assume that our readers know the basic principles of educational design such as writing learning outcomes and the design of reliable tests. For this reason, you will not find all the basic principles of educational design in this handbook. Instead, we focus on the extra effort required to create an environment in which students can develop their interdisciplinary thinking skills.

There are different models and ideas for curriculum design available. In this book we use the principle of constructive alignment because it is an easily applicable idea, quickly explained to people involved in teaching and curriculum design, and is very effective in creating a powerful learning environment for students. Constructive alignment is a form of outcome-based educational design connected to a constructivist understanding of learning (Biggs, 2011). Constructivists' view on learning is that students are not passive vessels simply undergoing teaching but are actively constructing meaning and learning from what they are taught, integrating new material with previous knowledge and experiences. Teaching and learning are conceived as an interactive system of four components: the intended learning outcomes, what the teacher does (teaching activities), what the student does (learning activities) and assessment of this learning environment. This model enables course and programme developers to align content, teaching and learning activities with the intended interdisciplinary learning outcomes. A correct match between intended learning outcomes, teaching and learning activities and assessment criteria helps to make the overall learning experience transparent and meaningful to students.

We begin in **chapter 2** (An overview of the development stages) by providing a roadmap for the development of engaging and effective interdisciplinary education. This chapter addresses the steps, questions and challenges of the design process and showcases the steps in practice, with a case study illustrating the development of a new Bachelor's degree.

In chapter 2 we discuss the different stages of curriculum design. In the chapters that follow, we further explore and guide you through these stages (see figure 1). Curriculum design is an iterative and systematic way of going about planning instruction, even though it consists of flexible steps. The process starts with analysis and moves on to design, followed by development and finally implementation. Evaluation occurs at various stages. Although there are plenty of similarities between the process of regular curriculum design and the process for interdisciplinary programmes, we focus on the additional questions specific to interdisciplinary education.



Figure 1 Stages in the curriculum development process

In **chapter 3** (Unravelling interdisciplinary understanding), we explore the differences between multidisciplinary, interdisciplinary and transdisciplinary higher education. Because of the wide range and variability of the terms used for interdisciplinary understanding, this chapter aims to unravel the construct of interdisciplinary understanding with the purpose of making it tangible in educational settings.

A vision of the curriculum is a starting point for the creation of a design concept. It provides a point of reference as alternative designs are debated and negotiated. In **chapter 4** (Developing the raw sketch), a method is described to draft a vision, and examples in practice are given.

In **chapter 5** (Formulating interdisciplinary learning outcomes), the focus turns to formulating clear outcomes and translating programme results into intended learning outcomes at the course level. This chapter answers the following questions: What skills, attitudes and knowledge are students expected to acquire? And how can this be translated into clear and measurable learning outcomes?

One of the greatest challenges in interdisciplinary education design is to obtain coherence within the curriculum. The decision-making process for determining the shape of the curriculum is discussed in **chapter 6** (Embedding integration in the programme design). Examples of much-used models and guiding questions are discussed, and multiple ways to deal with 'depth' and 'breadth' of knowledge are outlined. Here we provide tools to find the best fit between the scope and learning outcomes of the programme and the shape of the curriculum.

Chapter 7 (Hiring and engaging faculty) provides ideas and practices regarding the involvement and engagement of faculty. Some of the issues discussed in this chapter include the features an interdisciplinary teacher should have and how to get the right person(s) to teach the right course. We also look at whether the reward system is adequate for interdisciplinary teaching and at the additional needs that interdisciplinary teachers have.

Exploring the teaching philosophy and didactic methods (**chapter 8**) allows you to reflect on and articulate beliefs and practices in the new programme. In this chapter, the focus is on the often implicit assumptions that students and teachers have on learning and understanding and how crucial it is to take these assumptions into account when deciding on a teaching philosophy. The practicalities around formulating a teaching philosophy are outlined and illustrated. A shared teaching philosophy is a starting place for collaboration within the teachers' team. Furthermore, this chapter explores some didactic methods that could be used to foster interdisciplinary understanding in students. We discuss examples such as the use of authentic and complex problems, collaborative learning, the teacher as a coach, and team teaching.

Assessment is an important part of any (interdisciplinary) programme because it monitors whether the students have reached the intended learning outcomes. **Chapter 9** (Assessment of interdisciplinary learning outcomes) provides an overview of appropriate assessment methods for interdisciplinary learning outcomes and examples of grading rubrics for interdisciplinary outcomes. Furthermore, this chapter explores some assessment forms that appear to be particularly important for the assessment of interdisciplinary learning objectives, namely: portfolio assessment, assessment of group work, assessing interdisciplinary work from multiple perspectives, and student-centred assessment.

When we teach, we engage in two closely related but distinct activities. First, we design the course by gathering information and make a number of decisions about the way the course will be taught. Second, we engage in teacher-student interactions as we implement the course we have designed. Although the focus of this handbook is on designing and development, in **chapter 10** (Interdisciplinary teaching in practice) we discuss how to teach interdisciplinary skills using reflective functioning, critical thinking, and collaboration in practice.

Once an interdisciplinary programme or course has been implemented, an important question arises. Does the new programme or course meet the students' and teachers' expectations? In the **final chapter**, which focuses on programme assessment and adjustment, the quality of educational practices is discussed.

In every chapter you will find an activity that can be undertaken individually or collaboratively as part of the design and development process. The **activities** are indicated via the following icon:



We also include key advices that we found to be helpful, which consists of suggestions and warnings from practice or the literature. **Key advices** are displayed in the following way:



Case studies are examples of programmes, courses, teaching methods in various settings and are indicated by:



For an overview of the activities, key advice and case studies, see the appendices.