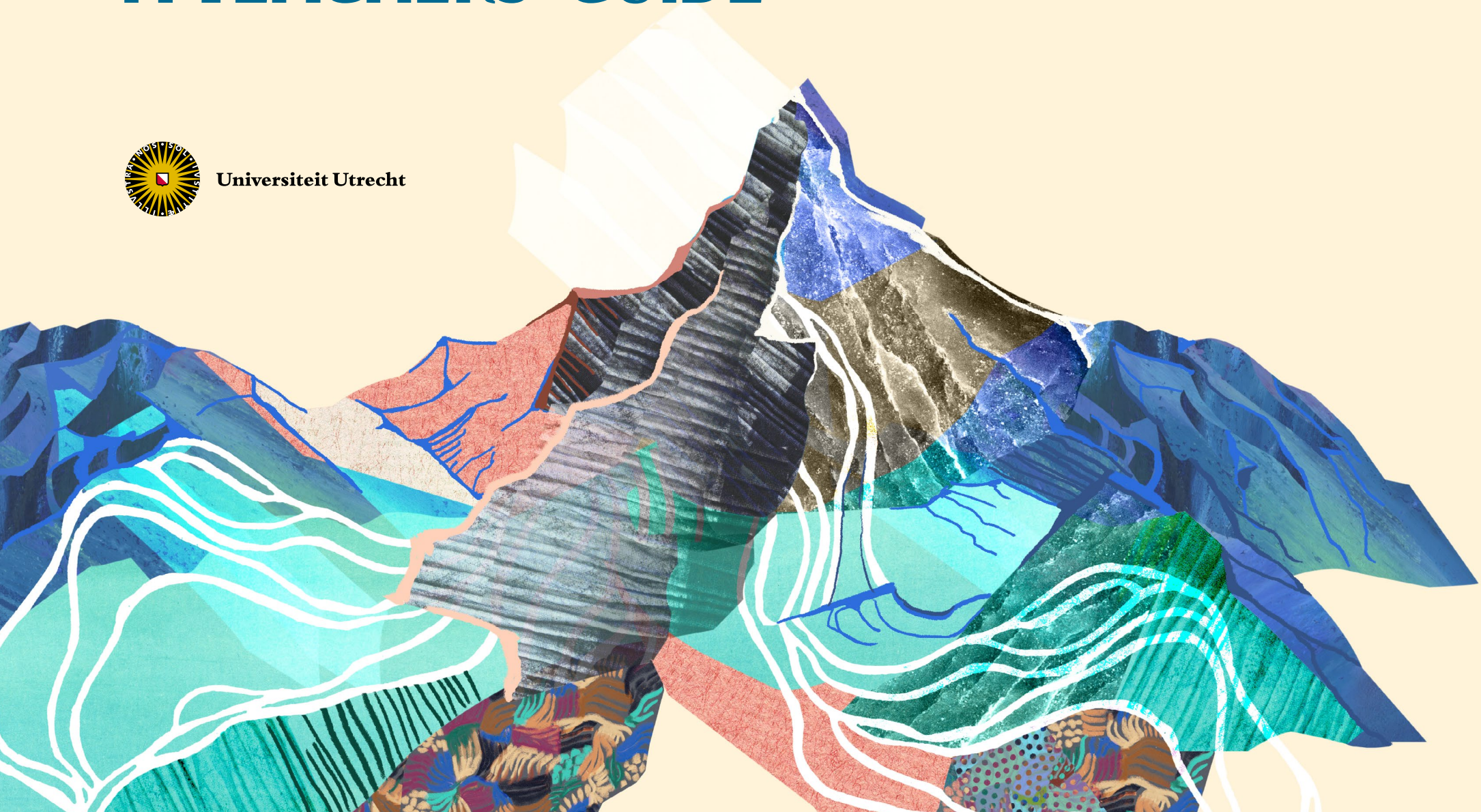
INTERDISCIPLINARY ORIENTATION
A TEACHERS' GUIDE

Universiteit Utrecht



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Authors
Eleanor Rowan, Lizzy Angerer, Fred Wiegant
Institute of Education,
Department of Biology
Faculty of Science
Utrecht University

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This booklet was written within the framework of a Senior Fellow Comenius project (funded by NRO) aimed at designing a learning progression for interdisciplinarity in a disciplinary environment (Department of Biology at the Faculty of Sciences). This booklet serves as a companion for teachers aiming to use the booklet "Interdisciplinary Orientation; Learning to navigate beyond your discipline" in their course or program.

Artwork
The mountain landscape with a variety of facets and "rocky layers" symbolizes an overview of disciplinary perspectives on complex topics. Where these perspectives overlap, new patterns, ideas and insights emerge. The view on this landscape invites you to navigate beyond your own discipline and to immerse into an interdisciplinary orientation.

Design & Illustration
Larisa Wiegant - Graphic Design & Illustration

CONTENT

1. INTRODUCTION

Interdisciplinary research is an active field in which collaboration between different disciplines is seen as a useful avenue for approaching, understanding and solving complex problems. However, being able to work with other disciplines can be challenging.

Current developments in Higher Education to improve the preparation of students to work efficiently in multidisciplinary teams are complicated by the difficulty many teachers find in adequately preparing students to work in interdisciplinary teams. Developing learning experiences in this field can be daunting since it represents a variety of hurdles for both disciplinary teachers and educational specialists alike.

Earlier we wrote the booklet "Interdisciplinary Orientation; Learning to navigate beyond your discipline" to function as a learning resource for both students and teachers. Our aim with the booklet was to provide readers with an awareness of what interdisciplinarity entails, and what is required to work efficiently and productively in multidisciplinary teams. This is framed within an overall aim of achieving a more comprehensive understanding of complex problems and/or achieving novel and unexpected insights or solutions.

We realized that disciplinary teachers often need some inspiration, ideas and suggestions for how to use the Booklet in their courses or programs. The aim of the current Teachers' Guide is just that: to inspire teachers to use the Booklet by providing ideas for activities, reflections and discussions with different interdisciplinary-inspired learning goals. This will hopefully encourage teachers to go on to develop their own ways of using the booklet, and of preparing students to do interdisciplinary work. In this Teachers' Guide we emphasize the relevance of the initial leaning goal, which is an "interdisciplinary orientation". This means developing an understanding & awareness of what interdisciplinarity is, why it can be important & necessary, but also why it is challenging and requires special preparation, in addition to disciplinary education.

This guide is aimed at helping you to apply the ideas presented in the booklet "Interdisciplinary Orientation" in the classroom, to support the development of your students' skills and knowledge for interdisciplinary work. Descriptions of interdisciplinary work, such as the learning goals from pp. 89-90 of the Interdisciplinary Booklet, often start with an understanding and working within one discipline, and from there gradually move into integrating more than one discipline. The disciplinary grounding, as this is often called, is a well-documented step that can easily be broken down into small steps, and trained through in-class activities. However, the final step of the process, engaging in interdisciplinary work and achieving some type of integration to achieve a more comprehensive understanding, is often challenging. This is also due to the fact that its process is not completely understood or well-documented. Most step-by-step guides get vague when it comes to this final step, which can only be achieved in long-term individual or group projects. These can be difficult to design, and intimidating to set as an assignment when you are not sure if your students will be able to achieve this. The main purpose of the booklet is therefore to outline what we call an interdisciplinary orientation – an understanding of the skills and processes involved in interdisciplinary work, which is knowledge that can make it easier to engage in interdisciplinary work when given the opportunity. We propose this learning goal (interdisciplinary orientation) as the first step in engaging in interdisciplinary work, as laid out below. However, if you want to train your students to engage in interdisciplinary work, we believe that interdisciplinary orientation needs to be accompanied in the classroom with disciplinary grounding and perspective taking. The skills and knowledge gained can then best be assessed in the form of a longer group or individual interdisciplinary assignment.

We have created this guide to provide inspiration and to give suggestions for how to incorporate the booklet "Interdisciplinary Orientation; Learning to navigate beyond your discipline" in your classroom, with:

- reading questions and activity ideas for giving students an interdisciplinary orientation,
- suggestions to raise awareness and to develop some of the skills & attitudes to allow for efficient and productive work in multidisciplinary teams
- discussion questions and activity ideas for giving students a disciplinary grounding,
- discussion questions and assessment ideas for perspective-taking, creating common ground and integrating perspectives.

Where possible, we recommend blending these learning goals, so that an activity on disciplinary grounding leads to recognising other disciplinary perspectives, or an activity on taking different disciplinary perspectives leads to finding some common ground between these perspectives.

In Table 1, the learning goals and some learning objectives of interdisciplinary education in relation to the ten steps formulated by Repko & Szostak (2021) for interdisciplinary work are shown. Often, but not always, these steps are used to structure the work of students and researchers while writing an interdisciplinary paper or when being involved in interdisciplinary research.

In the sections on Interdisciplinary orientation (interdisciplinary theory & interdisciplinary skills), tables are presented in which questions are mentioned in relation to activities that are focused on various aspects of interdisciplinarity described in different parts of the Booklet. In addition, suggestions are given for discussion questions and learning activities in relation to disciplinary grounding, perspective taking, finding common ground and integration. Finally, some general activities are suggested which teachers may like to use in their courses.

Table 1: Learning goals and some learning objectives for interdisciplinary learning in higher education, in relation to the different steps that were formulated by Repko & Szostak (2021) to guide interdisciplinary research.

LEARNING GOAL	SUB-GOALS / LEARNING OBJECTIVES	REPKO'S STEPS
Interdisciplinary orientation	▹ Develop understanding of why interdisciplinary work is important ▹ Develop understanding of when interdisciplinary work is necessary ▹ Develop understanding of why interdisciplinary work is difficult ▹ Develop understanding of the conditions required for interdisciplinary work to successfully occur ▹ Frame a research question or problem statement that justifies an interdisciplinary approach ▹ Be able to assess which aspects of which disciplines might be most relevant for a specific problem or question ▹ Develop understanding of what interdisciplinary work can look like ▹ Being aware of the (leadership) skills and attitudes working in a multidisciplinary team requires	**1.** Define the *complex* problem/state the research question **2.** Explain why this requires an inter/multidisciplinary approach **3.** Identify potentially relevant disciplines and indicate possible contributions of each discipline
Disciplinary grounding	▹ Develop epistemological understanding of your own discipline/s ▹ Explain basic concepts, theories and epistemological assumptions of your own discipline ▹ Consider the limits of your disciplinary approach ▹ Develop disciplinary humility ▹ Being aware that disciplines understand and approach problems differently	

Perspective-taking	▹ Distinguish the basic concepts, theories and epistemological assumptions of your discipline from those of other disciplines ▹ Understand when a (complex) problem might require more than just one disciplinary approach ▹ Evaluate the limitations of different disciplinary perspectives ▹ Compare and contrast the appropriateness of different disciplinary methods for a given problem ▹ Consider a problem from the perspectives of different disciplines ▹ Reflect on your own disciplinary biases	**4.** Conduct a literature survey in each discipline **5.** Identify the defining elements of the relevant disciplines **6.** Analyse and evaluate the disciplinary insights
Creating common ground (in the context of specific disciplines used)	▹ Identify the different levels on which disciplines, that are used to approach a complex problem, can have differences and/or common ground ▹ Identify the similarities between basic concepts, theories and epistemological assumptions of the different disciplines used ▹ Identify the conflicts or differences between basic concepts, theories and epistemological assumptions of your discipline and those of other disciplines	**7.** Identify conflicts or differences between disciplinary insights/views **8.** Create common ground among insights and between concepts or theories
Integration	▹ Work in a multi-disciplinary team, on a complex problem that requires an interdisciplinary approach ▹ Formulate (possibilities for) connections across different perspectives ▹ Be able to connect coherently selected disciplinary insights, ideas or findings to achieve a more comprehensive understanding ▹ Be able to integrate disciplinary insights in a coherent and effective way which may result in novel and/or unexpected insights or solutions ▹ Reflect on the interdisciplinary process, on an individual and group level ▹ Consider how to improve the interdisciplinary process, on an individual and group level ▹ Being aware of the benefits and limitations of the different contributing disciplines, and the integrative approach used ▹ Consolidate understanding of the steps in the interdisciplinary process, and formulate improvements in future actions	**9.** Integrate disciplinary insights to construct a more comprehensive understanding and draw conclusions **10.** Reflect on how an interdisciplinary approach has enlarged your understanding

2. INTERDISCIPLINARY ORIENTATION

2.1. Interdisciplinary theory

In many descriptions of the interdisciplinary process, there is a build up from disciplinary awareness to taking other perspectives and then comparing & contrasting ideas, findings and perspectives from different disciplines followed by an integrative process to obtain a more comprehensive understanding or finding an innovative solution to a complex problem. At this stage, often a conceptual understanding of interdisciplinarity is gained, especially if combined with reflection. We propose that there is enough of a knowledge base around interdisciplinarity now to present students with conceptual knowledge around interdisciplinarity before asking them to do interdisciplinary work, with the aim of supporting and facilitating this process. We call this first step an orientation to what interdisciplinarity is, aims to be, and what makes it complex and contested. The first part of the booklet "Interdisciplinary Orientation; Learning to navigate beyond your discipline" aims to explain what interdisciplinary work is, and can be used to help your students achieve an interdisciplinary orientation. The table below gives suggestions for reading, assignments, discussion questions and in-class or homework activities to extend the ideas raised in the booklet.

Table 2: Suggested Questions and Activities on Interdisciplinary theory in relation to the learning goal: Interdisciplinary orientation.

BOOKLET SECTION	QUESTIONS	ACTIVITIES
Introduction, pp. 6-15	▹ Why is interdisciplinary work important? ▹ How would you respond to the "valid concerns" about the value of interdisciplinary work? ▹ What are the skills required for interdisciplinary work? ▹ Explain in your own words the ideal composition of an interdisciplinary team and explain why this is the case. How would you represent this visually? ▹ What do you think an "interdisciplinary orientation" means? ▹ Summarise the benefits of interdisciplinary work	▹ Write a small paragraph explaining how you understand interdisciplinarity, and your personal motivation for engaging in interdisciplinary work. This is for yourself, and here is no right or wrong answer. If you want, you can share this with others. ▹ Justify interdisciplinary work to someone who believes entirely in the disciplinary perspective, or make students play devil's advocate and argue for disciplinarity.

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What is Interdisciplinarity, pp. 20-26	▹ What makes interdisciplinarity a contested term? ▹ In your own words, how would you define a discipline? ▹ What is the discipline you identify with most strongly? Can you explain the strengths and some shortcomings of your discipline? ▹ How can two separate disciplines be similar? ▹ Which two academic disciplines do you think are the furthest apart? ▹ What does the prefix "inter" mean, in the term "interdisciplinarity"? and compare it with the prefix "multi" in the term "multidisciplinarity" ▹ Do you think one individual person can do interdisciplinary work alone? ▹ How does the "funnel of expertise" distinguish cross-, multi-, inter- and transdisciplinarity? Do you think it is useful to distinguish these terms? ▹ Which types of "boundary-crossing" can occur in interdisciplinary work? ▹ Consider the two definitions on p. 26. What differences can you see in these definitions?	▹ Ask students to work together to develop images representing cross-, multi-, inter- and transdisciplinarity, and the differences between these. Focus less on absolute definitions and more on all the different ways that disciplines can interact. Can you think of any other ways in which disciplines can interact, and terms to describe this?
The Interdisciplinary Process, pp. 27-31	▹ In your own words, what is the aim of each step in the interdisciplinary process? ▹ Which skills or qualities do you think are important for each step, and overall? ▹ Do you think you have ever experienced any of the steps in the process? ▹ Which step do you think is the most difficult to achieve? Why?	▹ Imagine you are leading an interdisciplinary project. Choose a step in the process, and think of an icebreaker for your team to do before a work session, in order to warm up the skills needed to achieve that step in the process. Then, decide on a metaphor to use to explain how you want your team to feel and communicate during this step. Are you a hive of bees, all working for the queen? A group of geese flying in a V-shape?, A bunch of lemmings jumping off a cliff?
Metaphors, pp. 31-36	▹ Have you come across metaphors within your own discipline? Have you come across metaphors within another discipline, for example at school? ▹ Explain in your own words why a metaphor can be a useful interdisciplinary tool ▹ Can you think of any other useful tools (in the broadest sense) to help interdisciplinary teams to communicate? ▹ What disciplinary influences can you detect in this explanation and definition of metaphors? Do you know any other disciplinary perspectives on how to define a metaphor, and why it might be useful as an interdisciplinary tool?	▹ Ask students to find a metaphor in another section of the booklet and analyse how this is used to facilitate understanding ▹ Ask students to come up with a metaphor used in a contemporary pop song. What two things are being compared? How does this facilitate understanding?

A Brief History of Interdisciplinarity, p. 37-44	▹ What are the three main characteristics associated with "disciplinarity"? ▹ How would you describe what a discipline is to someone who has not been to university? ▹ Are reductionism and holism terms you have heard before? Which way of thinking do you think your discipline tends more towards? ▹ Why and how did interdisciplinarity come about? ▹ Read Becher's description of different disciplines as "tribes". Why does Becher describe disciplines as "tribes"? How do you experience talking and interacting with people from different disciplines? ▹ What do you think is the most important benefit of interdisciplinary work? ▹ What makes interdisciplinary writing difficult to successfully do? ▹ Have you ever read a paper from a different discipline? What did you find different and/or difficult about it?	▹ The box on p. 40 gives some examples of questions from the life sciences that require an interdisciplinary approach. Choose one of these questions, and explain which disciplines other than the life sciences are useful for answering this question, and why. ▹ Ask students to read the box on p. 58 about consciousness. Then, choose a discipline other than neuroscience, and investigate how this discipline understands human consciousness. A nice question to ask to compare perspectives across disciplines is, are humans special?
Interdisciplinary methodology: Repko's steps, pp. 45-52	▹ For each step, read the description and answer the following questions: ▹ What makes this step difficult? What qualities or skills are important to have in order to achieve this step? Do you feel able to complete this step?	▹ Find an interdisciplinary paper (such as van der Lecq, 2012), and see where you can find examples of each of Repko's steps
Interdisciplinary methodology: Systems thinking, pp. 52-59	▹ You previously read about reductionism as the opposite of holism. How and why is reductionism described as the opposite of systems thinking? ▹ Can you think of any useful examples of reductionism in your discipline? ▹ Why is systems thinking useful for interdisciplinary problems? ▹ Compare and contrast Repko's steps and systems thinking: what ideas do you see in common? What key differences do you see? Can you think of any situations in which Repko's steps would be more useful, and any situations in which systems thinking would be more useful?	▹ Give students examples of "wicked problems" (climate change is a great example) suitable for an interdisciplinary approach and ask them to draw systems maps of these problems, based on what they currently know. ▹ Within Biology interesting topics dealing with interactions between different system levels are: "genes and behaviour", "role of microbes in ecosystems" ▹ Watch the video "Powers of Ten" in class, and discuss systems and levels of magnitude: what is the biggest level possible of a system? What is the smallest? How do you decide which level to work at, at a given moment in time? ▹ Find an interdisciplinary paper and see where you can find evidence of systems thinking
Interdisciplinary methodology: the magic, pp. 60-63	▹ Look at the image of "the magic" on p. 28. Why do you think the authors chose to represent interdisciplinary work in this way? ▹ How is this different to how interdisciplinary work is defined in Repko's steps? ▹ Look up the Slow Science Academy and their work. Can you find a defence of slow academic work in any other disciplines? How is this justified?	▹ Find an example of a concept that seems similar to "the magic" from another discipline. Creative arts and sports science are good places to start. But also writing a disciplinary review in which you want to combine many different insights. What are the conditions that facilitate this state? Is this useful to think about when trying to do interdisciplinary work? ▹ Schedule in empty time for yourself to think. Reflect on how this feels, and what happens. ▹ Play the free association game in class.

2.2. Interdisciplinary skills

You also need to develop certain skills and qualities, as well as knowledge and understanding, in order to do interdisciplinary work. A detailed description of what these skills are and why they are important for interdisciplinary work can be found in part 2 of the booklet, and the table below provides suggestions for how to support students' development of both these skills and the awareness of the importance of these skills for interdisciplinary work.

Table 3: Suggested Questions and Activities on Interdisciplinary skills in relation to the learning goal: Interdisciplinary orientation.

SKILL	QUESTIONS	HOW TO ADAPT AN ACTIVITY TO DEVELOP THIS SKILL
Curiosity	▹ Read about the skill of curiosity p. 67-68, and explain in your own words (or images) what curiosity means to you ▹ What does curiosity mean in your discipline? Why is curiosity important in your discipline? ▹ Why is curiosity important for interdisciplinary work? ▹ How would you rate your ability to be curious? ▹ Think of an example of when you displayed curiosity ▹ How can you challenge yourself to be more curious? Are there any resources or support your teacher could give you to help you develop your curiosity? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie curiosity and its use for interdisciplinary work?	▹ To facilitate curiosity, ensure that the questions asked are big, open questions. Give students time to think, and space to follow what interests or excites them. Facilitate an atmosphere of play by thinking about rules and boundaries, and making sure that these are always up for discussion. ▹ Read a paper or article which is completely outside your own comfort zone and see if you can use its methodology or message in your own field of expertise
Collaboration	▹ Read about the skill of collaboration p. 6 and p. 69, and explain in your own words (or images) what collaboration means to you ▹ What does collaboration mean in your discipline? Why is collaboration important in your discipline? ▹ Why is collaboration important for interdisciplinary work? ▹ How would you rate your ability to be collaborative? ▹ Think of an example of when you displayed collaboration ▹ How can you challenge yourself to be more collaborative? Are there any resources or support your teacher could give you to help you develop your collaboration skills? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie collaboration and its use for interdisciplinary work?	▹ Asking students to work in a group shifts the focus of an activity to collaboration. To facilitate collaboration, the "working together" aspect of the task needs to be given time and space. Make it explicit that students need to work together, discuss steps and approaches and not just divide tasks, and give them time to do this. Make it explicit that taking the time to discuss and seek feedback is an important step, and where possible, reward this. Finally, make sure that the task is complex and open enough. Asking students to decide what to do, as well as how to do it, requires more collaboration. For example, asking students to decide on a research question for a project, or decide on a case study.

Communication	▹ Read about the skill of communication p. 69-70, and explain in your own words (or images) what communication means to you ▹ What does communication mean in your discipline? Why is communication important in your discipline? ▹ Why is communication important for interdisciplinary work? Is it different in nature in comparison with communication within your own discipline? ▹ How would you rate your ability to be communicative? ▹ Think of an example of when you displayed communication ▹ How can you challenge yourself to be more communicative? Are there any resources or support your teacher could give you to help you develop your communication? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie communication and its use for interdisciplinary work?	▹ To facilitate communication, incorporate both oral and written communication into activities. Giving students time to clarify their own ideas on a topic by thinking or writing can lead to better communication, and emphasising the importance of listening. You can separate out individual aspects of communication like listening by using a discussion format like a fishbowl, or any format in which some participants are given the role of listening. You can also slow down communication by asking students to communicate entirely through writing, by silently writing ideas and responses and then exchanging and responding to these.
Creativity	▹ Read about the skill of creativity p. 71-72, and explain in your own words (or images) what creativity means to you ▹ What does creativity mean in your discipline? Why is creativity important in your discipline? ▹ Why is creativity important for interdisciplinary work? Is it different in nature in comparison with creativity within your own discipline? ▹ How would you rate your ability to be creative? ▹ Read the section on the Disney Strategy, p. 72. Which phase comes easiest to you? ▹ Think of an example of when you displayed creativity ▹ How can you challenge yourself to be more creative? Are there any resources or support your teacher could give you to help you develop your creativity? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie creativity and its use for interdisciplinary work?	▹ To facilitate creativity, you can explore different formats for expressing and responding to content and ideas. A nice place to start is experimenting with allowing students to create or co-create art in any form for assessment and homework tasks, when relevant to the content.

Criticism	▹ Read about the skill of criticism p. 72-73, and explain in your own words (or images) what criticism means to you ▹ What does criticism mean in your discipline? Why is criticism important in your discipline? ▹ Why is criticism important for interdisciplinary work? Is criticism given to members within a multi-disciplinary team given in a different way in comparison with criticism provide to members of a disciplinary team? ▹ How do you deal with criticism? When and how do you prefer to receive criticism? How confident do you feel in criticising the work of others? How do you communicate these preferences to others? ▹ How would you rate your ability to be critical? ▹ Think of an example of when you displayed criticism ▹ How can you challenge yourself to be more critical? Are there any resources or support your teacher could give you to help you develop your ability to be critical? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie criticism and its use for interdisciplinary work?	▹ To facilitate criticism for the sake of improvement, you need to incorporate criticism into feedback loops, not just one-off instances. For example, you can ask students to give feedback on a piece of written work, and then apply their own feedback to writing a better version. You can turn feedback into co-creation, asking students to write half a paper, or plan a paper, and then swap with another person who has to finish the task. Feedback can be given based on a rubric that highlights positives, negatives, and how to improve the negatives, and can be given through dialogue rather than in written form, so both the giver and the receiver contribute to sense-making around the feedback. To ensure feedback is for improvement, it can usefully be focalised, directing students' attention to surface features of a text, deeper features of a text such as the development of ideas, and broader features of the text such as the validity of the assumptions a text rests on, for example.
Flexibility	▹ Read about the skill of flexibility p. 74, and explain in your own words (or images) what flexibility means to you ▹ What does flexibility mean in your discipline? Why is flexibility important in your discipline? ▹ Why is flexibility important for interdisciplinary work? Is it different in comparison with flexibility required within a disciplinary team? ▹ How would you rate your ability to be flexible? ▹ Think of an example of when you displayed flexibility ▹ How can you challenge yourself to be more flexible? Are there any resources or support your teacher could give you to help you develop your flexibility? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie flexibility and its use for interdisciplinary work?	▹ To facilitate flexibility, acknowledge roles in activities, such as timekeeper, note-taker, discussion leader, and make sure that students switch up the roles they take on. Games in which students have to rely on their instincts can also be useful in the classroom to train flexibility. Understanding different contexts for communication is also linked to flexibility, and this can be trained with content-based activities in which you ask students to explain a concept to a friend, a child, someone from a different cultural context, etc.

Confidence in competence	▹ Read about the skill of confidence in competence p. 75-76, and explain in your own words (or images) what this means to you ▹ What does confidence in competence mean in your discipline? Why is this important in your discipline? ▹ Why is confidence in competence important for interdisciplinary work? Is what way is it different (in nature or degree) in comparison with confidence in competence with disciplinary team work? ▹ How would you rate your ability to be confident in your competence? ▹ Think of an example of when you displayed confidence in your competence ▹ How can you challenge yourself to be more confident in your competence? Are there any resources or support your teacher could give you to help you in this? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie confidence in competence and its use for interdisciplinary work?	▹ To facilitate students' confidence in their own competence, as a teacher, you play an important role in giving them positive reinforcement. You can also encourage students to give each other positive reinforcement in reflection activities, or normalising giving compliments. Competence should be defined by individual markers, so that students are encouraged to see their own growth as personal, not relative.
Courage	▹ Read about the skill of courage p. 76-77, and explain in your own words (or images) what courage means to you ▹ What does courage mean in your discipline? Why is courage important in your discipline? ▹ Why is courage important for interdisciplinary work? Is it different in nature or degree in comparison with courage in disciplinary work? ▹ How would you rate your ability to be courageous? ▹ Think of an example of when you displayed courage ▹ How can you challenge yourself to be more courageous? Are there any resources or support your teacher could give you to help you develop your courage? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie courage and its use for interdisciplinary work?	▹ To facilitate courage, define it in an individual, not a relative manner, and reward students for doing something they find scary. Create space in the classroom for students to admit that a task scares them, building awareness of what being brave can look like. Asking for help when you need it takes bravery, and you can incorporate this into activities, giving students phrases for asking for help, offering help, rejecting offers of help, and giving useful help. Positive reinforcement is key. You can also incorporate activities that students may find scary, such as public speaking, in a repeated, low-stakes context.
Commitment	▹ Read about the skill of commitment p. 77-78, and explain in own words (or images) what commitment means to you ▹ What does commitment mean in your discipline? Why is commitment important in your discipline? ▹ Why is commitment important for interdisciplinary work? Is it different in nature or degree in comparison with commitment in disciplinary work? ▹ How would you rate your ability to be committed? ▹ Think of an example of when you displayed commitment ▹ How can you challenge yourself to be more committed? Are there any resources or support your teacher could give you to help you develop your commitment? ▹ Read the section on empathy, pp. 78-79. How does empathy underlie commitment and its use for interdisciplinary work?	▹ To facilitate commitment, also define it in an individual manner, and reward students for sticking to something that they find hard, making the most of positive reinforcement. Again, ask big, open questions, so that students are able to come across ideas that challenge them and require commitment.

3. DISCIPLINARY GROUNDING

Disciplinary grounding entails understanding the discipline or disciplines you have been trained in, in order to understand how disciplines take singular perspectives, what those perspectives can look like, and how these perspectives affect how practitioners within a discipline understand and therefore seek to address problems. Understanding what a discipline is, how it works and what are its strengths and shortcomings is a key prerequisite for interdisciplinarity, and is therefore an important area of knowledge to train your students in. Though disciplinary grounding is a prerequisite for interdisciplinary work, the booklet "Interdisciplinary Orientation; Learning to navigate beyond your discipline" does not focus much on working towards this goal. The table below suggests activities in class that can be adapted for different disciplines to help students develop an understanding of their own discipline, and start to reflect on the meta-disciplinary level, developing an understanding of what constitutes and characterises a discipline. Note that for many of the activities below, you will need a good understanding of your students' disciplinary background/s.

Table 4: Suggested discussion questions and learning activities to achieve various learning objectives within the overall learning goal of disciplinary grounding.

LEARNING OBJECTIVES	DISCUSSION QUESTIONS	LEARNING ACTIVITIES
Develop epistemological understanding of your own discipline/s	▹ Why did you choose to study this discipline? ▹ What do you love most about this discipline in terms of content? ▹ What do you love most about this discipline in terms of processes? ▹ What do you consider as the strength(s) of your discipline? What do you think is the big, unsolvable question in your discipline?	▹ Write an individual reflection report, answering the discussion questions ▹ Write a report OR express your answers to the discussion questions through a more creative medium, you choose the form ▹ In an interdisciplinary classroom, pair students of first the same and then different disciplines, and discuss the questions ▹ Stage a debate on the value of each discipline. Students can argue for their own discipline (arguing for another discipline can work well, but is a more advanced task). This works best if the tone is light and playful, and students focus on making logically constructed but somewhat ridiculous arguments – "studying literature teaches you to read, which is an important skill. It is not certain that studying science actually teaches you to read!" ▹ Ask students to interview an expert in their discipline, using the discussion questions or similar ones they develop

Explain basic concepts, theories and epistemological assumptions of your discipline	▹ Which subjects, objects and behaviours fall within the research domain of your discipline? ▹ How does your discipline consider truth, knowledge, and what can be known? ▹ What does your discipline accept as true or certain? ▹ What are the methods and processes used by your discipline to conduct, organise and present research?	▹ Ask students to fill in the table on p. 104 of the booklet with the defining elements of their discipline individually, as a group, or in collaboration with an expert in the discipline (which could be incorporated into the interview-an-expert activity above) ▹ Ask students to find and share a TED talk explaining (a relevant aspect of) their discipline to a non-specialised audience. ▹ Ask students to explain their discipline in a way that children would understand. This could be a short written or oral task, or creating a video or animation that explains their discipline to a young audience. You could even then try to find some children to show the videos to, and respond to any questions they might have.
Consider the limits of your disciplinary approach	▹ What do you think is the big, unsolvable question in your discipline? ▹ Why do you think this is an unsolvable question? ▹ What do you think is a contemporary issue that cannot be solved by your discipline alone? ▹ Why do you think one discipline cannot solve this problem?	▹ Ask students to research "wicked problems". These can include issues such as poverty, climate change, education, homelessness, sustainability. ▹ Give students an example of a "wicked problem" and ask them to first research/discuss/think deeply about what their discipline is doing to solve this problem, and then share this with others from the same or other disciplines. ▹ Highlight the question of WHY one discipline might not be able to solve a problem alone. Give students time and space to individually reflect on this question. Ask students to discuss it as a group, and ensure they are considering the limits of disciplines, not just discussing what makes a problem complex.
Understand how disciplines might understand problems and address problems differently	▹ What do you think is a contemporary issue that cannot be solved by your discipline alone? ▹ What is another discipline that you think might be able to contribute? ▹ What aspects of this discipline make it relevant for this problem? ▹ What aspects of your discipline are relevant for this problem?	▹ Find a piece of writing examining a "wicked problem" from a lens that you know is different to your students' disciplinary background, and ask them to highlight the ideas or reasoning that feels strange or different to them. You could even ask students from different disciplines to discuss their answers with each other. ▹ Ask students to share the big, unsolvable question from their discipline with someone else from a discipline. How do they think their discipline would understand or tackle this question? ▹ Ask students to discuss a "wicked problem" with a person they know from another disciplinary background, the further away from their own the better, in a social context. Ask them to be conscious of what it feels like to have a discussion across disciplinary boundaries, and reflect on the process, and the conclusion of the discussion. Parents and older relatives are a good option, or even a stranger who seems amenable to a conversation.
Develop disciplinary humility	▹ How has your discipline affected the way you see the world? ▹ How might your discipline have limited the way you see the world? ▹ What is a bias that your discipline might have instilled in you?	▹ Ask students to write a response to a "wicked problem", highlighting what their discipline might be able to do, but also the limits of this. ▹ Develop understanding of bias through a quick online test such as the IAT from Harvard University. ▹ In a light-hearted manner, ask students to discuss stereotypes around disciplines – what does a philosophy major or biology major look like, talk like, eat, etc.? Ensure you create an inclusive atmosphere in which students do not use these stereotypes to make those from other disciplines feel bad. ▹ Ask students to read pp. 82-83 of the booklet, disciplinary humility. Ask them to examine the figure from Tripp & Shortlidge (2019) and discuss how they would visually represent the importance of disciplinary humility.

4. PERSPECTIVE-TAKING, CREATING COMMON GROUND AND INTEGRATION

4.1. Learning objectives

The final three learning goals cover actually doing interdisciplinary work, and are perspective-taking, creating common ground and then integrating these perspectives. Building on the understanding of a disciplinary grounding, taking perspectives entails moving from a disciplinary perspective to being able to consider different disciplinary perspectives and their advantages and disadvantages, with an open mind. Common ground is usually defined as the shared basis between conflicting disciplinary insights or theories, and so identifying common ground is a creative process that involves modifying or reinterpreting disciplinary elements that conflict. It also incorporates the identification of how terms are used differently in different disciplines and defining problems explicitly in neutral terms in order to create a common vocabulary that can be applied to the object of study. The final step, integration, involves generating a new understanding that would not have been possible using a single discipline. It includes being able to use integration techniques (e.g. models, metaphors) to find new holistic understanding. Integrating perspectives is a creative process, and can take many forms, such as developing a new model, a metaphor, a method, or a future scenario. The new metaphor, interpretation, or model is also tested or used to solve a problem or guide research, and to communicate clearly. These learning goals do not as easily fit with reading questions and small in-class activities. Instead, once you feel your students are ready, we suggest achieving these learning goals through a longer-term individual or ideally group project, like writing an interdisciplinary paper or doing research on a complex topic. Below you can find these three learning goals broken down into sub-goals to help you better conceptualise each goal, and ideas for activities that you can adapt for projects or assessments.

Table 5: Suggested learning objectives within the indicated learning goals of interdisciplinary education.

LEARNING GOAL	SUB-GOALS / LEARNING OBJECTIVES
Perspective-taking	Distinguish the basic concepts, theories and epistemological assumptions of your discipline from those of other disciplines
	Evaluate the limitations of different disciplinary perspectives
	Compare and contrast the appropriateness of different disciplinary methods for a given complex problem
	Consider a complex or 'wicked' problem from the perspectives of different disciplines
	Understand when a complex problem might require more than a disciplinary approach
	Frame a research question or problem statement that justifies an interdisciplinary approach

Creating common ground	Identify the different levels on which disciplines can have differences and/or common ground
	Identify the conflicts or differences between basic concepts, theories and epistemological assumptions of your discipline and those of other disciplines
	Identify the common ground or similarities between basic concepts, theories and epistemological assumptions of your discipline and those of other disciplines
	In the context of a specific problem, and specific disciplines, discover common ground
Integrating perspectives	Work in a multi-disciplinary team, on a complex problem that requires an interdisciplinary approach
	Reflect on the interdisciplinary process, on an individual and group level
	Consider how to improve the interdisciplinary process, on an individual and group level
	Consolidate understanding of the steps in the interdisciplinary process, and the conditions required

4.2. Activities

The following activities are examples of activities that can involve longer-term individual or group work. The suggestions below are not discipline-specific, and can be adapted to many different contexts and learners, though they are intended for undergraduate university students. Many of the suggestions are fairly vague, compared to the activities above, and we recommend seeing these as suggested ways to adapt current assessments or classroom practices. Take these suggestions, and the booklet, and make them your own!

Table 6: Suggested activities plus explanations to achieve the different learning goals of interdisciplinary education.

ACTIVITY	EXPLANATION
Analyse examples of interdisciplinary work	Students can be asked to analyse an example of interdisciplinary work that is relevant to their discipline(s) as individuals or as a group. This can be an article, but could also be the process behind the development of a product as documented in a TED talk, a journalistic article or a documentary. Students can use Repko's steps and the figure on pp. 28 – 29 of the booklet as a framework based on which to analyse the interdisciplinary process. They can look for evidence of different perspectives being taken, common ground being found, or any other of Repko's steps being followed. If using a journal article, they can also compare and contrast this with the kind of academic research they have been taught to conduct, such as the APA framework for writing up research, and the extent to which this is relevant for interdisciplinary work.

Focus on perspectives	The process of taking perspectives can be dramatized in role-play activities. Students can take the perspectives of other humans, famous disciplinary theorists, and enact or devise how these thinkers might respond to "wicked problems" or each others' ideas. This involves group sense-making, and can also include devising new metaphors to explain and reflect on the process. This works extremely well in an interdisciplinary classroom, but can also work in a disciplinary classroom.
Problem solving	Working to understand, analyse and then devise solutions for wicked, complex problems is the best way to ask students to engage in interdisciplinary work. This can be individual or as a group, and the process can be as structured or as free as you think appropriate. The process can involve talking to people as well as reading, and the more opportunities for sharing ideas to a broad audience, or asking key stakeholders for feedback on solutions, the better.
Personal growth diary	Incorporate an explicit focus on the development of the skills needed for interdisciplinary work, such as creativity and curiosity, by asking students to write or develop reflections on their ability in these areas, such as a reflection diary. This can focus on during interdisciplinary work, or in general. It can be interesting to encourage students to reflect on whether the academic skills (creativity, collaboration, communication) used in disciplines, are different in nature or degree/intensity when used while working in multi-disciplinary teams. The concept of growth mindset (p. 67) could be incorporated, with students sharing examples of their own attempts to avoid a fixed mindset and approach problems with a growth mindset instead. Students can be given the freedom to choose the skills they specifically want to focus on, set their own targets and indicators of success in this personal growth activity. Students can also choose how they want to communicate their personal growth diary, as some may feel that writing is not the most appropriate medium for how they want to reflect. This can be expanded to group work, with a focus on the skills required for collaboration, by asking members of a group to track the group's process, struggles, and growth.
Reflection	Reflection activities, as well as keeping a personal growth diary, are important for learning from interdisciplinary work, and improving and growing in your interdisciplinary abilities. You can ask students to reflect on an interdisciplinary process in written form, as a discussion, as individuals or a group, or even in the form that they find most appropriate. You can also return back to the booklet and ask students to read and respond to ideas, in order to link personal reflections back to theory: Do you think you experienced interdisciplinary collaboration in this process? Read pp. 60-63 of the booklet, and the concept of "the magic" in the interdisciplinary process. Can you think of a different way of explaining this? Can you find an example of a concept that is similar to "the magic" from another discipline, such as "flow state"? You might like to look at creative arts or sports science. Explain how it is recommended to achieve this type of "magic", and compare and contrast this with the steps listed, as well as your experience of interdisciplinary work. What contributed to effective interdisciplinary teamwork? Read pp. 27-31 of the booklet, the interdisciplinary process. Choose a step in the process and come up with an ice-breaker to be used in an interdisciplinary team to prepare people to successfully enact this step in the process. Choose a step in the process and come up with a metaphor to explain how you want your interdisciplinary team to feel, communicate and work together during this step. Are you a volcano? A swarm of butterflies? A flock of sheep?

5. REFERENCES

Angerer, L., Brincker, L., Rowan, E., Scager, K. and Wiegant, F. (2021). "Interdisciplinary Orientation; Learning to navigate beyond your discipline". Utrecht University

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As the number of complex problems increase that our societies currently face, many regard attention to interdisciplinary education as a necessary step to prepare our students for multi- and interdisciplinary collaborations.

The booklet “Interdisciplinary Orientation, learning to navigate beyond your discipline”, which this Teachers’ Guide accompanies, has been written to acquaint readers with a basic understanding of interdisciplinarity, its underlying ideas and historical roots, its potential and difficulties, required skills and attitudes as well as pointers for further exploring interdisciplinarity and getting to know yourself. The Booklet can be given to students for self-study & self-regulated learning. In this Teachers’ Guide we aim to support teachers and course coordinators with ideas & suggestions for how to use the Booklet in courses and programs by suggesting specific questions to ask students, to indicate possible homework, short reflection essays, some concrete suggestions for interdisciplinary learning goals, etc.

We hope that teachers will be inspired by the ideas and suggestions that we offer in this Guide when implementing the booklet “Interdisciplinary Orientation” for students in their (disciplinary) courses or programs, to encourage students to be able to navigate beyond their own discipline.