



# **Building the 'How' of Science: A MonksHillLab Skill Development**

## **Session Series for Early-Career Researchers**

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## 1. Introduction

This living document serves as a guiding framework for a series of skill development sessions designed to build foundational competencies in communication, problem-solving, and scientific ownership for early career researchers. It was used as such within the Working Group for *Ecophysiology and Matter Cycling* of the *Leibniz Centre for Agricultural Research (ZALF)*.

Its core philosophy is that scientific expertise is not just about what you know, but how you operate. The primary goal of this session series is hence to cultivate the habits of mind essential for ownership and impact, empowering early career researchers to take full responsibility for their scientific journey.

Each session is built around a core element we call the "Engagement Starter Task"—a low-stakes, high-engagement task that serves multiple critical purposes:

- *Immediate Engagement:* It pulls participants out of a passive listening mode and into an active, collaborative mindset from the first minute.
- *Pressure-Testing Core Competencies:* The starter acts as a practical simulation, directly testing the very skills the session aims to teach.
- *Creating a Shared Experience:* It generates a common, memorable reference point that makes the subsequent theoretical discussion tangible and relatable.
- *Fostering a Growth Mindset:* By being challenging yet achievable, it builds confidence and prepares the group to engage deeply with the main content.

The remainder of each session uses this shared experience as a foundation. It debrief the starter to harvest insights, then introduce simple, powerful conceptual frameworks that participants can immediately integrate into their daily practice. This method ensures that the lessons are not just theoretical but are embodied, applicable, and lasting.

## **2. Sessions**

### **2.1 Session 1: Expectations**

#### **2.1.1 Purpose**

To establish a shared understanding of the supervisor-PhD student relationship as a two-way partnership. This session uses two experiential exercises to define the pillars of successful collaboration: the supervisor's responsibility to provide clear, empowering guidance (a "Stone House"), and the PhD student's responsibility to uphold accountability and reliability. The goal is to create a foundation of mutual respect and shared ownership from day one.

#### **2.1.2 Materials needed**

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Beamer and computer for slide show
- Whiteboard or flip chart
- Markers
- One six-sided die
- (Optional) Printouts of the "Three Houses" visual framework for the debrief.

#### **2.1.3 Session Workflow**

This session uses two consecutive starter tasks to explore both sides of the supervisory partnership: 1.) The Three Little Pigs and the Big Bad Wolf and 2.) Snow White and the 3 Dwarfs. For the first starter task participants are divided into three roles (pigs) for a quick drawing task (e.g., "draw a tree"):

- Pig 1 (Vague Instruction): The instructor gives a vague command ("Draw") and then criticizes the unexpected result.
- Pig 2 (Micromanagement): The instructor gives a command but immediately takes over the task, forcing the participant to just follow lines.
- Pig 3 (Empowerment): The instructor gives a clear, specific command ("Draw a tree with two branches and a thick trunk").

Debrief Focus: How did each style feel? This introduces the "Three Houses" framework (Vague, Micromanaging, and Empowering) as a metaphor for supervisory communication. For the second starter task participants collaboratively brainstorm and lists all components needed to write a paper (data, figures, draft, etc.). A die is rolled; any participant with a roll under 4 must remove a critical component from the list. Debrief Focus: What are we left with, and is it still a paper? This makes the PhD student's responsibility for accountability, reliability, and meeting deadlines tangible. In a final synthesis the insights from both starter tasks and debrief discussions are merged into a joint agreement on how to improve.

## **2.2 Session 2: Supervisory Meeting**

### **2.2.1 Purpose**

To empower ECR (and especially PhD students) to take initiative and get the most out of supervisory meetings, regardless whether it is a full day annual meeting or 15 min floor talk. This session addresses the common communication failure of presenting a problem ad-hoc and without context or a proposed solution ("it's not working, what shall I do?"). The goal is to equip ECR with a proactive framework that shifts their role from a passive passenger to an active driver of their academic journey ("being the CEO of their thesis/project/etc."), thus ensuring on their own that they receive the best possible guidance/advice they can get from their supervisors.

### **2.2.2 Materials needed**

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Beamer and computer for slide show

### **2.2.3 Session Workflow**

This session uses its starter task (The non-working Coffee Machine Diagnosis) to train the core of the scientific method: formulating a hypothesis, testing it, and drawing a conclusion/propose solutions. The goal is to make EXR proactive in applying this rigorous

framework to everyday problems. It teaches them to report this diagnostic process to their supervisor, not just the existence, thus asking for advice on their own thinking not a blueprint solution. For the starter task the participants are presented with the following scenario: the lab coffee machine is not working, and only the session leader knows the cause. The core rule is that participants cannot ask direct questions (e.g., "Is it unplugged?"). Instead, they must:

- State a clear hypothesis (e.g., "I hypothesize there is no water in the tank.").
- Describe the experiment to test it (e.g., "I will open the water tank and check the water level.").

The session leader then provides the resulting data (e.g., "You observe the tank is full."), allowing the group to confirm or reject the hypothesis and iterate until the root cause is found. Debrief focus: The discussion connects the exercise directly to supervisory meetings: a supervisor, like the session leader, holds key information, but the student must diagnose the situation through structured, proactive inquiry. The starter task also helps to introduce the 3-Act Communication Framework for meeting preparation and execution, which consists of:

- The BRIEF: Concisely state the current status and the specific issue. ("What is the topic?")
- The DIAGNOSIS: Present your analysis of the core problem or key question. ("What do I think is the cause or the central challenge?")
- The PROPOSAL: Offer potential solutions or specific next steps, and state what you need from your supervisor. ("What do I suggest we do, and what advice do I need?")

The session ends with practical tips for implementation, such as sending this 3-act agenda to the supervisor 1-3 days prior to the meeting and following up with a summary. This structure prevents vague problems and avoids low-quality, ad-hoc advice, ensuring the supervisor's input is focused and valuable.

## **2.3 Session 3: Scientific writing**

### **2.3.1 Purpose**

The primary objective of this session is to teach the principle of unambiguous communication in scientific writing. This is tried to be achieved by compose every text from the perspective

of a uninformed reader as an effective scientific writing strategy. Together with the use of a clear internal structure/logical flow of thoughts, and correct formalia, a precise and unambiguous language generates a level of clarity that avoids any misinterpretation, thereby "taking the reader by the hand and leading him/her through the paper, proposal, or thesis".

### **2.3.2 Materials needed**

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Pre-submitted 0.5 pages long methods sections from all participants (e.g., study site description, central measurement/analyses/sampling description)
- Beamer and computer for slide show
- One coffee maker, filters, ground coffee, a mug, and a water source.

### **2.3.3 Session Workflow**

The session is structured in two integrated parts: 1.) an engaging, principle-discovery starter task followed by a detailed debrief on why internal structure, unambiguous language/precision in language and formalia matters and 2.) a practical application of the learned. For the first part, a volunteer participant provides verbal instructions to the session leader on how to make a cup of coffee. The leader executes the instructions literally and in bad faith, deliberately exploiting any ambiguity, vagueness, or missing steps (e.g., using hands to "add water" if no container is specified, adding brewed coffee ("add coffee to container") instead of coffee beans to container if not specified that beans have to be used). This exercise creates a visual, shared understanding of how linguistic imprecision leads to catastrophic communication failure, mirroring the potential for misinterpretation in scientific texts. The second part contains the evaluation of short methods sections written by the participants in preparation of the session, thus acting as a practical application. It is executed as follows:

- Prior to the session, each participant submitted a methods section from their own work.
- The submitted texts are anonymized and redistributed by the session leader.



- Each participant critically evaluates another participant's text using the following criteria: 1.) internal structure/logical flow of thoughts, 2.) unambiguous/precise language, 3.) formalia.
- The groups add to the individual evaluations through discussion of single examples for found issues in tests
- The session leader concludes this phase by consolidating the group's criteria and providing targeted, expert feedback, reinforcing key concepts and offering refined solutions to common problems.

The session ends with a detailed debrief showing that ambiguity arises from three primary areas, forming a critical triptych for self-evaluation:

- Internal Structure: The logical flow of information. Is the narrative of the method clear? Does each sentence follow logically from the previous one?
- Language & Precision: The specific word choice and technical accuracy. Are verbs active and precise? Are quantities, temperatures, and conditions explicitly defined? Is jargon used appropriately and explained if necessary?
- Formalia: The adherence to standardized conventions (e.g., citation style, figure labeling, terminology). While sometimes perceived as minor, inconsistencies here directly undermine credibility and clarity.

Effective writing is constructed as a series of unambiguous steps that guide the reader. Participants conclude the session with a reviewed section of their own work, a clear, self-generated set of evaluative criteria structured around this triptych, and direct experience in the dual roles of a critical reader and a vulnerable writer.

## **2.4 Session 4: Scientific figures**

### **2.4.1 Purpose**

The primary objective of this session is to teach the principle of scientific figure is as a visual argument. The goal is to design figures that are self-sufficient, and guide the viewer to an unambiguous conclusion, substantiating the text of a paper/thesis/poster. A figure must be a curated visual experience that is both pleasing to the eye and easy to understand/digest.

### 2.4.2 Materials needed

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Beamer and computer for slide show

### 2.4.3 Session Workflow

The session is structured in two integrated parts: 1.) an engaging, principle-discovery starter task followed by a detailed debrief on why strategy ("What?"), execution ("How?") and formalia in making figure matters and 2.) a practical application (playing Pictionary using the whiteboard) of the learned. For the first part. The session leader instructs two volunteers on how to draw a "car":

- The first volunteer gets overly complex rules (e.g., "draw the car upside down using only triangles and making it as detailed as possible")
- The second volunteer only gets the instruction to draw a car sucha as the rest of the group can easy guess what he draes

The resulting drawings and reaction from the group in guessing what is tried to be drawn creates a visceral understanding of how ambiguous "instructions" (aka design choices in making) lead to catastrophic communication failure for the first volunteer and an easy success for the second. The debrief establishes that figures must adhere to the normal expectations of the reader. The second part contains a practical application centered on an artificial dataset about NDVI and biomass measured for a field trial. All participants get 4 minutes to create a figure design/strategy for the dataset shown in a table on the 3<sup>rd</sup> slide. When the 4 min are over each participant presents his/her design before the session leader shows the actual figure for this dataset sufficiently displaying its temporal dynamics and absolute values. Following both starter tasks, the group discussion is structured around three iterative pillars of critique and improvement when it comes to make scientific figures:

- Strategy: What is the single, central message? Participants apply the "So What? Test," forcing a one-sentence takeaway. The practical task here is to define the figure's core argument before any design begins.
- Execution: How is the message built? This focuses on the visual mechanics:

- Visual Hierarchy: What is the first thing the eye sees? Is it the most important element?
- Clarity of Elements: Are all lines, labels, and data points necessary and clearly distinguishable?
- Chart Choice Logic: Is the chosen chart type (bar, line, scatter) the most effective for the story?
- Credibility: Does the figure inspire trust? This is the "formalia" of visual communication:
  - Correct axis labels, appropriate scale, defined error bars, consistent color schemes, and a legend that needs no explanation.

The session concludes by consolidating the principles into actionable Tips and Tricks:

- Strategy First: Define your one-sentence message before opening any plotting software.
- The Multi-Panel Mandate: Use multi-panel figures to tell a sequential story or compare scenarios effectively.
- The Stand-Alone Rule: A figure must be fully understandable—including its takeaway—without reading the main text.
- The "Silent Salesman" Test: Could your figure convince a viewer of its finding if you weren't there to explain it?

## **2.5 Session 5: Work organization**

### **2.5.1 Purpose**

The primary objective of this session is to teach major principles of an effective work organization but moves beyond simple to-do lists to address the core challenge of ECR: constant overload. The goal is to equip ECRs with a strategic mindset and practical tools to manage an inherently overwhelming workload. It focuses on shifting from reactive chaos to proactive control, teaching how to make conscious choices about what to do, and crucially, what not to do, in order to reduce stress and increase effective output.

### 2.5.2 Materials needed

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- A rack with approximately 20 small containers (e.g., Eppendorf tubes)
- Pipettes
- Several different colored liquids (water with food coloring is sufficient)
- A timer
- Beamer and computer for slide show

### 2.5.3 Session Workflow

The session is structured in two integrated parts: 1.) an engaging, principle-discovery starter task followed by a group discussion and detailed debrief as well as 2.) a practical application (using the Eisenhower Matrix as prioritizing tool). The session begins with a simulated stress test (part 1). A volunteer is asked to perform a "DNA extraction" using the provided materials. Every 20 seconds, the instructor gives a new, specific task that builds on the previous one (all on slides); the sequence is designed to be impossible to complete in the time given. Simultaneously, the instructor distracts the volunteer with questions about e.g., their actual PhD work to simulate constant context-switching. The exercise is engineered to lead to a controlled, guaranteed "failure". In the debrief, the experience is analyzed by the group, focusing on how it felt for the volunteer to be in this stressful situation and how it felt to not finish one task. This is to address the likely observed facts that:

- Volunteer always jumped right into the newest given task without thinking about to finished the previous one first, thus at least finishing some tasks
- No one offered help of his peers even though seeing the volunteer struggled
- Volunteer did not ask for help neither, highlighting a common culture of silent struggle.

Afterwards, the session leader introduce the Eisenhower Matrix d as a practical framework for making prioritization choices consciously. To practice its use, the individual task lists of the participants prepared as task prior to the session are used and sorted into the Eisenhower matrix within the slide show by the session leader for single participants. Finally, the session

concludes by sharing practical rules of thumb: the Template Rule (create templates for any repetitive task), the 15-Minute Misery Rule (dedicate 15 minutes daily to a hated admin task), and the 30-Minute Rule (if a task takes less than 30 minutes, do it immediately to clear mental load).

## **2.6 Session 6: Scientific Presentations**

### **2.6.1 Purpose**

The primary objective of this session is to move beyond the simple transfer of information to the construction of a compelling scientific narrative. The goal is to teach ECRs how to design a presentation as a curated, visual argument that is both intellectually rigorous and engaging for an audience in an effective manner. The focus is on clarity, structure, and audience adaptation under real-world constraints.

### **2.6.2 Materials needed**

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Beamer and computer for slide show
- Computer for participants
- Timer
- Single dice

### **2.6.3 Session Workflow**

The session begins with a starter task named "Planned Panic". The session leader sets the initial scenario as follows: an important international guest has arrived, but the (notoriously unreliable) coffee machine of the WG is broken. While the PI steps out to resolve the crisis, the ECRs must keep the guest engaged.

To do so, they have 15 minutes (prior to the arrival of the guest presumably) to prepare a maximum 3-slide presentation about their own work, designed for a 5 minute talk. The presenter are not chosen in advance; after the preparation time, a single dice roll determines who (2 to 3 depending on group size) will present to the "guest" (the group). This simulates the need to be prepared to communicate clearly and effectively at any time, to any audience. Following the presentations, the session debriefs. As discussion by the group, pros and cons of the heard presentations are analyzed, focusing on the strategic choices made under pressure. This leads directly into the introduction of the three pillars of a successful and effective presentation:

- *The Arsenal:* Building and maintaining a personal repository of high-quality, reusable slides and figures to assemble presentations effectively (e.g. in 15 minutes), avoiding the inefficiency of starting from scratch.
- *The Storyline:* Constructing a clear narrative using frameworks such as the 3-act narrative (Problem → Findings → Proof) or headline communication (where every slide header states the slide's core message).
- *The Practice:* The necessity to practice aloud and often to internalize the narrative, enabling the presenter to react flexibly to the audience and setting rather than simply reciting a memorized script.

The session concludes by general minor tips and tricks such as the rule of 2 minutes per slide when it comes to presentation time, clear the clutter rule (remove all non-necessary), ect.

## 2.7 Session 7: GHG Flux Calculation

### 2.7.1 Purpose

The primary objective of this session is to demonstrate that calculating GHG fluxes is not a straightforward task. The goal is to reveal the hidden complexity within flux calculation algorithms, thereby building a critical understanding of why using standardized, well-tested scripts is essential. The focus is to develop troubleshooting skills and the ability to interpret—not just blindly run—standardized code, shifting time and effort from reinventing methods to the underlying science.

### 2.7.2 Materials needed

The following minimal materials are required to facilitate the practical starter and subsequent discussion:

- Beamer and computer for slide show
- Timer
- Computer for participants

### 2.7.3 Session Workflow

The session begins with a starter task designed to induce engagement and reveal core assumptions. The session leader shows a simple, linear concentration-time plot from a closed-chamber measurement, without specifying the gas or measurement context. ECRs are split into groups and given 15 minutes to design a step-by-step algorithm to calculate the flux from this idealized data. Each group then presents their method. Following this, the leader reveals three problematic real-world datasets (e.g., non-linear, noisy, or too short). For each, the group discusses how their simple algorithm would process the data and where it would likely fail, highlighting the practical complexity of robust flux calculation. This revelation leads directly to introducing the working group's standardized R scripts, explaining their built-in features for handling such complexities (e.g., model selection, outlier detection). Key practical tips are shared: always visualize raw data first, understand the output flags, and develop a personal troubleshooting checklist for preparing data and running scripts (e.g., checking chamber seal, assessing fit appropriateness, judging result plausibility). The session concludes by reinforcing that the goal is not to write new code, but to become a critical, expert user of the established tools. This approach saves time and mental energy for the actual science, rather than the methodological overhead of GHG flux calculation.

## 2.8 Session 8: Project Proposal Writing

### 2.8.1 Purpose

The primary objective of this session is to demystify the proposal writing process by focusing on the most critical first step: finding the right "match" between a research idea and a funding agency. This session teaches ECRs that a successful proposal is not just about the quality of

the science, but about how well that science aligns with a funder's specific mission and core motivations. By the end of the session, participants should understand that different funders (e.g., DFG vs. Federal Ministries) seek different types of impact and that a proposal must be tailored to these specific expectations to be successful.

### **2.8.2 Materials needed**

The following minimal materials are required to facilitate the practical starters and subsequent discussion:

- Beamer and computer for slide show
- Pre-submitted proposal ideas: 0.5-page descriptions of a research idea from each participant (submitted one week prior).
- Role descriptions for Starter Task I: A list of different "coffee machine committees" with unique preferences and constraints (see attachment)
- A list/catalog of available coffee machines for the committees to choose from (see attachment)

### **2.8.3 Session Workflow**

The session is structured around two starter tasks that build from a decision-making exercise acting as an analogy to a practical matchmaking application for their own research. For the first starter task ERCs are told the lab coffee machine is broken and must be replaced. The group is divided into three committees, each representing a different "funder" archetype with hidden preferences (e.g., one prioritizes technical durability, another seeks the lowest price, and another wants innovative features (descriptive text in attachment for this session)). The three groups have 5 minutes to discuss and choose one machine from a provided list that best fits their specific (though initially hidden) criteria. To debrief, all ECRs discuss why each group did choose a different machine? This reveals that the "best" choice depends entirely on who is "funding" the purchase. This is used to introduce the different funder types (DFG, Federal Ministries, EU, Foundations) and their core motivations.



The second starter task uses the ECRs own project ideas to practice real-world funder alignment (send prior to session by each ECR as 0.5 pages project idea to session leader). For the starter task each student receives a peer's anonymized 0.5-page project idea. They have 5 minutes to read it and 1 minute to present the core idea to the group. The entire group then argues which funder (e.g., DFG, EU, GIZ, or a specific foundation) would be the best fit for that specific idea and why (e.g., Does the project need to be framed as "basic science" for the DFG or as a "practical solution" for a ministry?) and the session tips and tricks for research proposal writing.

## **2.9 Session 9: Thesis Brackets Writing**

### **2.9.1 Purpose**

The "bracket" or "mantle" of a cumulative PhD thesis is often misunderstood as a mere summary of publications. This session shifts the mindset from a sum of papers to a real synthesis. By forcing participants to find a common theme/topic for rather random paper topics, they learn to identify the actual storyline that connects their own research. The session further emphasizes that a thesis is evaluated on that synthesis and the overarching scientific story, not the individual papers.

### **2.9.2 Materials needed**

The following minimal materials are required to facilitate the practical starters and subsequent discussion:

- Beamer and computer for slide show
- Pre-submitted paper topics/titles by ECRs (submitted one week prior).
- The "Paper Jar": A container filled with folded slips of paper containing paper titles/topics collected from participants beforehand.
- Dice

### **2.9.3 Session Workflow**

To introduce the concept of a thesis synthesis, the session leader presents an "impossible match" between two papers: one on archaeological mapping of Roman fortresses and another

on remote sensing of crops using plant indices (represented by the comic within the slide show). The connection is revealed to be the identification of sub-surface structures via "crop marks," demonstrating how a strong conceptual "bracket" can unite diverse studies into a coherent investigation. Following this, the session moves into the "Paper Roulette" starter task. Pairs of ECRs draw three random paper topics from a jar and have fifteen minutes to develop a single overarching thesis title and a logical storyline integrating them. To keep the energy high, groups roll dice (after 15 min presentation time), and the three highest rollers pitch their integrated outlines for five minutes. This leads to a group discussion on whether the integration feels like a genuine scientific advancement or a "forced" connection. The session concludes with practical tips for writing the bracket.

## **2.10 Session 10: Scientific Poster Presentation**

### **2.10.1 Purpose**

The primary objective of this session is to redefine the scientific poster as a strategic hook rather than a mere transfer of knowledge. Unlike a presentation, which provides a guaranteed audience, a poster must deserve its audience by actively attracting attention in a high-competition environment. Participants will learn that designing an effective poster often requires more effort than a talk because the poster must act as a "silent salesman"—it must be self-sufficient enough to convince a viewer of its findings and initiate a conversation without the author's immediate input. The goal is to move from "data dumping" to creating a visual experience that sticks out from the mass.

### **2.10.2 Materials needed**

The following minimal materials are required to facilitate the practical starters and subsequent discussion:

- Beamer and computer for slide show
- Pre-submitted posters from ECRs (submitted one week prior).
- Computers for groups to perform the "Pimp My Poster" task.

### 2.10.3 Session Workflow

The session starts with a first starter task, which simulates a conference Poster walk. ECR stand 2.5 to 3.0 meters from the wall while a slide show of up to 8 pre-submitted posters moves from right to left, staying on screen for only 10 seconds each. Afterward, 2–3 "volunteers" try to name the topics and core messages they remember. This is followed by a discussion, which centers on how little is actually retained during a standard walk-through and what specifically caused certain posters to stand out (or fail to). During the second starter task ("Pimp My Poster"), groups of two receive a peer's poster and have 15 minutes to analyze and implement immediate improvements. The focus is on creating an appealing layout, guiding the reader's eye, and removing text overload. Afterwards, the groups present the "Old vs. New" versions to the group to demonstrate how external perception might differ from the author's intent. These starter tasks are followed by more general tips and tricks as well as three practical example for potentially working "Poster hooks".

## Appendix — Slide Show Presentations

### List of Sessions:

1. 03\_MonksHillLab\_Session\_Expectations\_I.pptx
2. 04\_MonksHillLab\_Session\_Supervisory\_Meeting\_I.pptx
3. 05\_MonksHillLab\_Session\_Scientific\_Writing\_I.pptx
4. 06\_MonksHillLab\_Session\_Scientific\_Figures\_I.pptx
5. 07\_MonksHillLab\_Session\_Work\_Organization\_I.pptx
6. 08\_MonksHillLab\_Session\_Scientific\_Presentations\_I.pptx
7. 09\_MonksHillLab\_Session\_GHG\_Flux\_Caculation\_I.pptx
8. 10\_MonksHillLab\_Session\_Proposal\_Writing\_I.pptx
9. 11\_MonksHillLab\_Session\_Thesis\_Brackets\_Writing\_I.pptx
10. 12\_MonksHillLab\_Session\_Scientific\_Poster\_Presentation\_I.pptx