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Humility and grit: how can PhD students deal with eco-inadequacy?

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There are two principal reasons for pursuing PhD studies: curiosity and career development. But there is also the intention to make a difference, *e.g.*, by mitigating climate change, tackling pollution, or combating social and economic inequality. It is this intention that is the focus of this letter. Perhaps you have just started your PhD studies and are already overwhelmed by the sheer magnitude of the challenges ahead. Or maybe you are approaching the end of your studies and feel that you have achieved little, or that your work is meaningless. Alternatively, you might be a supervisor or mentor who is trying to comprehend why some of your students are plagued by feelings of despair and inferiority. Here we would like to raise our voices to move this overlooked issue to the fore.

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Many of your peers in a wide range of disciplines, from the natural sciences to the social sciences, battle with this sense of frustration and failure, which we term *eco-inadequacy*. Yet these feelings are seldom discussed in the scientific (or indeed the wider academic) community, and students bury themselves in work instead. They feel alone and perhaps even disappointed with the path they have taken so far.

This letter offers you a different perspective. One important point to remember is that you are not doing a one-off marathon, but a lifelong journey that will stretch far beyond your PhD studies. Our message here is that you need to take care of yourself so that you can make a lasting contribution: when feasible, take time to reflect, collaborate and expose yourself to other disciplines. While your degree is important, your true goal was always to contribute to the world. Remember *why* you love the planet we live on, and focus on setting the stage for a long and fruitful career in which you can make a difference.

Students select their courses driven by curiosity, to boost their careers and – in our experience – increasingly because they are concerned about the future of our planet. Fortunately, many universities around the world today offer a wide range of forward-looking courses that *equip* students with the tools needed to tackle pressing environmental and socio-economic challenges *via* their future professions. In the meantime, many campuses have a diverse student body, one that offers opportunities for debate alongside the need to complete coursework and pass exams.

The majority of students complete their university education at the Bachelor's or Master's level, and then find employment in the private, public or non-profit sector. Some even start their own companies. Yet some students start a doctoral degree, and this is where *your* journey continues. You are deeply curious about your subject and your goal, as you understand it, is to become an expert in your chosen field. Surely a few years spent researching a topic in depth will enable you to both advance your career and make a meaningful contribution?

The latter ambition does not necessarily coincide with the traditional scope of many PhD programs. Some programs demand more course work, some include teaching duties, many have a specific time frame, and most come with the pressure to write and publish scientific articles. In countries from Spain to South Africa and Australia, you might be encouraged to deliver a PhD thesis by publication,[1] while in others – China, for instance – first-author publications are effectively mandatory.[2]

These quantitative metrics result in PhD students measuring their success against the achievement of their peers. Here, the supervisor and research group culture are of critical importance (see our

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advice below). At best, competitiveness is invigorating and leads to mutual inspiration. At worst, research turns from a knowledge-seeking quest into a pragmatic exercise, where the impact of a scientific work in terms of the prestige of the publication and, ultimately, its "citations" becomes more important than the insight gained. This can undermine your commitment to the values of *science*, such as creativity, objectivity, and accountability. Moreover, the increasing occurrence of scientific misconduct can make PhD students question academia. And then there is the rise of artificial intelligence, a wonderful tool, but one that can be intimidating and requires careful use. It is within this environment that students reach the end of their PhD journey and contemplate the next step in their career.

At this point, it is perfectly natural for PhD students to compare their ambitions with actual tangible achievements, which can trigger distress and feelings of inferiority. For students seeking to expand the boundaries of scientific knowledge, the original ambition to *save the planet* is coloured by the realisation that their own contribution seems small. This can lead to an overwhelming sense that your work is inadequate when considering the gravity of environmental and socio-economic challenges: "Sometimes I question my worth to society".[3] We term this state of low self-esteem and anxiety in the face of ecological challenges *eco-inadequacy*. Such feelings are shared by professionals and students across many disciplines.

These insights, which arose from discussions with historians, lawyers, natural and social scientists, writers and artists-in-residence during a shared sabbatical at the Stellenbosch Institute for Advanced Study (STIAS), is what prompted us to share our thoughts with you. Throughout the academic community, there is a need for real concern for how best to support graduate students in an increasingly fragile and violent world, with fake news and huge and seemingly unsolvable problems on all sides.

Take eco-anxiety, for example: the despair felt in the face of grim environmental issues such as increasingly catastrophic climate change.[4,5] Considering that sustainability science has environmental, social and economic dimensions, such bleak feelings can affect peers from the natural and social sciences alike. A materials scientist may be frustrated because we replace plastic shopping bags with ones made of cloth, but do not deal effectively with the main sources of microplastics, such as car tires and textiles; an ecologist may experience *solastalgia*[6] while witnessing the destruction or loss of a natural habitat or the extinction of a species; a researcher in women's studies may despair because of persisting gender bias across the globe; a historian may lose hope because an age-old conflict resurfaces; and an economist may be distressed by widening social and economic inequality. So do not hesitate to share your feelings with others – you are not alone with your frustrations.

The perspective of time and history is helpful in dealing with these feelings. The Anthropocene started a long time ago, and the horrendous impact on climate that we are witnessing today was caused by actions taken in the past. This is not on you, but on previous generations. Therefore, you should not feel desolate because your PhD work has not yet had a tangible impact. The duration of your PhD studies is not the most helpful timescale. Instead, rather consider your long-term career and impact.

What is (or will be) on you is how you will use your knowledge throughout your career, be it as a scientist, engineer, activist, business leader, bureaucrat or politician. Remember that some of the greatest minds of the sustainability movement made lasting contributions only very late in life. Examples include Hans Carl von Carlowitz (1645–1714), who coined the term *Nachhaltigkeit* (German for sustainability) when he wrote about forestry in 1713;[7] and Rachel Carson (1907–1964), who raised awareness about the toxicity of widely used chemicals such as the pesticide dichlorodiphenyltrichloroethane (DDT) in her seminal book *Silent Spring* published in 1962.[8]

Therefore, give yourself time; continue to learn and maintain the passion and conviction that you had when you started your PhD studies. Remember that scientific discoveries take time to disseminate. The ability to examine long-held beliefs in retrospect or from a broad perspective is often an acquired trait based on scientific experience and awareness, and one that takes a lifetime to learn and practice.

Finding sustainable solutions necessitates collaboration in which researchers from a broad spectrum of different disciplines contribute through an iterative process. Instead of elevating the person who first makes a discovery, we must learn and develop in tandem with one another. Effective science is no arm-wrestling contest, but rather a team sport. The more diverse the research team and the more collaboratively we work, the better. Like many scientists, you probably already work long hours and there will be periods when this is both necessary and appropriate. In fact, it might be hard to satisfy your intellectual curiosity and passion if you allow too many interruptions to your work. Regardless, you should *not* work even more but rather dedicate at least a small portion of your productive hours to interacting with colleagues from different backgrounds and disciplines. While online meetings are sometimes preferable, we insist that some personal contact – often necessitating travel – is important to engage deeply with colleagues and gain first-hand experience.

Reflect on the purpose and context of your research. It is easy to be caught up by the need for productivity; writing and publishing papers is after all the means you have for sharing the knowledge you have gained. Yet many students loathe writing simply because they are required to do so. Instead, treat the written word as an opportunity to express yourself, to interact with peers, and to develop your professional abilities.

We are aware that you may be working in an environment where you experience immense pressure from your peers, your supervisor, and also "the system" – which will only promote the most "promising researchers", as defined by a narrowly selected set of quantifiable criteria. However, an occasional "*lying flat*" response, *i.e.*, rejection of the pressure to

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overachieve, will not only preserve your mental health, but also equip you with the resilience and grit that you will need to make a lasting difference. You will be more creative if you give yourself time to reflect, collaborate and seek dialogue with others, a process Isabelle Stengers calls *Slow Science*.[9] We are not suggesting that you work less. After all, working toward a PhD is, and will continue to be, hard work. However, we do ask you to broaden your view. Coincidentally, the soft skills that you hone by taking in different perspectives will also make you more employable; and collaboration can be key to identifying post-doc opportunities. Ask yourself: What is more important, one high-impact idea published today, followed by burnout, or a cumulative and collegial contribution to your field throughout a long career? Also remember that in the long term your legacy is more than just your research: the work you will do as a colleague, teacher, mentor and role model is equally important.

So how to proceed? There are a number of actions you can take to develop a more positive outlook. In the text box below we have compiled an essential list: the first part focuses on you as a person, while the second part addresses your professional self. The actions that you take as an individual can only tackle *your* current situation. Supervisors and ultimately the institutions that enrol PhD students have a responsibility to learn from the challenges that you and your peers are facing. We encourage policies that, *e.g.*, educate supervisors, foster teamwork rather than competition, provide support for tackling emotionally difficult topics, and enable career paths beyond academia by cultivating relationships with the private, public and non-profit sectors. Ultimately, working toward a sustainable future requires a collaborative effort between students, supervisors and our institutions.

We would like to briefly share a few of our insights with our fellow supervisors. We must remember that our role is to support our students and ensure they are not left to navigate this journey alone. It is equally important not to forget the time when we were in their position (even if it was long ago), the emotions and challenges we faced during that critical PhD phase, and the fact that the dynamics in academia are constantly evolving. There is no doubt that this topic deserves a dedicated discussion. For now, we will conclude by sharing our personal experiences from our laboratories. We were at first very concerned that our message might result in an exodus from the lab. However, the opposite has happened. Since we shared the thoughts expressed here, our students are more engaged with their studies; they ask critical questions more often, and – excitingly – we have witnessed a tremendous rise in creativity. Maybe, despite everything, there are ways to make science more fun again, while at the same time contributing to a more sustainable future.

How to take care of yourself

- First of all, cherish your curiosity and passion for your subject. These are your most potent motivators.
- Don't forget yourself: you have come this far because of who you are. Don't let work take over every aspect of your life. Enjoy your hobbies and sports. These will also help you deal with anxiety and despair – exercise is especially good for mental health.
- Every so often, read a book or a poem, go to a concert, an opera or musical, visit the theatre or an art gallery to broaden your horizons. Art can unlock creativity in research and can also be a source of emotional comfort and support.
- Travel and engage with other cultures. Take the train if possible. You may be able to travel "on campus" by meeting and mixing with fellow students.
- Learn to cook and explore the *science of cooking*. Invite your fellow students to dinner. Talk to your friends and family. Carry their recipes forward into the future.
- Grow vegetables and maybe even plant a tree.
- All researchers fail more often than they succeed. Do not forget to celebrate your wins, even small ones.

Professional advice to PhD students

- Be strategic. Know your expectations and select your research environment and supervisor accordingly. If you have already started your studies, share your expectations and ask your supervisor to do the same.
- Remember that you can restart your PhD (this advice is based on the personal experience of one of the authors).
- Decline positions that are not financially acceptable.
- Seek a mentor who can provide you with counsel and guidance.
- Be mindful of how you spend your time. Understand when you are most creative and productive and be protective of these hours. Challenge routines.
- Making time is difficult for everyone; maybe carve out two hours a week for reflection, dialogue and collaboration.
- Do not measure the *quantity* of work that you do; instead, focus on quality through the research questions that you address.
- Be impatient with more senior colleagues! Challenge your supervisor by asking what they are doing *right now* to address our many environmental and socio-economic challenges.
- Set yourself practical goals such as mentoring high-school students, public outreach, activism, *etc.* If these overlap with your personal interests and hobbies, even better.
- Once you have reflected on the meaning of your work, from both a short- and long-term perspective, revisit the hypotheses of your PhD thesis.
- Finally, write a letter to your future self, to help determine where you are heading. Do not forget to state why you are passionate about sustainability. You may have forgotten twenty years from now.

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