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Higher Education and Wicked Problems: Students Engaging with Complexity and Uncertainty in Sustainability Transitions

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Abstract
The challenges we collectively face, such as climate change, are characterized by more complexity, interdependence, and dynamism than is common for educational practice. This presents a challenge for (university) education. These sustainability transition challenges are often described as wicked or VUCA (Volatile, Uncertain, Complex, and Ambiguous) problems. In response, educational innovations that are inspired by ecology, such as living labs are starting to emerge, but little is known about how students engage within and with these more ecologically-inspired forms of education. This work is an exploratory study into how students navigate VUCA learning environments linked to tackling sustainability transition challenges, with a focus on the positive qualities of these experiences. This is done through interpretative phenomenological analysis (IPA) of seven students (using semi-structured interviews) of the MSc Metropolitan Analysis, Design and Engineering program, a joint degree from Wageningen University and Delft University of Technology in the Netherlands. The main findings, which are both psychological and educational, of this exploration include openness to new experiences (1), flexibility (2), a process appreciation of learning (3), a desire to create a positive impact on one's direct biophysical environment and society (4). In addition, we discuss the potential limitations of the malleability of these different qualities and propose future avenues for research into ecological learning for universities. This work closes by highlighting recommendations for educators to consider when designing or engaging in ecological forms of higher education that connect to sustainability transitions.

Keywords: Higher Education, Wicked Problems, VUCA, Complexity, Uncertainty, Sustainability Transitions, Ecological Learning

'*But I do remember how hard it was when it was pouring rain and we had to still like pick out the weeds. That was not fun to do. But I think that helps in learning how it works. Interact with it, I think*'

1 Introduction

Today, in 2021, humanity faces a wide range of wicked challenges including an enduring global pandemic and dire climate predictions (Masson-Delmotte et al., n.d.). With the world in disarray, the need for educational transformation to adapt its approach to fit the volatile, uncertain, complex, and ambiguous (VUCA) nature of these problems is more evident than ever. However, engaging with an education that connects to VUCA transition challenges also asks different psychological qualities from students. Educational institutions need to transform their approaches and practices to prepare to deal with the wicked problems of a VUCA world and to help shift the world towards a sustainable path. One approach that has been adopted by educators in the field of sustainable development is forms of *ecological learning*.

Learning ecologies, the environments that foster ecological learning, provide a new approach towards higher education. Starting from a relational understanding of education (Biesta, 2021, Wals, 2019), the focus of learning ecologies primarily lies on creating the conditions for students (e.g., Pisters et al., 2019) to connect with and act on a particular challenge in a particular place. By critically reflecting on those experiences, students challenge their assumptions, shift perspective and engage with *transformative learning*. A range of educational shifts is at the heart of this movement, such as shifts from passing on knowledge to understanding and getting to the root of the issues, from teaching attitudes and values to encouraging values clarification, from raising awareness to changing the mental models which influence decisions and actions, from answers to asking better questions, and from seeing people as the problem to seeing people as facilitators of change (Tilbury, 2011). Examples of such learning ecologies already in practice include the Challenge Lab initiated by Chalmers University of Technology in Sweden (Holmberg & Larsson, 2017), and the MSc MADE Urban Living Lab Course at the Amsterdam Institute for Advanced Metropolitan Solutions (Bohm et al., 2020; Steen & van Bueren, 2017; Vogel, 2020). Although there is a growing body of research on how these learning ecologies can be shaped, we know little about students' experiences within them. To rethink education to be better equipped to deal with VUCA sustainability transition challenges. And so that it enables transformative learning and provides students with the necessary life skills to thrive in complexity and uncertainty, we need to acquire insights into the experiences that students gain there.

In this paper, we will focus on students' lived experiences as they unfolded while navigating uncertainty and complexity. We zoom into Amsterdam, the Netherlands, where the MSc Metropolitan Analysis Design Engineering (MADE) program provides us with a specific research context. Through seven semi-structured interviews with students in this program and an Interpretive Phenomenological Analysis (IPA) approach to the data gathered, we indicate answers to the central question in this paper: how do students navigate uncertainty and complexity in higher education that links to and co-creates sustainability transitions?

2 Theoretical Background

2.1 The Nature of Wicked Problems

The rise of higher education programs that specifically focus on sustainability transitions at the core of their curriculum such as those identified above introduces the specific nature of sustainability challenges into educational practice (Wittmayer, Schäpke, van Steenbergen, & Omann, 2014). Rittel and Webber (1973) were the first to point out the nature of these challenges and consequently coined the term *wicked problems*. According to them, wicked problems are "ill-defined, rely upon elusive political judgement for resolution" (p. 160), and include nearly all public policy issues. Recently, in the context of sustainability transitions and a wide range of fields, the nature of these problems has been defined as Volatile, Uncertain, Complex, and Ambiguous (VUCA)(Schick, Hobson, & Ibisch, 2017). Scientific theories and approaches for confronting social policy problems have fallen short because of the nature of these problems. The positivistic paradigm of science and engineering cannot be applied to these problems because they are designed to solve *tame* problems, which are definable, separable, and have findable solutions. Wicked problems are characterized by at least ten distinguishing properties such as the lack of a "definitive formulation", solutions not being "true-or-false, but good-or-bad, and not possessing "an enumerable (or an exhaustively describable) set of potential solutions" (Rittel & Webber, 1973, p. 161). Pohl et al. (2017, p. 329) identify the "purpose of dealing with wicked problems" as the factor that substantially distinguishes transdisciplinary research from standard research. Research since the 1990s has shown the need for multi-stakeholder constellations of actors and disciplines to collaborate in a process of co-producing knowledge. There is a growing consensus that transdisciplinary approaches to research and education are required (Hadorn et al., 2008). In educational practice, this means students need to learn how to think and act from the perspective of multiple disciplines simultaneously. Or even to transgress these boundaries entirely (Lotz-Sisitka, Wals, Kronlid, & McGarry, 2015).

2.2 Complexity Theory

Uncertainty and complexity are two closely related concepts. Complexity refers to systems whose aspects are connected via non-linear, dynamic interactions. As a consequence, these interactions are characterized by interrelationship and interdependency. Uncertainty relates to the paradox that "while our understanding, knowledge, and technical power continue to increase, we face greater uncertainties than we previously have" (Dovers & Handmer, 1992, p. 262-263). With our growing ability to influence our environment, more unintended and unpredictable outcomes arise. In other words, the challenges, and systems we work with are becoming more complex. Which subsequently raises the uncertainty involved. However, from a human sciences perspective, the more uncertainty is introduced the more unsafe a learning environment becomes. This represents a paradox for universities that intend to engage with transition challenges (Kaufman, 2020).

One framework that unites both concepts is complexity theory. This is a theory that has been developed and used throughout a wide range of fields and theories such as general systems (Amagoh, 2018), cybernetics (Sage, 2013), chaos (Warren, 2013), ecological (Preiser, Biggs, De Vos, & Folke, 2018), enactivist (Sumara & Davis, 1997) and autopoetic theories (Gregory, 2006). "Complexity theory examines how living phenomena (learning, for example) emerge in a web of relations that form among things, including both social and

material things, such as bodies, instruments, desires, politics, settings, and protocols" (Fenwick & Dahlgren, 2015, p. 360).

Complexity theory aligns strongly with the ecological perspective on learning. The non-linear cause-effect structure of these uncountable relations leads to the continuous development of novel possibilities and exercise multiple causal influences on what emerges. These continuously evolving and emerging structures are the reason why complexity and uncertainty are so closely related. The notion that complex systems are characterized by uncertainty also means that the effects of human actions can never be fully anticipated or predicted (Portes, 2000) and that unexpected and unintended consequences are inevitable. As a consequence, the use of words such as emerging and navigating is prominent over terms such as managing, steering, or controlling transitions (Olsson, Galaz, & Boonstra, 2014). Acknowledging that uncertainty is inherently part of the change in complex systems then leads to the question of how to thrive with these dynamic qualities of complexity, especially for students who engage with sustainability transition challenges through learning ecologies.

3 Methodology

According to Jackson (2013), an individual's learning ecology encompass their processes and set of contexts, relationships, and interactions that provide opportunities and resources for learning, development, and achievement. An ecological approach to education thus includes both iconographic and relational qualities. To investigate the lived experience of master students learning to navigate uncertainty and complexity in higher education that links to and co-creates urban sustainability transitions, a method that can explore both dimensions is required. One such method is interpretative phenomenological analysis (IPA), which we conducted on seven semi-structured interviews with students of the MSc MADE program (Metropolitan Analysis, Design and, Engineering)[1].

IPA has roots in psychology but is also frequently used in related fields such as human, social, and health sciences (Smith, Flowers, & Larkin, 2009). The phenomenological aspect of IPA describes the focus on investigating the individual experience as the central aspect, rather than trying to fit it in abstract, predefined categories. It is based on the concept of phenomenology by the philosopher Edmund Husserl (Smith et al., 2009, p. 12) who emphasized the importance of going "back to the things themselves". The goal is to break through the "hierarchy of experience" (Smith et al., 2009, p. 2) which starts with the most elemental level, the unconscious, the rather passive flow of experience. The real focus of IPA however, is to engage with the experience point when everyday events become meaningful forms of living. These more complex types of experience usually occur when something important or impactful happens to us - this can be a negative, positive or indifferent aspect. It turns from just experience into 'an experience'. This change in quality usually is accompanied by elevated levels of awareness, consciousness, and hence, the richness of details. This focus of IPA on meaningful, or transformative, experiences also explains the emergence of the method in health-related topics. For this analysis, we hypothesized that engaging with the ecologically inspired MADE course was a meaningful enough event for IPA.

[1] MSc MADE is a two-year joint-degree master program from Wageningen University and Delft University of Technology located at the Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute). The program focuses on urban sustainability by a largely challenge-based pedagogical approach. Many courses take real-life, urban challenges from the Amsterdam Metropolitan Area as a starting point of learning, and students from different disciplinary backgrounds investigate these challenges in a transdisciplinary way.

The second step of IPA is interpretation, this is done iconographically before relational patterns are sought. In this study, this step was primarily conducted by the first author. The research team discussed and an intersubjective consensus for the interpretations was sought.

4 Results

4.1 Openness to New Experience

Participants showed appreciation and enjoyment in working on openly formulated problems: *'I think for me, what was really interesting in this challenge was, again, this was fully open-ended and up to us, it was not like organized by teachers or anything, we just had to reach out to experts, to also teachers, but it was all up to us'*. They also mirrored the importance of openness for complexity: *'I think that's what I liked about the open ends (...) I think that's for the really large and complex issues, that is sort of necessary because you cannot know upfront what is the most important thing'*. Appreciating open approaches to problems mattered to the students, as well as certain freedom, or sense of agency, in their own personal and professional choices. Many of the participants enjoyed working in transdisciplinary environments because it allowed them the opportunity to keep their development as broad as possible. One student explained this as follows: *'I can have architecture in a place but change that place of the architectural designer into something that is more open. I like it because I can work in whatever. If you have a lot of works (...) it's always challenging, because you're always trying to learn new things from that'*. While this quality proved to be important for the students themselves and their own development, they also appreciated openness in the people they worked with, such as problem owners. Openness can be seen as a catalysator for new ideas and progress: *'I was actually kind of surprised. The municipality is lucky to have some people that just were like: 'Yeah, why not? Let's see where it goes. Because that's where the right innovations happen'*.

4.2 Psychological Flexibility

Being cognitively and behaviorally flexible seems to play a major role in successfully dealing with complex systems and interdisciplinarity due to the inherent multiplicity of factors and the consequent variety of possible approaches. The presence or lack of flexibility often becomes apparent in confrontation with conflict or unexpected events. When approaching a complex problem, there are multiple possible angles and perspectives to take. Often the optimal approach is not clear initially and emerges throughout the process as information is gathered. One student described it as follows: '*But that also felt in the beginning at the start, there were so many things that are happening on the housing market, and so many things that are not going that great, that it was also a bit of: 'Okay, how are we going to start ever?*''. This uncertainty of outcomes then requires a certain level of flexibility during the process. Additional options emerge while others can be ruled out or fall away: '*Yeah, and being flexible [is important]. Like yeah (...) in our group, we want to do focus groups, but if we didn't had focus groups, then we had to be flexible'*. Staying aware of this constantly changing context and adapting the action plans accordingly is effortful and can cause a considerable amount of frustration. Especially when promising routes that a student has invested time and effort into turn out to be unfruitful. The required flexibility seems to be a learnable skill to a certain degree formed by previous experience such as prior education. One student described the influence from her previous degree as follows: '*Maybe hierarchy is not the good word, more structure. And I think I liked working in that way better. Because I also really like when things make sense. And maybe that's because my technical background*'.

Switching roles within transdisciplinary teams also requires high levels of flexibility. Depending on the composition of the team and skill sets of the other members, each individual needs to find his or her place over and over. One participant described this fluency between roles: '*You're working with so many different people with all the different expertise (...) you have to find where your position fits best, and what your qualities are that you can use in this time or this project*'. However, to a certain degree, a person's level of flexibility also seems to be subject to personal preference or a character trait. It is important to mention that flexibility should not be seen as a dichotomous concept, where an individual is flexible or not, but rather on a continuum. The same student also said: '*But [uncertainty] also set us free. So little bit like, you can also be like, go crazy and creative*'. Hence, certain preferences for structure can also go hand in hand with, ergo is not mutually exclusive of, appreciation of flexibility. The creativity aspect of flexibility got mirrored by other participants who explicitly mentioned it as an aspect they enjoyed: '*I really enjoy the fact that you just have to figure everything out. So it's like a constant adventure and roller coaster (...) Because of the defining, like, puzzle and to find out something new to create something new, and be creative with whatever people put on the table*'. Almost all participants reported on their flexibility relating to their study choices. Many of them decided to join the MSc MADE program on a gut feeling or following a happenstance: '*So then I started looking for information and actually decided to switch on the final day before the deadline. And I think that was a great decision*'.

4.3 Process Appreciation of Learning

The reply of one student to the question of whether there are aspects that they wished they had known when they started the program displays the appreciation of learning as a process: '*There's not really a thing that I thought I should have known already. (...) And it also kinda beats the purpose of education (...) There might be things that I've learned where I was like, well, if I knew this few years ago, I would have done my courses better. But then what's the point?*'. Certain aspects are not something you learn by reading a book or by hearing about them in a lecture, certain aspects need to be experienced. The important feature then does not consist of the fact or the knowledge itself but rather the process of dealing with a challenge. It involves struggling with a problem and then overcoming it. This type of learning then becomes more valuable and ingrained than just a simple transfer of knowledge. Another participant described her experience as a young child in the school's garden: '*But I do remember how hard it was when it was pouring rain and we had to still like pick out the weeds. That was not fun to do. But I think that helps in learning how it works. Interact with it, I think*'. These accounts stress the importance of ecological learning forms such as the living labs implemented in the MADE program. In addition to this appreciation of the process itself, the participants displayed high motivation for self-improvement and self-development through seeking out learning opportunities. As mentioned, interdisciplinary contexts provide a rich environment for these opportunities by exposing the individual to a wide variety of possibilities and perspectives: '*That's something that I choose then to focus on that every time in a new project, I choose something that I really want to learn, and then I'm going to make that my new expertise. But I think that that is every time something new, I'm learning also for myself, but from within, from my background, I'm usually the connector of everything.*' This constantly evolving set of new requirements is rich in opportunities while simultaneously setting high expectations for the student. This experience can be frustrating but also extremely rewarding: '*That's my motivation to also already start learning how other people from different backgrounds in this program work together. And that's not always very easy, but very interesting*'. It seems that a growth mindset is the right fit for complex learning

situations: '*I really believe in the sort of constant stimulation of seeing different things and I definitely learn from difference'*.

4.4 Desire to Create Positive Impact

One participant expressed the following observation: '*Because (...) the thing that you always run into within my bachelors or within the technology part, we always designed something and that would never be applied and would never be adopted by any policy or anything because no one was able to translate it in such a way that the policymakers would understand'*. Connecting theory and practice, therefore, was a logical conclusion for many of the students. Building the bridge means taking research and implementing it into the real world where it can make a difference in peoples' lives. Furthermore, they emphasized that in complex systems it was important to make choices between a variety of different options and that the most important factor was to maximize impact: '*Because we eventually chose to focus on the option that had the best potential and the solution that would have the greatest impact'*. They brought up a problem that links to the hyperlocal nature that is inherent to living labs, especially related to the city of Amsterdam, which can be seen as a model city in many regards but also a utopia when compared to other places: '*If we would be able to communicate the concept of Dutch cycling infrastructure more (...), if we only were able to wrap up this concept, export into a different country, we would affect the lives of 15 million people (...) Well, isn't that worth something?*'. These lines of thinking display the participants' high aspirations and motivation to create an impact not only on the lives of people in their vicinity but around the world. The fascination with the urban context can also be explained by their desire. As one participant put it in the context of his interest in urban areas and impact maximization: *'Because they're very little area, but they contribute most to a lot of global challenges. So, solutions in the city usually mean, it impacts a lot of lives*. Their motivation is not only limited to society but also more specifically to the biophysical surroundings: '*I would really love it if I can help to create a greener world. This sounds really idealistic, but sometimes I picture myself just working in a shop or being, like a very practical job (...) but then eventually, I just really want to help this change*'.

5 Discussion

5.1 Openness to New Experiences and Psychological Flexibility

Openness to new experiences and flexibility are closely connected to resilience thinking through the dynamic nature of social-ecological systems (Cumming, Olsson, Chapin, & Holling, 2013). These complex and adaptive systems are characterized by constantly emerging gradual and abrupt changes and the consequent necessity to adapt and transform accordingly (Folke, 2016). A shift towards an ecological consciousness (Pisters et al., 2019) can only be made possible by the ability to adapt and transform current pathways onto more sustainable ones. Openness to new experiences and flexibility seem to be necessary to enable students and professionals to make these shifts.

Additionally, both factors are crucial to every individual working in interdisciplinary teams, since actors find themselves in varying roles depending on the composition and the skill set of each team. Overall, the interplay between these two factors and interdisciplinarity was a reoccurring theme in participants' accounts of their experiences. VUCA learning environments and the related wicked, real-world challenges, almost by definition, transgress the traditional boundaries of disciplines. As a result, those who strive to navigate these

environments and challenges successfully need to be flexible and open-minded when applying their skills and knowledge. This is especially true for those cases, where students were educated in rather traditional, monodisciplinary environments.

5.2 Desire to Create a Positive Impact

The desire to create a positive impact on one's direct biophysical environment and society directly relates to the educational shifts described by Tilbury (2011). More specifically, it is connected to the shift from teaching attitudes and values to encouraging values clarification. Wicked problems and their inherent complexity and uncertainty can cause considerable amounts of frustration. Dealing with setbacks, course changes, and other hindrances seems to require high levels of intrinsic motivation. All students in this research displayed remarkable levels of desire to have a positive impact, which seems to serve as a powerful driving force. It might play a central role in thriving in complexity by bolstering students' energy, resilience, and perseverance. It is also possible that this is a potential pitfall for students engaging in such forms of education, as it is possible, they are so motivated that they push too hard and burn themselves out. This is something that educators have to pay attention to. Encouraging and supporting students to explore and consolidate their values concerning sustainability transition challenges should therefore be placed more centrally in higher education curricula.

5.3 Process Appreciation of Learning

The dynamism and transformative nature of VUCA problems related to sustainability transitions require individuals who deal with them to constantly evolve and adapt to the emerging structures and factors. The process appreciation of learning relates to the skills needed to function or even excel in transdisciplinary teams dealing with complex problems. The students are required to constantly seek out opportunities for learning and self-growth as new challenges, or new elements to the challenge, emerge. It was highlighted how powerful ecological constellations to learning are for exposing students to learning beyond superficial knowledge to the root of the problem (Tilbury, 2011) by interacting and struggling with it. Consequently, this type of learning then becomes more valuable and ingrained. These might be the characteristics of learning that enable transformations that eventually lead to a change in qualitative consciousness (Pisters et al., 2019). Understanding and appreciating these qualities of learning is therefore crucial for students and educators alike.

5.4 Are These Elements Educable?

An important sociobiological educational question that follows from these findings is to which degree these four above-described qualities are malleable and hence, teachable and to which degree they are predispositions and hence, subject to selection or recruitment procedures. Like with most dichotomies, the truth lies somewhere in the middle. A similar question that philosophers and scientists historically have debated over is the one of whether characteristics are innate or acquired. Today, we know that all traits require both genetic and environmental factors for their development (Griffiths & Linquist, 2021). Thus, it is not unreasonable to assume there will be students who are more educable in ecological constellations. Research by Ben-Avie and Darrow (2018, p. 46) into malleable and immutable student characteristics found that "malleable characteristics among students were more important predictors than immutable ones". Further, they emphasized the importance of focusing on students' development since "in fact, promoting the highest levels of development among students seems to be what helps them reach high academic goals" (p.48).

Hence, enhancing all students' development of openness to new experiences, flexibility, a process appreciation of learning, and a desire to create a positive impact on one's direct biophysical environment and society seems to be a promising avenue to pursue. More research is necessary to instigate how exactly this can be accomplished. At the same time, well-designed selection and recruitment procedures might enable universities to identify those students that are not only able to learn through the complexity of VUCA problems but also able to thrive under these circumstances.

5.5 Limitations

When evaluating our findings, a number of limitations need to be taken into consideration, such as certain general limitations concerning the method of IPA. Noon (2018) investigated the appropriateness of IPA as a method for educational research. He concluded that "it has the potential to be a powerful tool in helping researchers to understand the lived experiences of those within the education system" and that "findings of IPA studies can contribute in assisting educationalists in shaping future policy and practice around the needs and expectations of both students and educators" (Noon, 2018, p. 82). However, he also mentioned a number of limitations and challenges which apply to our research. "Language barrier" refers to the fact that IPA assumes that "language provides participants with the necessary tools to capture their experiences" (Noon, 2008, p. 81). The richness of responses determines to which degree it is possible to access the participants' experiential worlds. While the interviews for our research were held in English, all of the participants and researchers were non-native English speakers. It therefore might be possible, that the language barrier limited our insight into participants' experiences. However, all participants are participating in a master's degree taught in English, which indicates high-level language proficiency and permits the assumption that results are sufficiently detailed. A second limitation is "uncomfortable dualism" which refers to "dualistic tension between idiographic commitment and the search for connections across cases". It can become difficult to represent individual experiences sufficiently, while still generating common themes. This is especially true if the published articles are restricted by word limits, which then leads to the necessity to reduce other sections to ensure that "findings are not diluted". This is also true for this research, which originally included a more in-depth review of literature on underlying theory. Consequently, the focus is on the students' lived experiences rather than a detailed account of the theoretical background. This focus also connects to the third aspect of generalizability. IPA is based on relatively small sample sizes, in our case the experiences of seven individuals, which "inevitably raise questions concerning representativeness and transferability of findings". The goal of IPA, however, is not to make general claims about all settings, but rather represent the individual experiences in a specific setting. Our research aims at contributing a small piece to the whole, then "through the gradual accumulation of similar studies, more general claims can be made". It is for these reasons that we consider these results as indicative only.

6 Conclusions

Our research on the lived experience of students from the MADE program provides an entry point to further investigation of learning ecologies and the qualities that enable students to thrive under complexity and uncertainty. While the labels attached to these forms of education differ – Living Lab, Challenge Lab, Fieldlab – the underlying educational purpose is the same: exposing students to wicked problems in VUCA environments with the ultimate goal of transformative learning (Holmberg, Andersson, & Larsson, 2015) and changing a

place (Pisters et al., 2019). With growing interest in learning ecologies in educational practice also grow the number of opportunities to examine what makes them successful. Which educational elements provide students with the best opportunities to foster important skills and to consolidate existing personal qualities? This research was designed and conducted with an exploratory focus using IPA. Individual experience is at the heart of this method and hence, also at the heart of our findings. These findings provide a detailed, in-depth insight into seven students' encounters with the complexity of VUCA problems. Their experiences point towards the importance of openness to new experiences (1), flexibility (2), a process appreciation of learning (3), a desire to create a positive impact on one's direct biophysical environment and society (4) as key elements of thriving in VUCA learning environments such as ecological forms of higher education. Whether these factors apply to a more general population and whether there are additional crucial factors needs to be determined by further research. Learning ecologies seem to be a promising route to introducing real-world complexity into learning environments and consequently equipping students with the necessary tools to thrive under VUCA circumstances. More ecological forms of higher education will likely emerge and the authors applaud these efforts. At the same time, the authors hope to have shown that careful consideration of the human elements of such education is essential, and much about engaging with such forms of education for students remains unknown. We hope that the provided insights can help other practitioners in (re)designing their own ecological education that connects to VUCA challenges in place, and warmly invite more research into the design of such higher education and how they are experienced.

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