1   The Long Game to mitigate earth system tipping points

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12   **Abstract**

13   The devastating impacts of triggering earth system tipping points are unfolding, not only in physical and
14   infrastructural losses and damages, but also in increasing eco-anxiety and trauma. Here we present and
15   discuss "The Long Game", i.e. a concept of gamifying education for triggering action at scale and self-
16   efficacy as well as facilitating active engagements in real-world socio-ecological projects through
17   collaborations with transformation actors. The Long Game can serve as a pedagogical entry point for
18   hosting and fostering unlearning and double loop learning processes in the education system. This in
19   turn can trigger self-reinforcing positive social tipping across wider socio-behavioral, economic,
20   technological and political domains for rapid mitigation of earth system tipping points as well as for
21   healing eco-anxiety and trauma.

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23   1. Introduction

24   The risk of triggering abrupt and irreversible changes in the earth system, i.e. negative tipping
25   points, is increasing (Lenton et al., 2019). Four out of 16 identified tipping elements are already
26   showing signs of instability (Armstrong McKay et al., 2022). Several major extreme events, e.g.
27   catastrophic flood in Western Europe in 2021 that caused fatalities and widespread damages,
28   have been attributed to the instability in these sensitive tipping elements such as lock-ins in the
29   Jet Stream (Tradowsky et al., 2023). Moreover, evidence suggests that six out of nine planetary
30   boundaries have already been exceeded, and consequently the humanity is operating in a risk
31   zone that may eventually face collapse (Richardson, 2023).

32   The devastating impacts of already triggered earth system tipping points are generating a new
33   discourse of fear (Saab, 2023). A characterizing feature of this fear is the insecurity about the
34   future and a growing tendency to develop forms of anxiety and distress, i.e. "eco-anxiety"

35 (Pihkala, 2020). The ever-growing threats to the stable biosphere and climate are further turning
36 eco-anxiety into paralyzing trauma, existentially questioning humanity's shared identity, and
37 continually triggering past personal, cultural, and intergenerational traumas (Woodbury, 2019).
38 Both eco-anxiety and trauma are expected to have long-term consequences for physical and
39 mental health, particularly across the young generation (Hickman et al., 2021).

40 This coupled physical-psychological crisis we are in demands also coupled two-fold action: (i)
41 abrupt, deliberate and self-reinforcing positive change in the society, i.e. positive social tipping
42 points, to rapidly mitigate negative earth system tipping points, and (ii) urgent support to deal
43 with eco-anxiety and heal trauma in young generation. However, over the past three decades,
44 international and national efforts led by United Nations initiatives (such as the Framework
45 Convention on Climate Change (UNFCCC)) have proven ineffective for meaningful climate
46 action and education (Stoddard et al., 2021). Moreover, individuals, particularly young
47 generations, understandably feel overwhelmed and helpless to take meaningful action even when
48 they are well-informed about the causes and effects of these global changes (Hickman et al.,
49 2021).

50 Here we present and discuss a concept of "The Long Game", which establishes gamification of
51 education as a model for hosting and fostering "unlearning", i.e. developing new knowledge,
52 routines and relations countering the conventional unsustainable practices, and "double loop
53 learning", i.e. participatory learning through collaboration with transformation actors and
54 institutions in real- world action projects (van Oers et al., 2023) (Figure 1). Here the primary
55 system for intervention is the "education system" involving schools providing primary and
56 secondary level education, since eco-anxiety and trauma in the young generation are both faced
57 and can be best dealt with in schools through the transformation of education system (Hickman
58 et al., 2021). We also argue that the Long Game can act as an enabling factor for triggering
59 positive social tipping points across wider systems to mitigate negative tipping as well as for
60 healing eco-anxiety and trauma by actively engaging learners in real-world transformative action
61 projects at an early stage of development.

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63 2. The Long Game

64 The concept of "The Long Game" (Bhowmik et al., 2022) originates as a response to the concept
65 of "The Climate Endgame" (Kemp et al., 2022), which claims that current climate scenarios
66 underestimate the catastrophic impacts of climate change and hence, urges for enhanced
67 exploration of such scenarios. In contrast, the Long Game prioritizes an action research agenda
68 acknowledging that catastrophic climate change is already here and capacity building and
69 empowerment are key for triggering rapid action and positive social tipping to escape this
70 catastrophe (Bhowmik et al., 2022). Here in this paper, we regard the education system as an
71 entry-point (leverage point) for triggering systemwide positive social tipping through early
72 intervention (as outlined by Otto et al. (2020)). By consolidating scientific evidence to date, we
73 discuss how gamification of education can foster capacity building and empowerment crucial for
74 rapid and transformative action. Hence, the Long Game here does not represent any particular
75 game but rather represents broader gamification of education that triggers real world
76 participatory social-ecological projects. These games may take diverse forms, e.g. simulation and
77 role-play (Rooney-Varga et al., 2018), and escape rooms (Tania & Wim, 2020), and can be
78 facilitated in both physical and digital formats according to the contexts and resources available.

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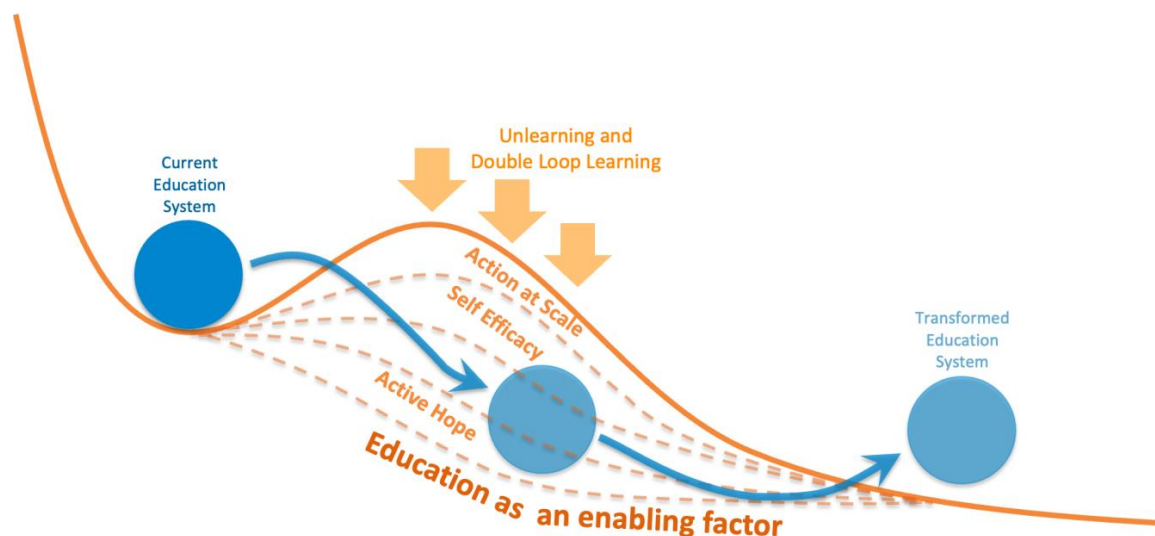
Figure 1: The Long Game, i.e. gamification of education for unlearning and double loop learning, can enable positive social tipping through triggering transformative action at scale, as well as can heal trauma by providing self efficacy and active hope.

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3. Action at scale

There is a "sweet spot" for a broad range of climate mitigation interventions at a community scale of 10,000 people (Bhowmik et al., 2020). This community scale is not too big, not too small and the size of many local governments (including school districts) and indigenous people bodies. This also represents a "glocal" scale, where individuals living their everyday lives converges with humanity's planetary scale and thus can optimally trigger positive social tipping in a system.

We suggest that effective participatory learning through gamification at primary and secondary schools can act as a positive social tipping intervention at the sweet spot community scale for triggering rapid transformation dynamics. Gamification of learning at schools can enable action through an acceleration of social learning and engagement using the tight contagion of students, parents, local transformation actors like farmers and entrepreneurs, and peers (Otto et al., 2020). This manifests in a two-step process: (i) *Unlearning* the complexity and deep intertwinedness of unsustainable growth and cultural dimensions through an education system that facilitates transformative learning, sustainable lifestyles and career pathways, and fosters collective engagement to enable agency for transformation via students-to-parents and parents-to-communities networks (van Oers et al., 2023; Lawson et al., 2019). (ii) *Double Loop Learning* through multi-level interactions across formal and informal institutions and state and non-state actors including local governments and civil society with schools to increase competence by providing facts, soft skills and strategies for behavioral change (Macintyre et al., 2018).

The Long Game can thus initiate, transfer and provide the means for practical and transformative socio-ecological projects at the community sweet spot, and empower communities with self-efficacy and optimism (Naes 2022). Students that unlearn through transformative learning

107 processes can transfer and motivate, first their parents and eventually the communities they live
108 in, into the unlearning processes (Lawson et al., 2019). Direct connections, communication and
109 exchanges between local transformation actors and students that are established at schools can
110 continue through communities and mobilize resources and skills from national and local
111 governments, NGOs and industries to community organizations, such as household associations.
112 For example, the Long Game can provide communities with a digital interface with supporting
113 pedagogical materials that feature i) relevant information from a global database of glocal sweet
114 spots/communities that identify environmental and social strengths, weaknesses, threats and
115 opportunities; ii) pedagogical and digital tools including role-playing, simulations, and
116 gamification to inform and empower learners in those communities; and iii) direct support and
117 mutual aid at the glocal scale to reduce risks, increase survivability, and facilitate dynamic
118 inclusiveness and deliberate democracy (Bhowmik et al., 2022).

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120   4. Active Hope

121 "Active Hope" infers the process of being clear what one hopes for and then playing one's role
122 in the process of moving into that direction (Macy and Johnstone, 2012). Active hope
123 distinguishes hope from "wishful thinking" by: (i) a deep recognition of the "great unraveling",
124 i.e. climate crisis and related environmental, social and psychological impacts, (ii) a consensus
125 that "business as usual" is not an option and (iii) a contribution to the "great turning", i.e. active
126 and in-person engagement in efforts and activities that helps mitigating the planetary crises and
127 and healing the psychological adversities through capacity building and empowerment.

128 Agency and self efficacy are central to active hope. Gamification of education to address human
129 impacts on the planetary boundaries through pedagogical and digital tools including role-playing,
130 collaborative problem solving and simulations and escape rooms can play a critical role in
131 creating agency and self-efficacy (Rooney-Varga et al., 2018; Tania & Wim, 2020). Students
132 feel intrinsically motivated in game-based learning, which can provide hands-on: (a) knowledge
133 and feedback about global change causes, dynamics and expected impacts, (b) affective
134 engagement including feelings of urgency and hope, and (c) understanding of social dynamics,
135 negotiations and decision making. The Long Game can thus motivate students to actively engage
136 themselves in real world mitigation projects and even invent and initiate projects with
137 community actors, which translates into collective efficacy for directly informing and
138 empowering community sweet spots (Rooney-Varga et al., 2018; Tania & Wim, 2020). These
139 can be as simple as installing solar panels on the roofs of the school buildings, starting and
140 nurturing gardens in the school courtyards and protecting forests nearby.

141 Action at scale, agency and self-efficacy achieved via game based education can facilitate active
142 hope through the connection established between school classes with local transformation actors,
143 such as farmers, entrepreneurs and NGOs and thus the transformation of schools into living
144 laboratories of climate action, providing a gateway for students suffering eco-anxiety and trauma
145 to involve themselves in activities that shape the future they hope for. In turn, this heals eco-
146 anxiety and trauma and empowers them to become potential seeders of positive social tipping
147 processes.

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5. Outlook

We invite the communities conducting research on sustainability science, tipping points, transformation and environmental education to test and validate the effectiveness of the Long Game for triggering positive social tipping dynamics and tackling eco-anxiety and trauma. This involves the assessment of suitability of broad range of games for schools in different world regions, participatory research on how local transformation actors can effectively collaborate with schools and students and how translation of the living laboratories between schools and communities can be facilitated. Strengths and weaknesses of this approach should also be examined and mechanisms for including the Long Game into the existing curricula should be outlined. Research on the Long Game can inform high level initiatives and global networks like Greening Education Partnership (UNESCO, 2024) on strategizing transformation of the education system and schools for rapid sustainability transformation.

Competing interests

The corresponding author has declared that none of the authors has any competing interests.

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