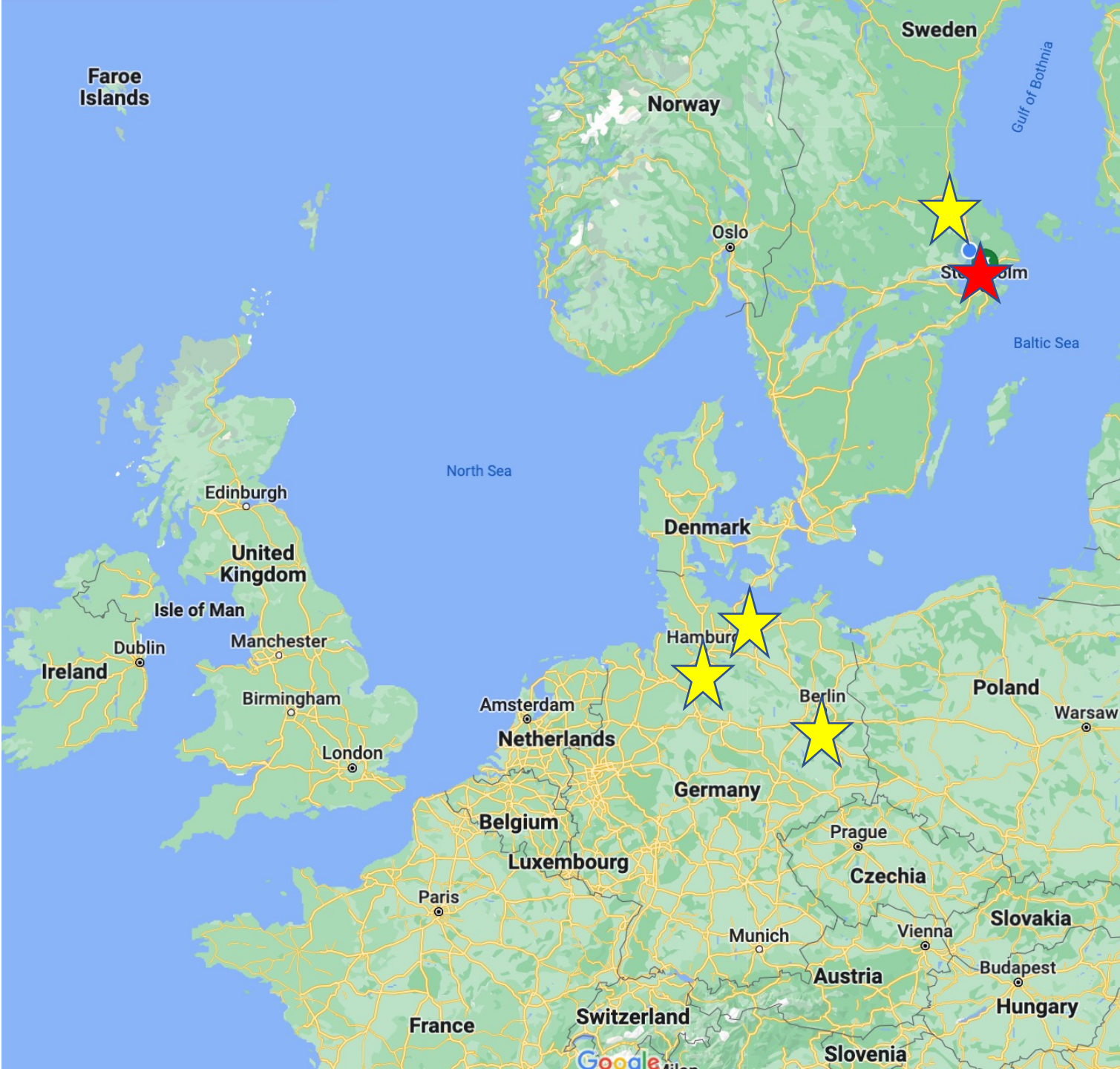# On the complexities & possibilities of ICT *education* for sustainability

Anne-Kathrin Peters (she/they)
Ass. Professor, Department of Learning
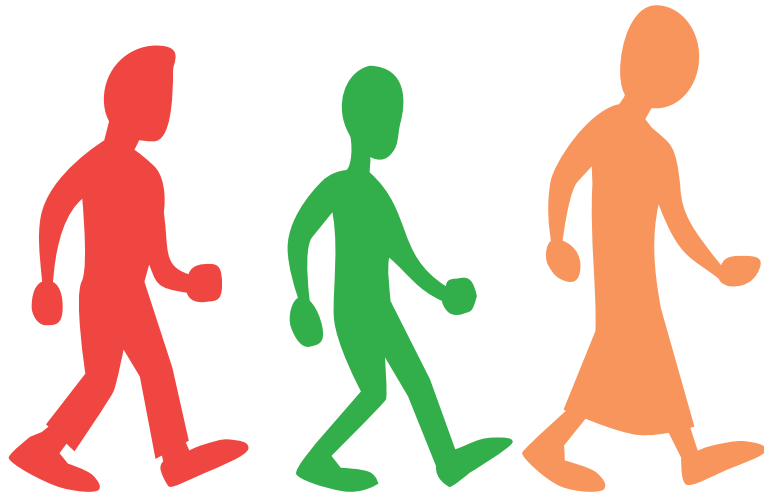KTH Royal Institute of Technology, Sweden

Who am I?

Navigating Computing

(Peters, Rick 2014)

Researching Computing Education

(Peters 2017, 2018)

Navigating contexts

Educational transformation for sustainability

Anne Peters

Anders Rosén

Marie Magnell

Björn Kjellgren

Björn Hedin

Lotta Dehlin

Tanja Richter

Linda Söderlindh

Marcus Angelin &
House of Science

Annica Gullberg

Susanne Engström
School Teacher Education

Kristina Andersson

Where are we in terms of sustainability in computing education?
What more could we do?
How does this speak to you?

On the complexities & possibilities
of ICT *education* for sustainability

Anne-Kathrin Peters (she/they)
Ass. Professor, Department of Learning
KTH Royal Institute of Technology

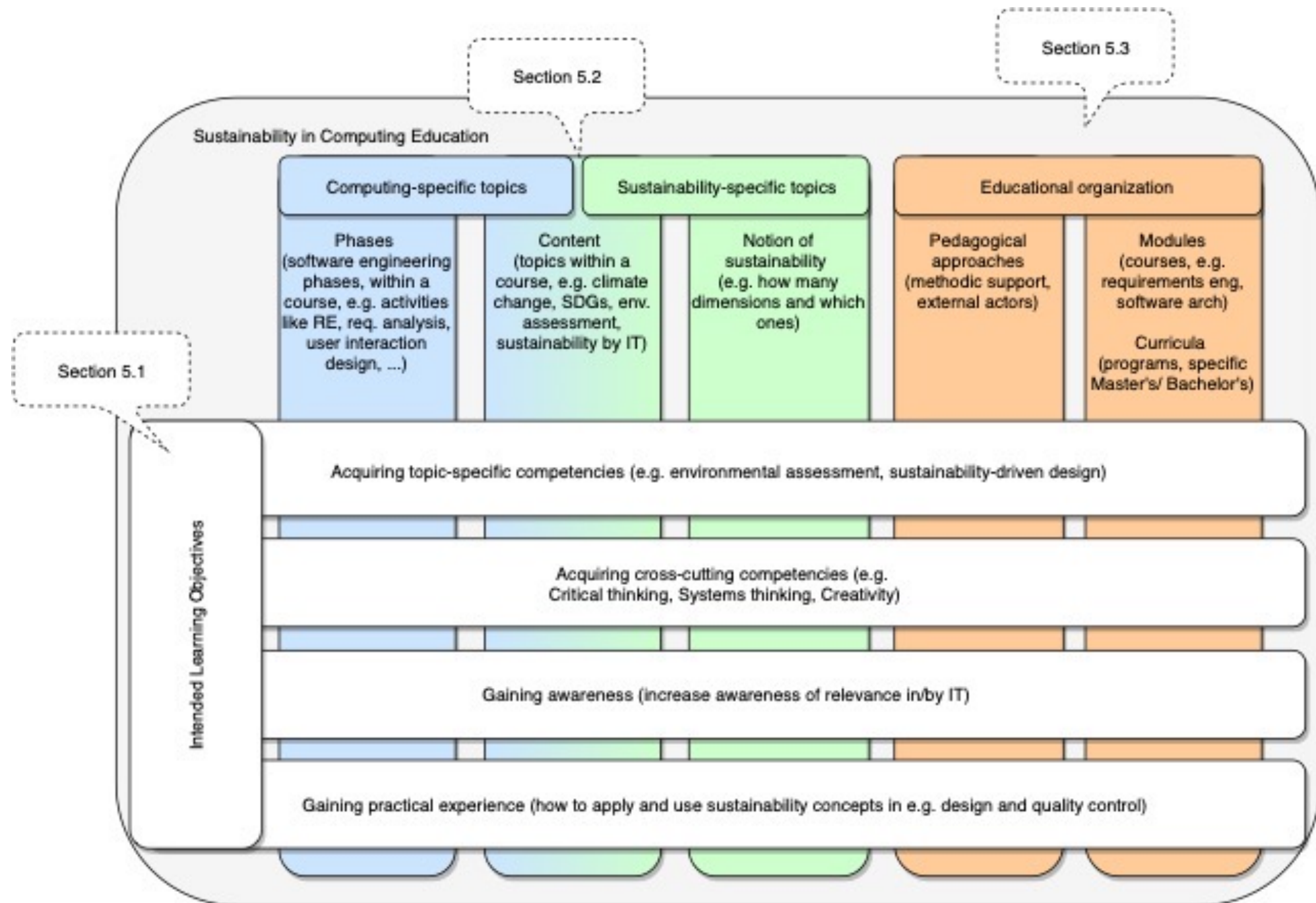# Sustainability in Computing Education: A Systematic Literature Review

A.-K. Peters, R. Capilla, V. C. Coroamă, R. Heldal, P. Lago, O. Leifler, A. Moreira, J. P. Fernandes, B. Penzenstadler, J. Porras, C. C. Venters

Analyse 90 relevant studies for:
1) conceptions of sustainability, computing for sustainability, and education,
2) implementations of sustainability in computing education
3) research on sustainability in computing education.

Results

Sustainability in Engineering Education

Examples of added topics and attributes:

o Scenario construction, forecasting, backcasting and visioning
o operating within planetary boundaries and social foundations for human societies
o Power, politics, authority in strategy building and change

o Design for sustainability:
- Life cycle perspective
- Circular economy
- Systems perspective including environmental, social and economic aspects
- Efficient and reduced use of energy, materials and land
- Reduce/eliminate environmental impact
- Reusability, remanufacturing, recycling, retirement

(Malmqvist et al, 2022)

THE CDIO SYLLABUS 3.0 - AN UPDATED STATEMENT OF GOALS

Johan Malmqvist, Ulrika Lundqvist

Chalmers University of Technology, Sweden

Anders Rosén, Kristina Edström

KTH Royal Institute of Technology, Sweden

Rajnish Gupta, Helene Leong, Sin Moh Cheah

Singapore Polytechnic, Singapore

Jens Bennedsen

Aarhus University, Denmark

Ron Hugo

University of Calgary, Canada

Aldert Kamp

Aldert Kamp Advies, The Netherlands

Ola Leifler, Svante Gunnarsson

Linköping University, Sweden

Janne Roslöf

University of Jyväskylä & Turku University of Applied Sciences, Finland

Daniel Spooner

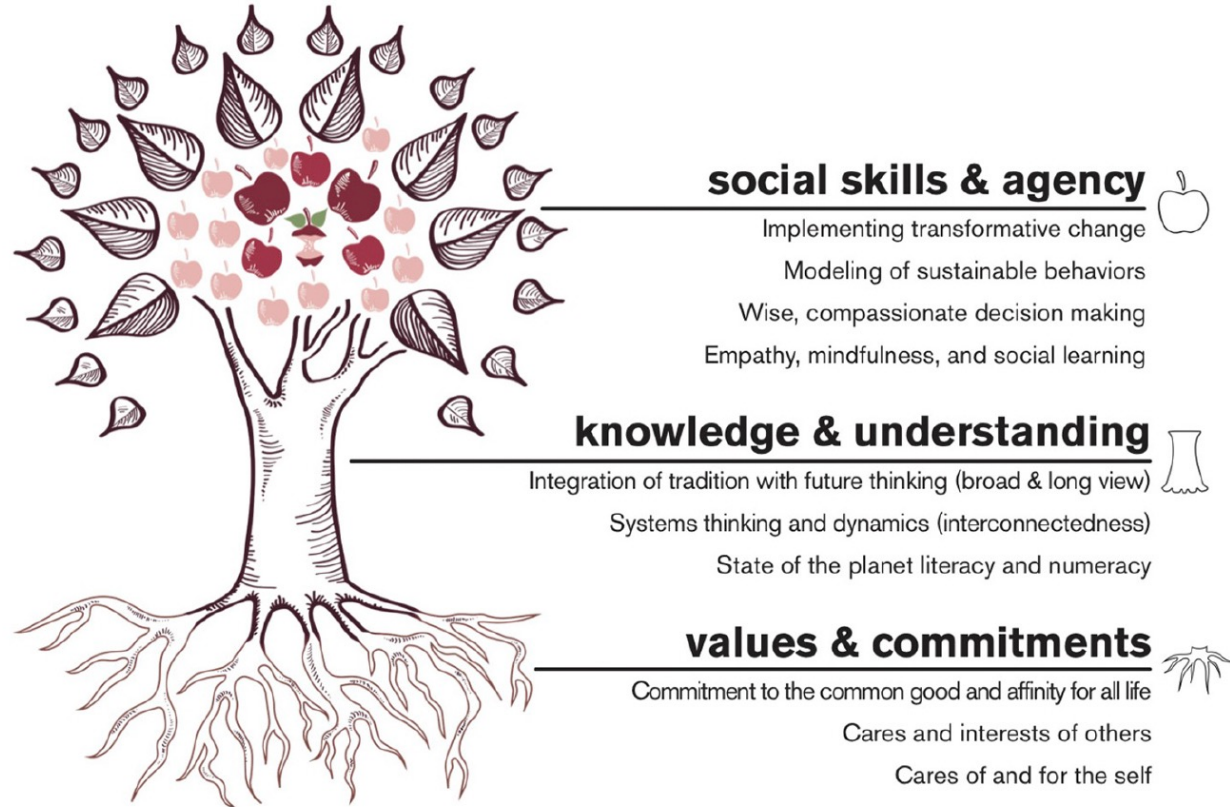Polytechnique Montréal, Canada

ABSTRACT

The CDIO Initiative is going through a process of reconsidering and updating the CDIO approach for engineering education development. Previous work resulted in substantial updates of the twelve CDIO standards and the introduction of "optional" CDIO standards. This paper reports on a similar review and update of the CDIO Syllabus to version 3.0. It has been developed by a working group consisting of four sub-groups and iterated and refined guided by feedback from the whole CDIO community. There are mainly three external drivers that

Proceedings of the 18th International CDIO Conference, hosted by Reykjavik University, Reykjavik Iceland, June 13-15, 2022.

Anders Rosén, aro@kth.se

Sustainability Key Competencies

LfS CORE COMPETENCY FRAMEWORK

social skills & agency
Implementing transformative change
Modeling of sustainable behaviors
Wise, compassionate decision making
Empathy, mindfulness, and social learning

knowledge & understanding
Integration of tradition with future thinking (broad & long view)
Systems thinking and dynamics (interconnectedness)
State of the planet literacy and numeracy

values & commitments
Commitment to the common good and affinity for all life
Cares and interests of others
Cares of and for the self

competencies build developmentally, upwards from root to fruit

Harold Glasser | Western Michigan University Office for Sustainability | harold.glasser@wmich.edu | Jan. 8, 2018

(Pacis & van Wynsberghe 2020, Wiek 2011)

Results

- Little on drastic systemic change
- Little connection to critical theory
- >50% experience reports
- Mostly describing modules
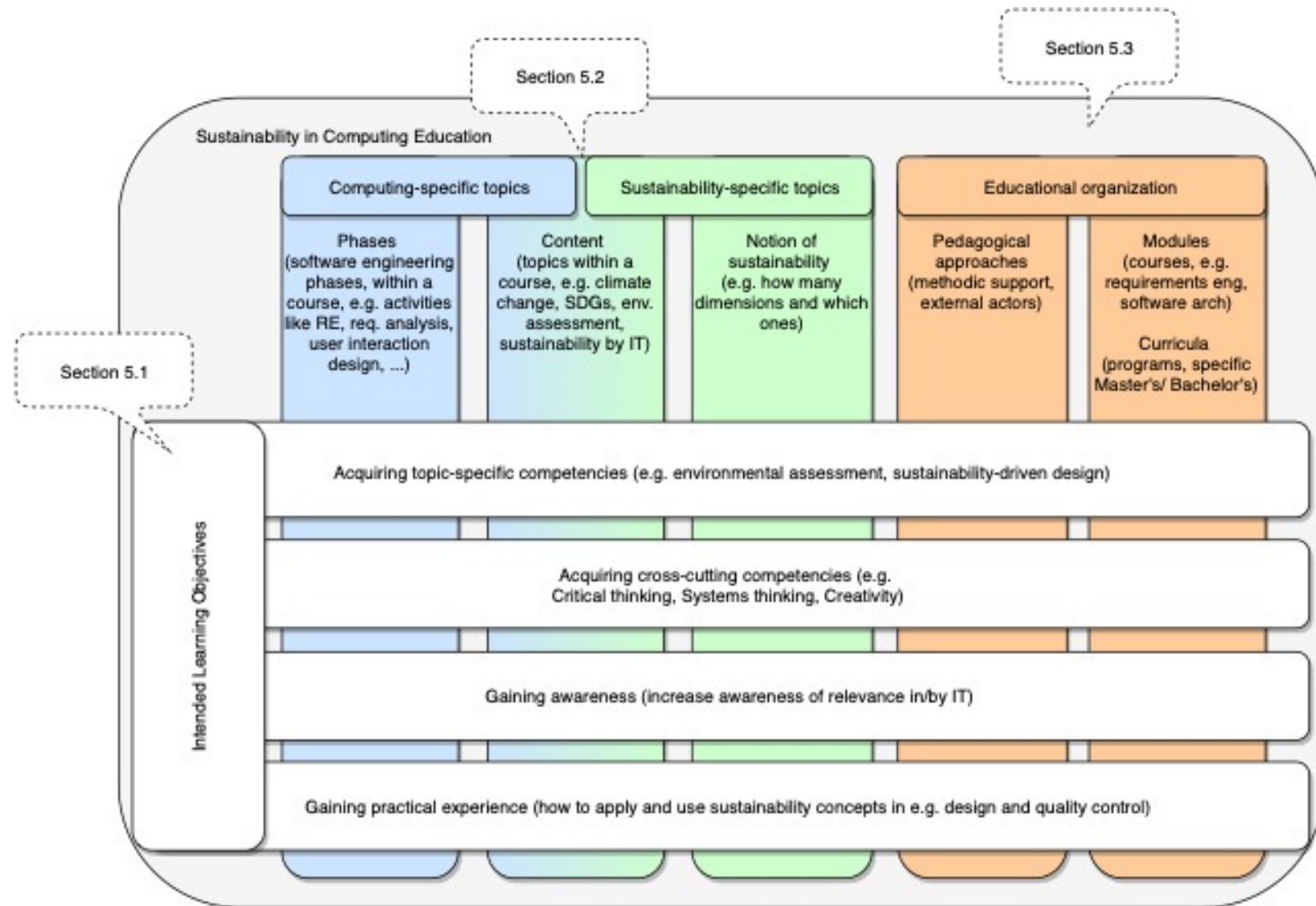
Student trajectories in education

Interview Year 1: "The connection between computer science and political science comes naturally."

Interview Year 3: "I think, one misses a lot when combining politics and CS. [...] *Political science [...] is about discussion [...] without getting anywhere.* [...] The only way to come to a point of right or wrong is to look at reality. In CS, it often feels like "I want to do a better solution". One tries: Can I do this algorithm slightly, slightly faster? As this is a theoretical, a natural science discipline, one can always test the solution [...] in a very small, secure environment."
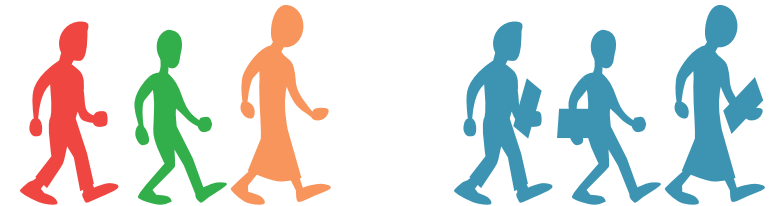
(Peters 2017, 2018)

UPPSALA UNIVERSITET

ANNE-KATHRIN PETERS   Learning Computing at University: Participation and Identity

Learning Computing at University: Participation and Identity

A Longitudinal Study

ANNE-KATHRIN PETERS

Participation & competence development (1)

Participation in CS/IT is experienced as…

	Label	Social Context
A	… using	Finley (IT, year 3): When you have managed to divide the problem into parts and merge the small solutions, and when you in the end have created something that seems to give the result that you were aiming for, when you realise that this can work, then I feel 'This is fun!' and then you become a junkie - that you want to feel this feeling again and again. And then you work towards that feeling that can exist in other situations as well.
B	… learning	
C	… creating	
D	… problem solving	
E	… problem solving for others	
F	… creating new knowledge	
G	… contributing to societal endeavours	Future contexts

Participation & competence development (2)

Participation in CS/IT is experienced as…

	Label
A	… using
B	… learning
C	… creating
D	… problem solving
E	… problem solving for others
F	… creating new knowledge
G	… contributing to societal endeavou

Amari (CS, year 3): "We have this bible, [. . .] a thick book which contains a lot of algorithms [...] and data structures. [...] it is very complete, [...] it contains only necessary text.
I: "How did you use it?"
Amari: "[. . .] The book contains a list of different algorithms that you can go through to see: 'That algorithm is suitable for this problem!'."
I: "How did the book get the name bible?"
Amari: "[. . .] Older students have called the book 'the bible', because for many students, CS is all about algorithms and data structures."

Marginalisation

Chris (CS, year 3): "The teacher [of the HCI course] was very interested in HCI. [. . .] We thought: 'He is not a real computer scientist!' (laughs) But then it turned out that he actually could program and that he was as good as we are, [. . .] just that he had an interest in that which was a bit fuzzy."

>Three decades of feminist critiques

"Among feminist critiques […] a recurring line of argumentation is that the engineering curriculum is reductionist, that is, privileges contextless and abstract knowledge over the situated and the context-bound. This is often explained by highlighting how engineering education is narrowly focused on mathematics and technology and modelled on the natural sciences"
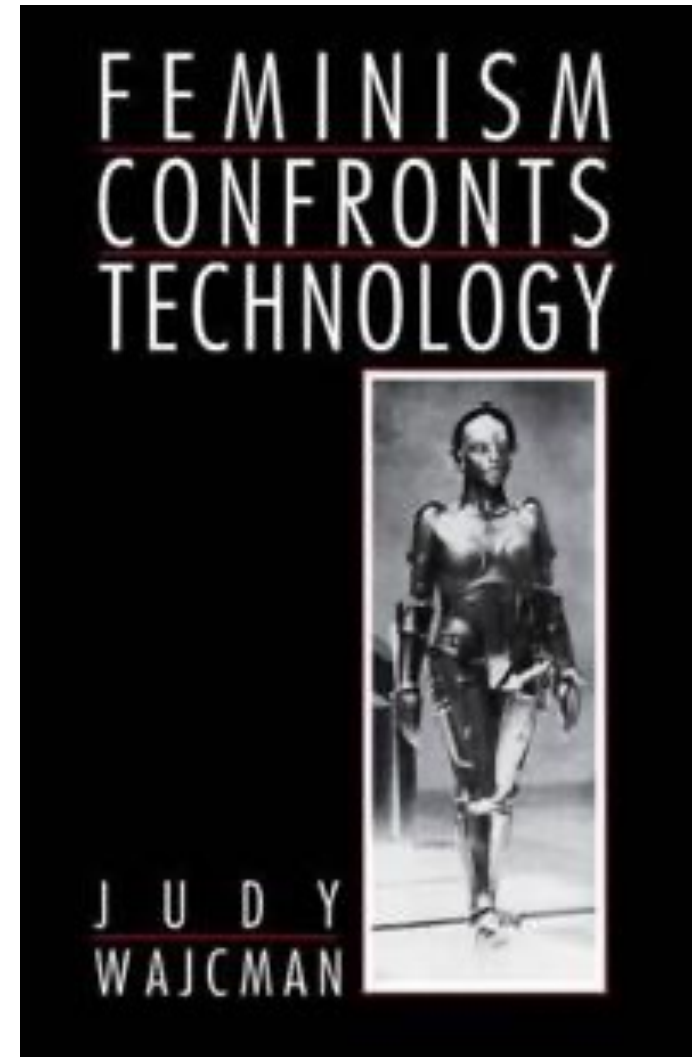
(Ottemo, Berge, Silfver 2020)

Calls for reimagining tech since long!!

"We revere that which is defined as 'rational' as distinct from that which is judged 'emotional'. We are no longer sure whether science and technology are the solution to world problems."

(Wajcman 1991)

FEMINISM CONFRONTS TECHNOLOGY

JUDY WAJCMAN

Three Decades of Climate Mitigation: Why Haven't We Bent the Global Emissions Curve?

Isak Stoddard,[1] Kevin Anderson,[1,2] Stuart Capstick,[3] Wim Carton,[4] Joanna Depledge,[5] Keri Facer,[1,6] Clair Gough,[2] Frederic Hache,[7] Claire Hoolohan,[2,3] Martin Hultman,[8] Niclas Hällström,[9] Sivan Kartha,[10] Sonja Klinsky,[11] Magdalena Kuchler,[1] Eva Lövbrand,[12] Naghmeh Nasiritousi,[13,14] Peter Newell,[15] Glen P. Peters,[16] Youba Sokona,[17] Andy Stirling,[18] Matthew Stilwell,[19] Clive L. Spash,[20] and Mariama Williams[17]

"… a common thread that emerges across the reviewed literature is the central role of power, manifest in many forms, from a dogmatic political-economic hegemony […] to narrow techno-economic mindsets and ideologies of control"

Education as an instrument of control

Education set up to maintain the system, to reach economic goals and ensure national competitiveness.

"Students can be viewed as raw materials in a production process or consumers in a market, not citizens nor human beings."

(Mendick and Peters 2022)
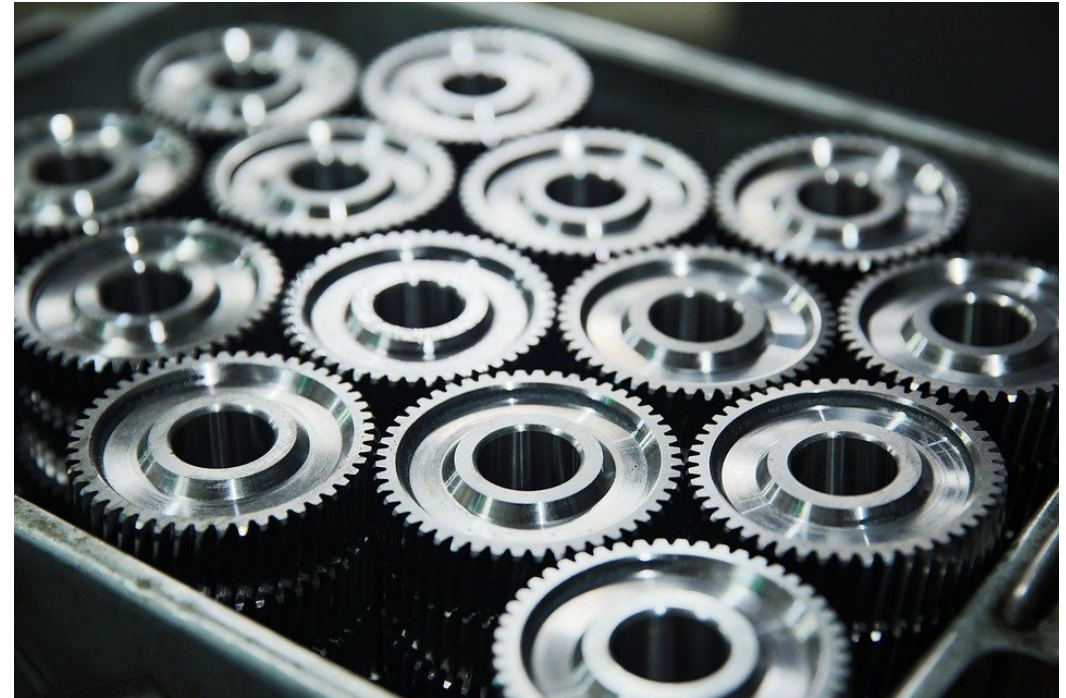
Are we still living in the Anthropocene?

The subject of the pedagogical test lecture is **"Recursive algorithms"**

GeeksforGeeks
https://www.geeksforgeeks.org › i... · Diese Seite übersetzen ⋮

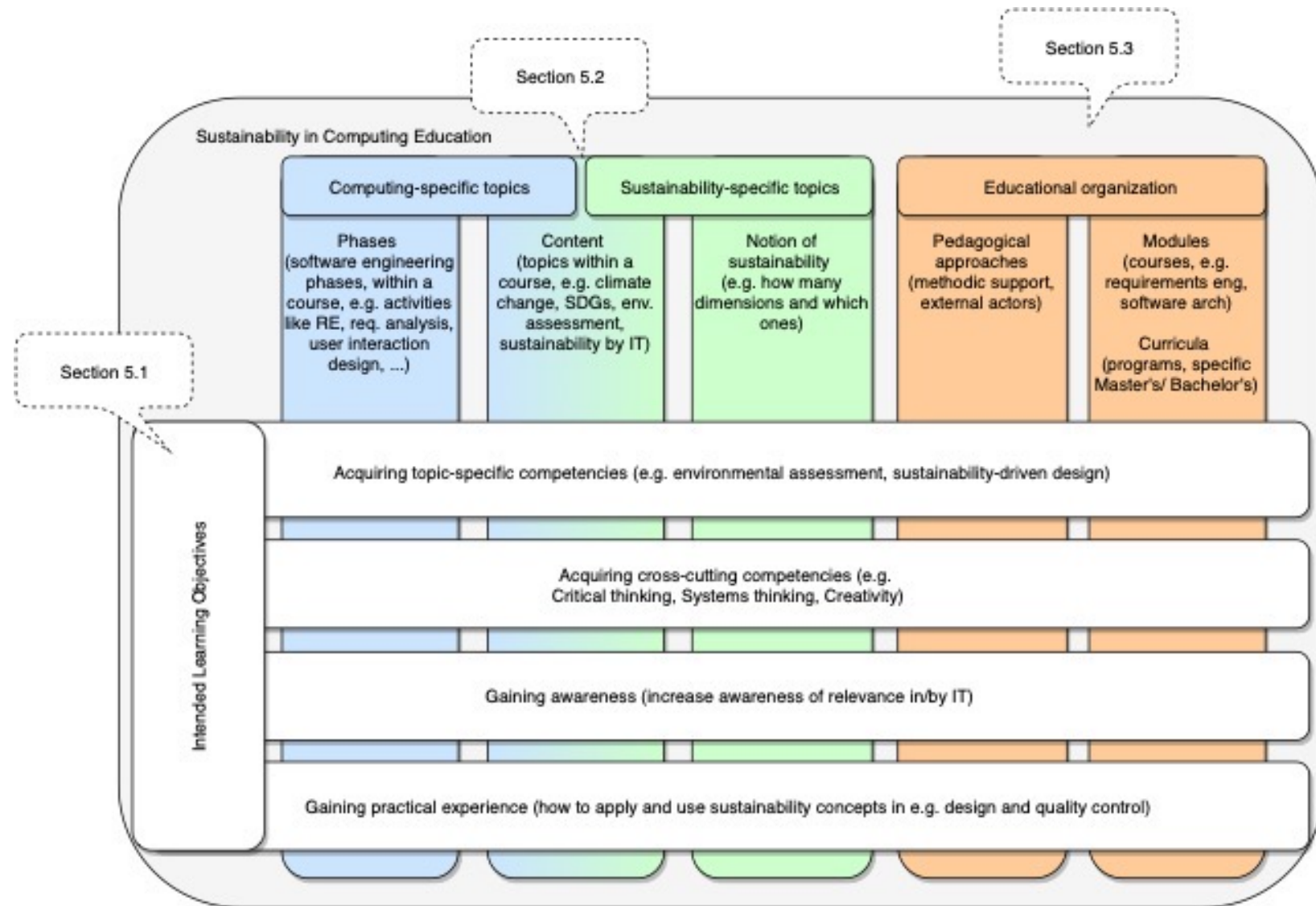Introduction to Recursion - Data Structure and Algorithm ...

31.03.2023 — A recursive **function** solves a particular problem by calling a copy of itself and solving smaller subproblems of the original problems. Many more ...

Education as "pig farming"

(Gert Biesta, 2023)

Responses?

"The master's tools will never dismantle the master's house."
(Audre Lorde, 1984)

Relationality with the computer

Teacher: "I am a nerd and I get paid. I am doing programming languages. That is my super nerdy thing. Why should you learn programming? It is fantastic to do programming, it is fantastic to be able to programme. A computer is a good gadget. Does humanity need it? Doubtful. But why not?"

Teacher: "Programming is like story telling [...] One can be 'carried away".

Teacher: "Who sees the mistake? (pause) Those who do, perhaps have programmed before and see it easier, because they feel it in the whole body."

(Peters, Bengtsson, in review)

Embrace emotions

	Pessimism	Optimism	Hope	Hopelessness	Sadness	Anxiety	Hapiness	Loneliness	Anger	Excitment
Before course	33	29	29	19	16	38	20	12	13	20
During course	39	29	35	36	23	26	8	5	21	19
Difference	6	0	6	17	7	-12	-12	-7	8	-1

N=65

(Eriksson, Peters, Pargman, Hedin, Laurell-Thorslund, Sjöö 2022)

Education as care, transformation, emergent

- From "education as preparation", training, to education as transformation
- Unique potential of education as a democratic domain
- Care in affective relationship

Taking Care of the Future?

The complex responsibility of education & politics

Deborah Osberg

In one way or another, all the essays in this volume address the question of how it is possible to take up an affirmative orientation to the future when, as Paul Cilliers writes in the foreword to this volume, "we have to make choices which cannot be reduced to calculation alone." If we *care* about the future, it matters very much that we do the "right" thing… it is important that we act in a way that will indeed positively influence the future, rather than that we act in a way that will have a negative effect or that we refrain from acting at all (which is nevertheless still taking a position that can have a negative effect). But if we can no longer know, in rational or calculable terms, what the "right" thing may be, then how should we act? What should we do? Under these conditions what is the meaning of normativity? How do we make sense of "*should*"? In this final essay I argue for the necessity to engage, *in complex terms,* with the question of how it is possible to adopt an affirmative orientation to the future. I use the politically and ethically

*"This report recognises the **value of diverse forms of knowledge** such as scientific, as well as Indigenous knowledge and **local knowledge**"*
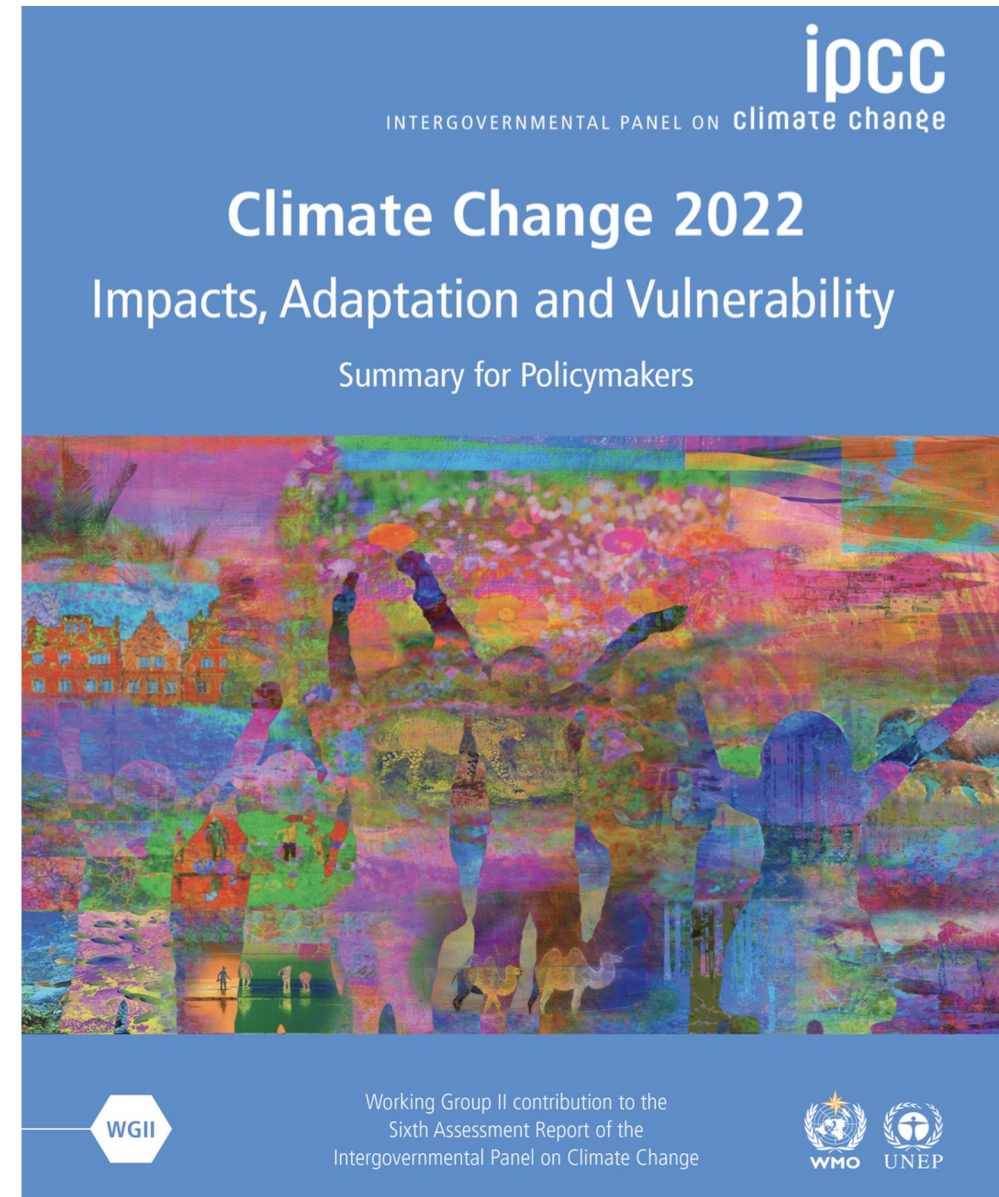
Radical futurity

- Convene around anticipatory emotions
- Engage with the paradox of sustainability & computing as emergent
- Attend to norms, values, power

Emergentist education and the opportunities of radical futurity

Susanna Barrineau [a,b,*], Laila Mendy [c], Anne-Kathrin Peters [d]

[a] Swedish International Centre for Education for Sustainable Development (SWEDESD), Uppsala University, MTC-huset, Dag Hammarskjölds väg 14B, 1 tr, 752 37 Uppsala, Sweden
[b] University of the Sunshine Coast, School of Law and Society, Australia Sustainability Research Centre Innovation Centre, USC, 90 Sippy Downs Drive, Sippy Downs, Queensland 4556, Australia
[c] Department of Earth Sciences, Uppsala University Geocentrum, Villavägen 16, 752 36 Uppsala, Sweden
[d] Department of Learning, KTH Royal Institute of Technology, Osquars Backe 31, 10044 Stockholm, Sweden

ABSTRACT

Higher education has been criticised for its instrumental character, which co
for meaningful change towards sustainability. Drawing on the concept of
develop a conception of education that we call "emergentist education". We
from futures studies, education for sustainable development, philosophy of e
into dialogue experiences from three futures-facing educational contexts at a
We identify three key areas to conceive of emergentist education and it
disciplinary and institutional norms, convening around anticipatory emotions
paradox of sustainability as emergent through radical futurity. We apply a
through these key areas to demonstrate how a reorientation of education a
allow students and teachers to contest visions of futures. This work helps
liberation of education to allow young people to come together whole-hea
matters to them.

From "education for sustainable development" to "education for the end of the world as we know it"

"We contend that the predicament we face is not primarily rooted in ignorance and thus solvable with more knowledge, nor primarily rooted in immorality and thus solvable with more normative values; rather, it is rooted in denials that stem from harmful desires for and investments in the continuity of the securities and satisfactions promised by modernity-coloniality"

(Stein et al. 2022)

GESTURING TOWARDS DECOLONIAL FUTURES

Thank you for listening!

Please reach out!! To Anne Peters: akpeters@kth.se

1. *Sustainability in computing education today?*

Sustainability in Computing Education: A Systematic Literature Review

A.-K. Peters, R. Capilla, V. C. Coroamă, R. Heldal, P. Lago, O. Leifler, A. Moreira, J. P. Fernandes, B. Penzenstadler, J. Porras, C. C. Venters

2. *What more could we do?*
    Education as care, transformation
    emergent, radical futurity

3. *How does this speak to you? E.g.*
    Examples of education as transformation?
    Reflections on the "computar-cene" &
    education?

On the complexities & possibilities
of ICT *education* for sustainability

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References

Barrineau, S., Mendy, L., & Peters, A.-K. (2022). Emergentist education and the opportunities of radical futurity. *Futures*, *144*, 103062. https://doi.org/10.1016/j.futures.2022.103062

Eriksson, E., Peters, A.-K., Pargman, D., Hedin, B., Laurell-Thorslund, M., & Sjoo, S. (2022). Addressing Students' Eco-anxiety when Teaching Sustainability in Higher Education. 2022 International Conference on ICT for Sustainability (ICT4S), 88–98. https://doi.org/10.1109/ICT4S55073.2022.00020

Intergovernmental Panel on Climate Change (IPCC). (2022). Summary for Policymakers. In *Climate Change 2022: Impacts, Adaptation and Vulnerability.*

J. Malmqvist *et al. (2022)* "The CDIO Syllabus 3.0 - An Updated Statement of Goals," i *Proceedings of the 18th International CDIO Conference, hosted by Reykjavik University, Reykjavik Iceland, June13-15.*

Mendick, H., & Peters, A.-K. (2022). How post-Bologna policies construct the purposes of higher education and students' transitions into Masters programmes. *European Educational Research Journal*, 14749041221076632. https://doi.org/10.1177/14749041221076633

Osberg, D. (2010). Taking Care of the Future? The complex responsibility of education & politics. In Osberg, Deborah & G. Biesta (Eds.), Complexity Theory and the Politics of Education (pp. 157–170). Sense Publishers.

Ottemo, A., Berge, M., & Silfver, E. (2020). Contextualizing technology: Between gender pluralization and class reproduction. Science Education, 104(4), 693–713. https://doi.org/10.1002/sce.21576

Pacis, M. and VanWynsberghe, R. (2020). Key sustainability competencies for education for sustainability: creating a living, learning and adaptive tool for widespread use. International Journal of Sustainability in Higher Education

Peters, A.-K. (2017) *Learning Computing at University: Participation and Identity: A Longitudinal Study*, Doctoral Thesis, Uppsala: Acta Universitatis Upsaliensis

Peters, A.-K., (2018) Student Experience of Participation in a Discipline – A Longitudinal Study of Computer Science and IT Engineering Students, in *ACM Transactions on Computing Education (TOCE), 9(1)*

Peters, A.-K., Capilla, R., Coroama, V., Heldal, R., Lago, P., Leifler, O., Moreira, A., Paulo, J, Penzenstadler, B., Porras, J., Venters, C. (submitted Sep '22) Sustainability Education in Computing: A Systematic Literature Review, Transactions in Computing Education (TOCE). Pre-print on arxiv: http://arxiv.org/abs/2305.10369

Peters, A.-K., Bengtsson, S. (in review) Towards an Understanding of Identity as Political. An Ethnographic Study of Computing Education at University.

Stein, S., Andreotti, V., Suša, R., Ahenakew, C., & Čajková, T. (2022). From "education for sustainable development" to "education for the end of the world as we know it". *Educational Philosophy and Theory*, *54*(3), 274–287.

Stoddard, I., Anderson, K., Capstick, S., Carton, W., Depledge, J., Facer, K., Gough, C., Hache, F., Hoolohan, C., Hultman, M., Hällström, N., Kartha, S., Klinsky, S., Kuchler, M., Lövbrand, E., Nasiritousi, N., Newell, P., Peters, G. P., Sokona, Y., … Williams, M. (2021). Three Decades of Climate Mitigation: Why Haven't We Bent the Global Emissions Curve? 37.

Wajcman, J. (1991). *Feminism Confronts Technology*. Polity.

Wiek, A., Withycombe, L, and Redman, C.L. (2011). Key competencies in sustainability: a reference framework for academic program development. Sustainability Science, 6, 2, 203–218.