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STUDENTS' PERCEPTIONS OF FUTURE, AGENCY AND TECHNOLOGY — RESEARCH-BASED IMPLICATIONS FOR SCIENCE EDUCATION

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FEDORA - Future-oriented Science EDucation to enhance Responsibility and engagement in the society of Acceleration and uncertainty This project received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement n° 872841 **www.fedora-project.eu**

Futures thinking

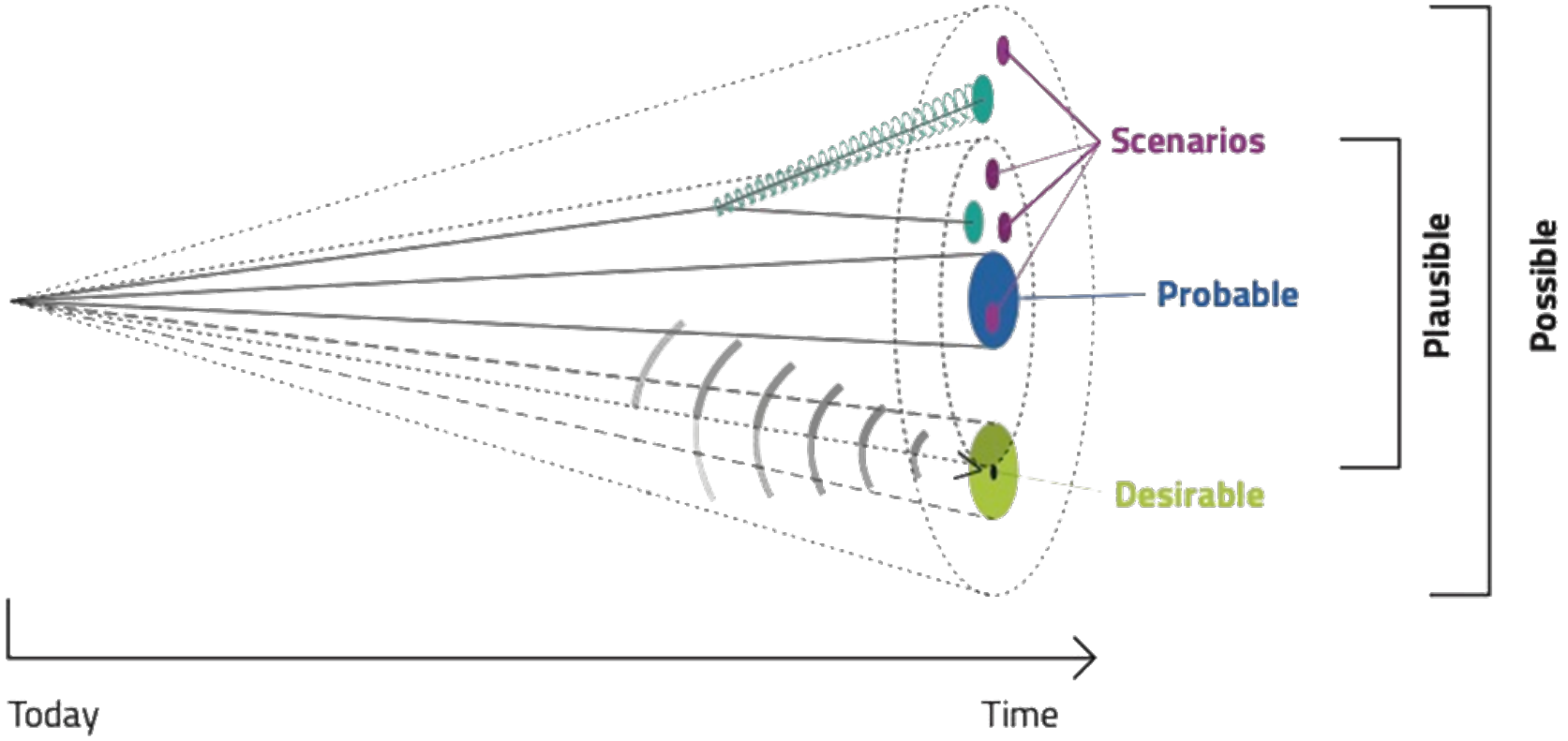


Image adapted from Voros, J, 2003. A generic foresight process framework, *Foresight*, vol. 5, no. 3, pp. 10-21.

Why investigate and develop students' futures thinking in science education?

THE BROADENING AIMS OF SCIENCE EDUCATION IN SCHOOL

VISION 1

- *disciplinary authenticity*
- traditional content knowledge

➡ prepares for further studies

VISION 2

- *personal relevance*
- scientific literacy

➡ using knowledge in everyday life and in society

VISION 3

- *agency*
- sustainability
- transformative learning

➡ value-based change in an individual and in the society

- Roberts, D. A. (2007). Scientific literacy/science literacy. Teoksessa S. K. Abell & N. G. Lederman (toim.), Handbook of research on science education (ss. 729-780). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kapon, S., Laherto, A., & Levrini, O. (2018). Disciplinary authenticity and personal relevance in school science. Science Education, 102(5), 1077-1106.
- Sjöström, J., et al. (2017). Use of the concept of Bildung in the international science education literature, its potential, and implications for teaching and learning. *Studies in Sc. Ed., 53*(2), 165-192.
- Laherto, A. & Rasa, T. (2021). Facilitating transformative science education through futures thinking. *On the Horizon, 30*(2), 96-103.

FUTURES THINKING IS IMPORTANT IN **AGENCY;** **SCIENCE** IS IMPORTANT IN **FUTURES THINKING**

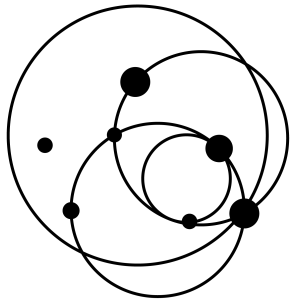
Agency and futures thinking are intertwined:

- "agency involves the idea of projection and implies anticipation" (Cuzzocrea & Mandich, 2016)
- our dreams, hopes and thoughts on the future have an impact on how we act at the present (Emirbayer & Mische, 1998; Carabelli, & Lyon, 2016; Lombardo & Cornish, 2010)
- e.g. the effect of climate anxiety on an individuals' agency (Ojala, 2012; Tolppanen, Aarnio-Linnanvuori, Cantell & Lehtonen, 2017)

Science and technology are integral to futures thinking:

- Young people's images of the future are loaded with science and technology – from dystopic visions to hopes for sustainability (Cook, 2016; Nuorisobarometri 2016; Rasa & Laherto, 2022)

FEDORA Work Package 3
set out to **future-orient science education**



- How do students perceive the future and their agency in it?
- What is the role of science and technology in students' futures thinking?
- What is the role of futures thinking in European science curricula?
- How can science education foster students' futures thinking and sense of agency?

Drawing on earlier research:

- earlier initiatives to adapt futures thinking in science education (e.g. Carter & Smith, 2003; Levrini et al., 2021; Paige & Lloyd, 2016)
- earlier research on (young) people's perceptions, carried out in a variety of fields: futures studies, youth studies, science and technology studies, and educational research (e.g. Besley, 2013; Cook et al., 2016)
- societally oriented approaches to science education (SSI, STSE etc.) (e.g. Bencze, 2020)

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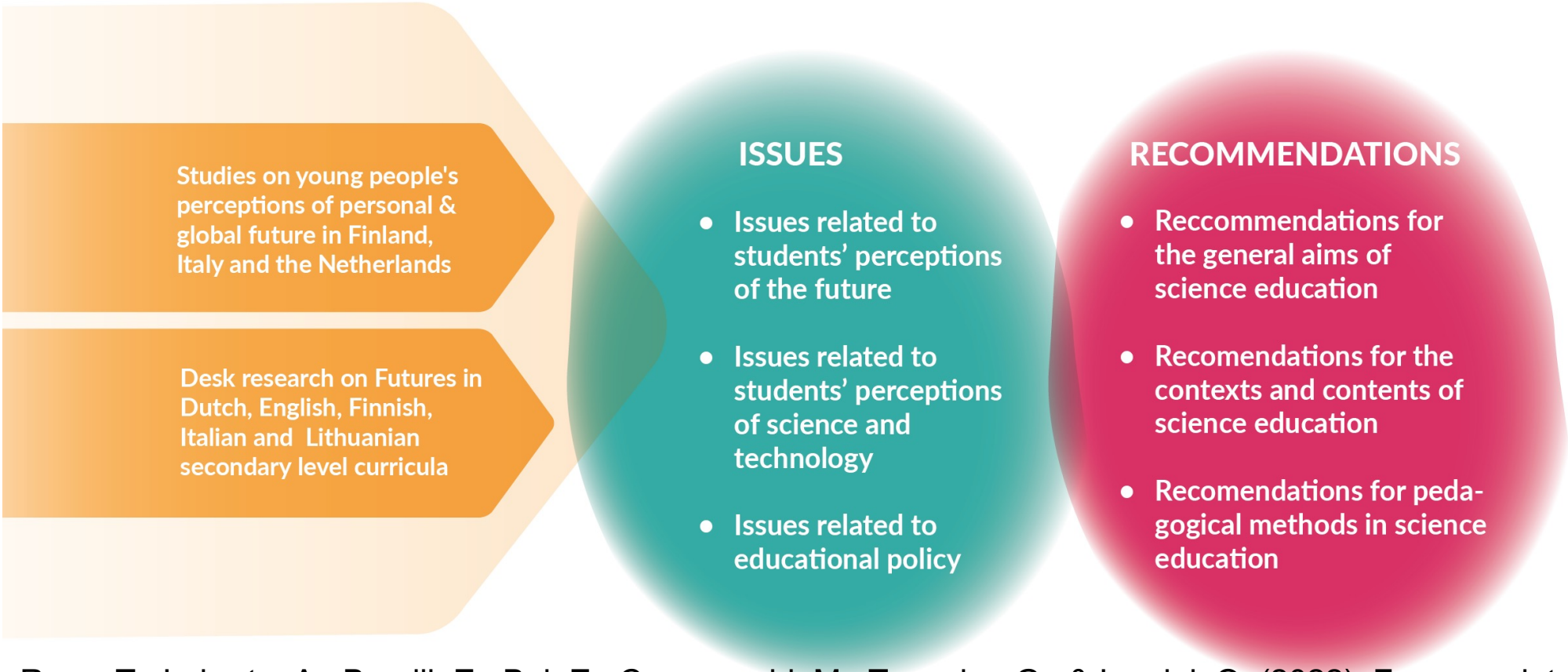

Rasa, T., Laherto, A., Barelli, E., Bol, E., Caramaschi, M., Tasquier, G., & Levrini, O. (2022). Framework to Futurize Science Education. https://www.fedora-project.eu/deliverables/ OR **bit.ly/fedoralink1**

FEDORA Work Package 3: Methods

- **four** part-studies on young people's perceptions (Barelli, 2022; Barelli et al., 2022; Rasa & Laherto, 2022; Rasa, Lavonen & Laherto, 2023)
  - 16-19 year old upper secondary school students' essays on a desirable future, collected in Finland (n=58) and Italy (n=223)
  - Additional data from the Netherlands to expand the research into younger, 8-14 years old children
  - Students' narratives were analysed by qualitative content analysis and narrative inquiry, also used in earlier research on youth's agency and views of the future (cf. e.g. Angheloiu et al., 2020)
- the curriculum study (see bit.ly/fedoralink1)
  - upper secondary school science curricula in Finland, Italy, Lithuania, theNetherlands and the UK
  - qualitative content analysis combined inductive and deductive coding, latter basing on the model of Futures Conciousness (Ahvenharju et al., 2018)

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ANALYTICAL FRAMEWORK & FINDINGS

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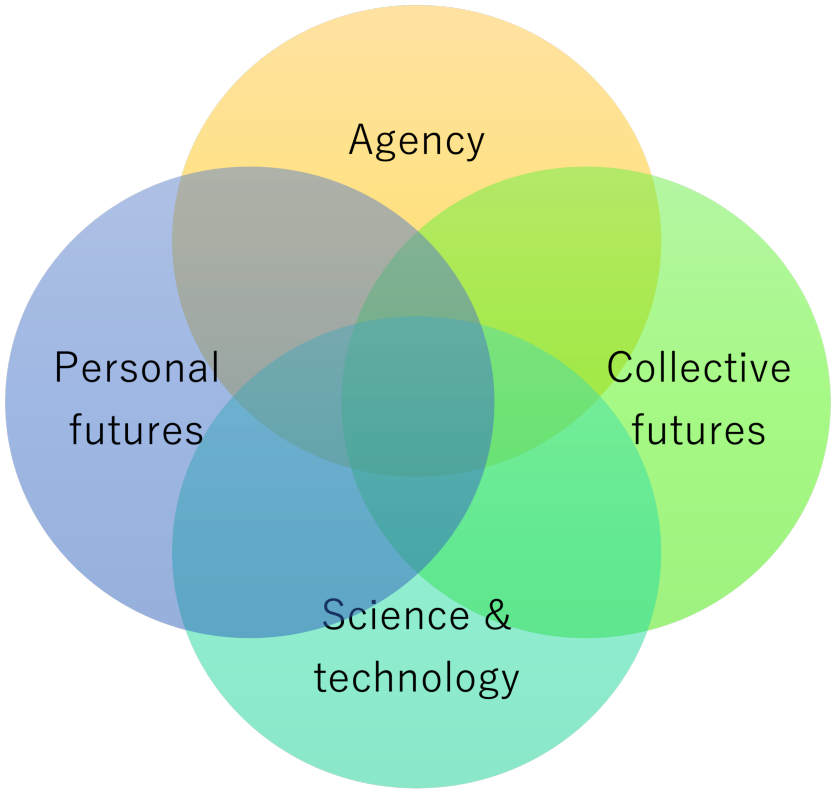

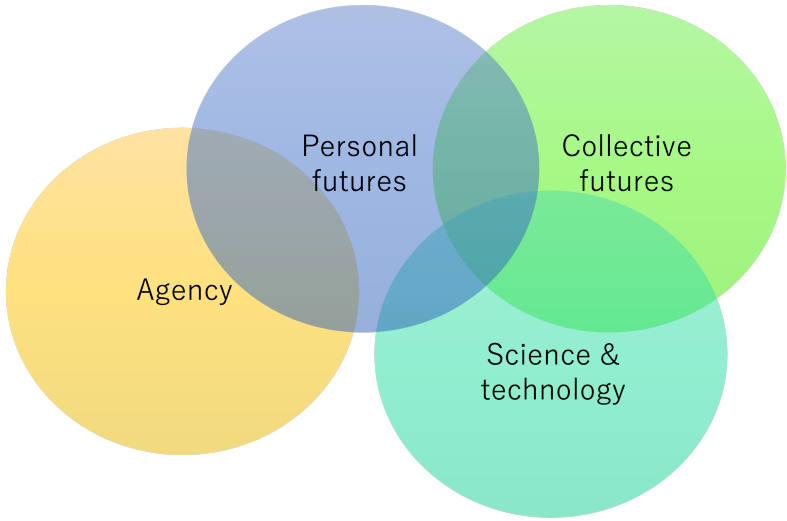

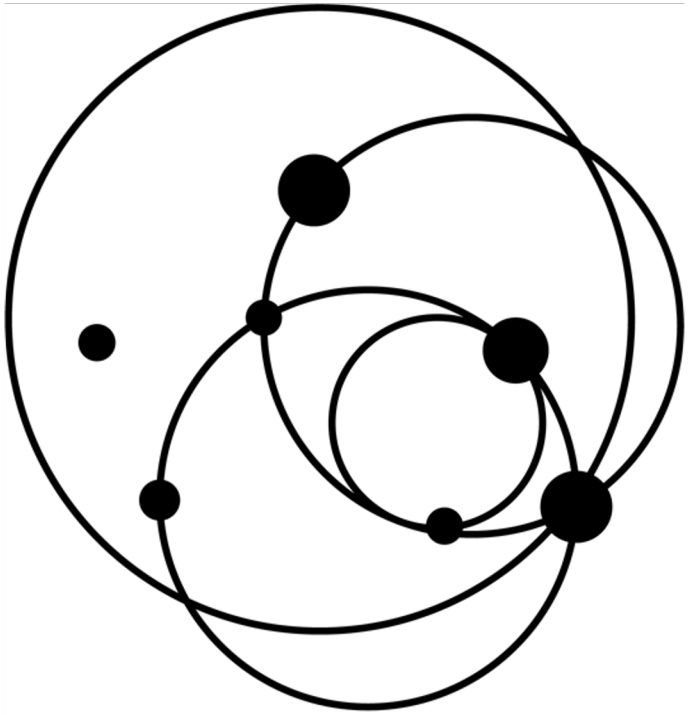

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FR3 - Framework to futurize science education

Rasa, T., Laherto, A., Barelli, E., Bol, E., Caramaschi, M., Tasquier, G., & Levrini, O. (2022).
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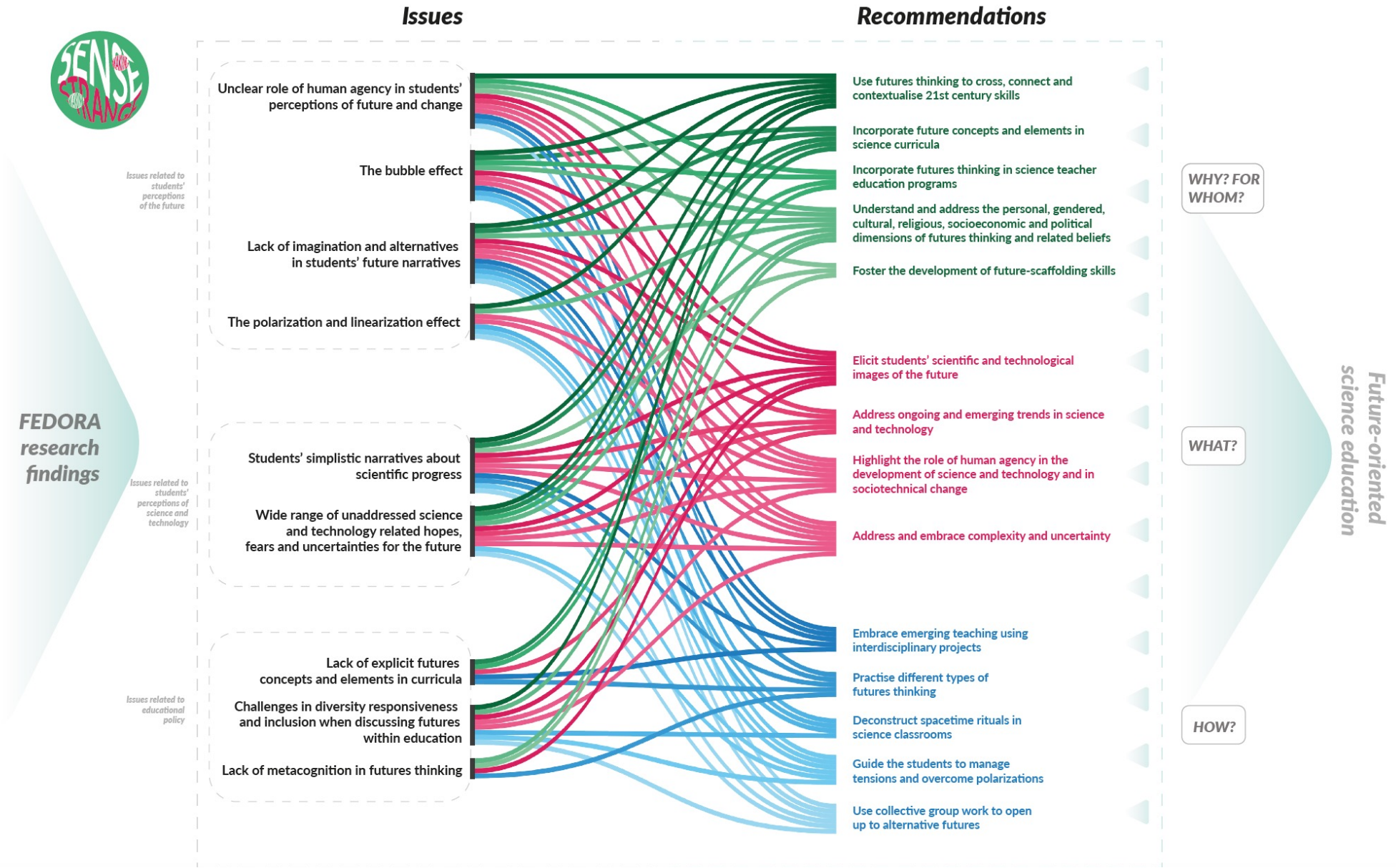

Issues
Recommendations
FEDORA research findings
Issues related to students' perceptions of the future
Issues related to students' perceptions of science and technology
Issues related to educational policy
Unclear role of human agency in students' perceptions of future and change
The bubble effect
Lack of imagination and alternatives in students' future narratives
The polarization and linearization effect
Students' simplistic narratives about scientific progress
Wide range of unaddressed science and technology related hopes, fears and uncertainties for the future
Lack of explicit futures concepts and elements in curricula
Challenges in diversity responsiveness and inclusion when discussing futures within education
Lack of metacognition in futures thinking
Use futures thinking to cross, connect and contextualise 21st century skills
Incorporate future concepts and elements in science curricula
Incorporate futures thinking in science teacher education programs
Understand and address the personal, gendered, cultural, religious, socioeconomic and political dimensions of futures thinking and related beliefs
Foster the development of future-scaffolding skills
Elicit students' scientific and technological images of the future
Address ongoing and emerging trends in science and technology
Highlight the role of human agency in the development of science and technology and in sociotechnical change
Address and embrace complexity and uncertainty
Embrace emerging teaching using interdisciplinary projects
Practise different types of futures thinking
Deconstruct spacetime rituals in science classrooms
Guide the students to manage tensions and overcome polarizations
Use collective group work to open up to alternative futures
WHY? FOR WHOM?
WHAT?
HOW?
Future-oriented science education

Issues related to students' perceptions of the future

Unclear role of human agency in students' perceptions of future and change

*Both bleak and optimistic images of the future can downplay opportunities for human agency. For example, **students may feel powerless** about influencing the ongoing sustainability crises.*

Lack of imagination and alternatives in students' future narratives

*While students' are able to actively imagine futures, they may have **limited skills and experience in imagining discontinuities**, completely new avenues, or amplification of current "weak signals".*

The bubble effect

*Daily-life personal rituals in which students feel like agents; a deep **detachment between the personal and the social dimension**.*

The polarization and linearization effect

*Students, in dealing with SSI, tend to **reduce the dynamics between the individual and collective dimension** to its extremes, either a mere personal/individual issue or a social/big issue.*

Issues related to students' perceptions of science and technology

Students' simplistic narratives about scientific progress

*Within the context of imagining futures, science and technology may be perceived as having a **fantastic, utopic role**.*

Wide range of unaddressed science and technology related hopes, fears and uncertainties for the future

*Science and technology take **various, also contradicting roles** in students' futures thinking.*

Issues related to educational policy

Lack of explicit futures concepts and elements in curricula

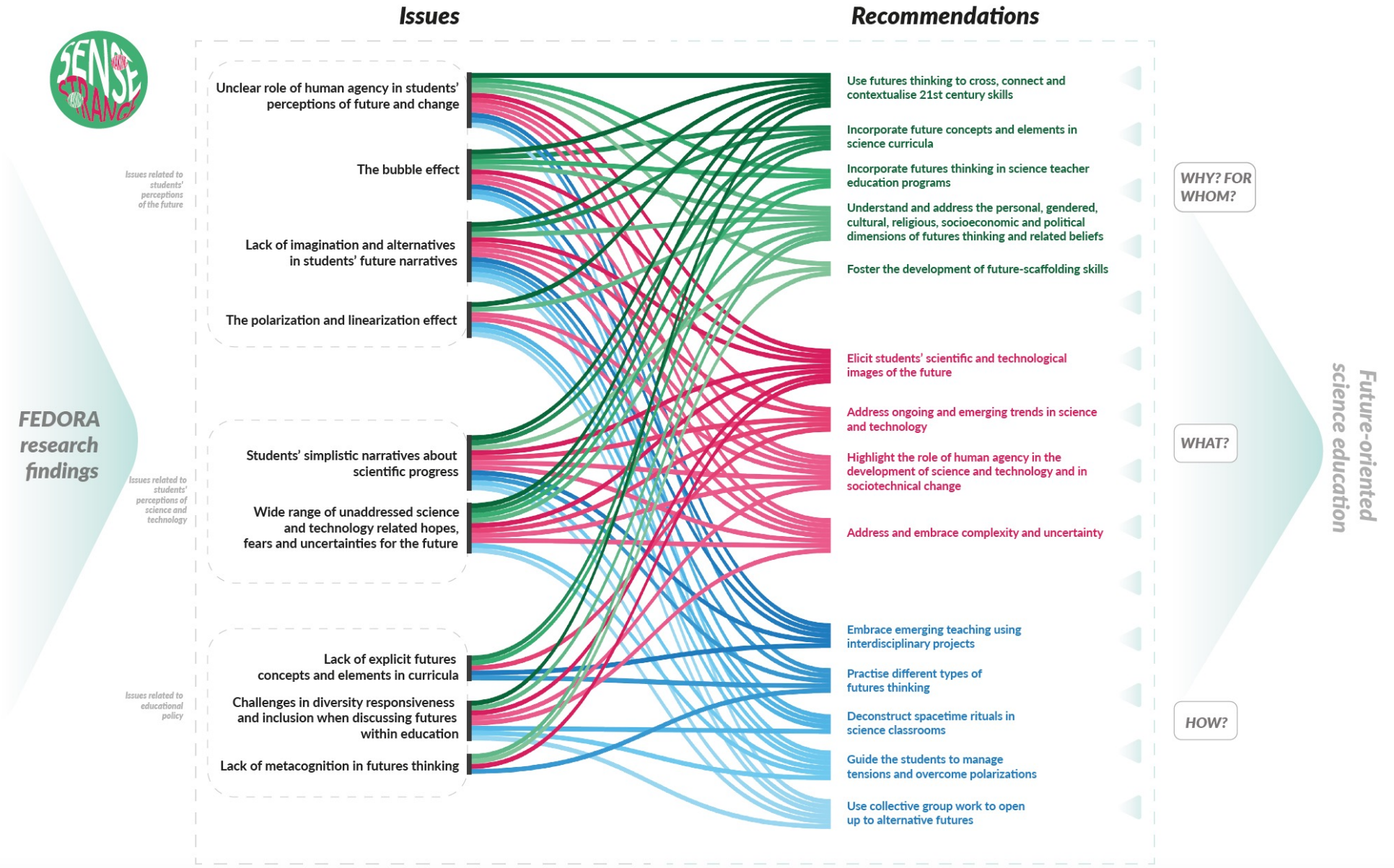
"Young people go to school to prepare for the future". However, there are hardly any explicit mentions of studying the future.

Challenges in diversity responsiveness and inclusion when discussing futures within education

Futures thinking is a part of one's worldview. This poses a challenge: when education addresses the future, whose future is addressed? Who is left behind or in the margins?

Lack of metacognition in futures thinking

Students lack the words to express the gain obtained through activities *in terms of development of structural skills i.e. abilities to organize pieces of knowledge and build systemic views, and dynamical ones i.e. competences to navigate across the complexity of knowledge,*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WHY? FOR WHOM?
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HOW?
Future-oriented science education

Recommendations part 1:

Why, for whom? General aims for science education

Recommendation I: **Use futures thinking to cross, connect and contextualise 21st century skills**

Recommendation II: **Incorporate future concepts and elements in science curricula**

Recommendation III: **Incorporate futures thinking in science teacher education programs**

Recommendation IV: **Understand and address the personal, gendered, cultural, religious, socioeconomic and political dimensions of futures thinking and related beliefs**

Recommendation V: **Foster the development of future-scaffolding skills**

Recommendations part 2:

What? Contexts and contents of science education

Recommendation VI: **Elicit students' scientific and technological images of the future**

Recommendation VII: **Address ongoing and emerging trends in science and technology**

Recommendation VIII: **Highlight the role of human agency in the development of science and technology and in sociotechnical change**

Recommendation IX: **Address and embrace complexity and uncertainty**

Recommendations part 3:

How? Pedagogical methods in science education

Recommendation X: **Embrace emerging teaching using interdisciplinary projects**

Recommendation XI: **Practise different types of futures thinking**

Recommendation XII: **Deconstruct spacetime rituals in science classrooms**

Recommendation XIII: **Guide the students to manage tensions and overcome polarizations**

Recommendation XIV: **Use collective group work to open up to alternative futures**

FEDORA WP3 publications

- “Imagining the School of the Future through Computational Simulations: Scenarios' Sustainability and Agency as Keywords”, Barelli (2022), Frontiers in Education, 7.
- “Young people’s technological images of the future: implications for science and technology education”, Rasa & Laherto (2022), European Journal of Futures Research, 10, 4.
- “Facilitating transformative science education through futures thinking”, Laherto & Rasa (2022), On the Horizon, 30(2), 96-103.
- “Making sense to youth futures narratives: Recognition of emerging tensions in students’ imagination of the future”, Barelli, Tasquier, Caramaschi, Satanassi, Fantini, Branchetti & Levrini (2022), Frontiers in Education, 7.
- “Agency and transformative potential of technology in students’ images of the future: Futures thinking as scientific literacy”, Rasa, Lavonen & Laherto, Science & Education, 2023

Implications

- The need to future-orient science education
  - Secondary level science education typically addresses socio-scientific issues (SSI's), but often in a reductive, reactive and atemporal way ("should they build a power plant in the city?")
  - According to FEDORA research-based recommendations, science education should foster **critical, proactive, anticipatory, systemic** and **transformative** thinking on the role of science and technology in the future

- The framework opens new research avenues, addressing e.g.
  - temporal notions of agency
  - science curriculum
  - SSI teaching
  - sustainability competencies
  - systems thinking
  - students' perception of time; hope and optimism
  - the social nature of futures thinking and futures education
  - teachers' futures thinking

REFERENCES (NOT ON SLIDES) (1/2)

Ahvenharju, S., Minkkinen, M., & Lalot, F. (2018). The five dimensions of Futures Consciousness. Futures, 104, 1-13.

Bell, W. (1997). Foundations of futures studies: human science for a new era. Vol. 1, History, purposes and knowledge. New Brunswick, NJ: Transaction Publishers.

Biesta, G., & Tedder, M. (2007). Agency and learning in the lifecourse: Towards an ecological perspective. 39(2), 132–149.

Bijker, W. E. (2001). Understanding technological culture through a constructivist view of science, technology, and society. In S. H. Cutcliffe & Carl Mitcham (Eds.), Visions of STS: Counterpoints in Science, Technology and Society (pp. 19–34). State University of New York Press.

Borup, M., Brown, N., Konrad, K. & van Lente, H. (2006). The sociology of expectations in science and technology. Technology Analysis & Strategic Management, 18(3–4), 285–298.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77–101.

Carabelli, G., & Lyon, D. (2016). Young people's orientations to the future: navigating the present and imagining the future. Journal of Youth Studies, 19(8), 1110-1127.

Carter, L., & Smith, C. (2003). Re-Visioning science education from a science studies and futures perspective. Journal of Future Studies, 7(4), 45-54.

Cook, J. (2016). Young adults' hopes for the long-term future: From re-enchantment with technology to faith in humanity. Journal of Youth Studies, 19(4), 517-532.

Cuzzocrea, V., & Mandich, G. (2016). Students' narratives of the future: Imagined mobilities as forms of youth agency? Journal of Youth Studies, 19(4), 552-567.

Emirbayer, M., & Mische, A. (1998). What Is Agency? The American Journal of Sociology, 103(4), 962-1023.

European Commission (2015). Science Education for Responsible Citizenship. Report to the European Commission of the expert group on science education. Luxembourg: Publications Office.

Hodson, D. (2003). Time for action: Science education for an alternative future. International Journal of Science Education, 25(6), 645-670.

REFERENCES (NOT ON SLIDES) (2/2)

Hodson, D. (2011). Looking to the future. Springer Science & Business Media.

Lipponen, L., & Kumpulainen, K. (2011). Acting as accountable authors: Creating interactional spaces for agency work in teacher education. Teaching and Teacher Education, 27(5), 812-819.

Lloyd, D., & Wallace, J. (2004). Imaging the Future of Science Education: the Case for Making Futures Studies Explicit in Student Learning. Studies in Science Education, 40(1), 139-177.

Lombardo, T., & Cornish, E. (2010). Wisdom facing forward: What it means to have heightened future consciousness. The Futurist, 44(5), 34.

Lotz-Sisitka, H., Wals, A. E., Kronlid, D., & McGarry, D. (2015). Transformative, transgressive social learning: Rethinking higher education pedagogy in times of systemic global dysfunction. Current Opinion in Environmental Sustainability, 16, 73-80.

Mogensen, F., & Schnack, K. (2010). The action competence approach and the 'new' discourses of education for sustainable development, competence and quality criteria. Environmental Education Research, 16(1), 59-74.

OECD (2018). The Future of Education and Skills: Education 2030. OECD Education Working Papers.

Ojala, M. (2012). Hope and climate change: The importance of hope for environmental engagement among young people. Environmental Education Research, 18(5), 625-642.

Roberts, D. A. (2007). Scientific literacy/Science literacy. Teoksessa S. K. Abell, & N. G. Lederman (Eds.), Handbook of research on science education (s. 729-780). Mahwah, NJ: Lawrence Erlbaum Associates.

Rubin, A. (2013). Hidden, inconsistent, and influential: Images of the future in changing times. Futures, 45, S38-S44.

Sjöström, J., Frerichs, N., Zuin, V., & Eilks, I. (2017). Use of the concept of Bildung in the international science education literature, its potential, and implications for teaching and learning. Studies in Science Education, 53(2), 165-192.

Tasquier, G., Branchetti, L., & Levrini, O. (2019). Frantic Standstill and Lack of Future: How Can Science Education Take Care of Students' Distopic Perceptions of Time? Teoksessa E. McLoughlin, O. Finlayson, S. Erduran & P. Childs (Eds.), Bridging Research and Practice in Science Education. Contributions from Science Education Research (s. 205-224) Springer.

Threadgold, S. (2012). 'I reckon my life will be easy, but my kids will be buggered': Ambivalence in young people's positive perceptions of individual futures and their visions of environmental collapse. Journal of Youth Studies, 15(1), 17–32.

UNESCO. (2017). Education for Sustainable Development Goals: Learning Objectives. France: UNESCO.