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What science do we need to effectively respond to the societal challenges of the 21st century?

Editorial; opinion paper

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Abstract. Science is a driving force for the development of human civilization – it is an efficient rationalistic tool to overcome existing issues and a valuable source for new transformational ideas. Significant shifts in organizational principles and values of society often have a deep impact on science, but major shifts in scientific paradigms have an even bigger impact on societies. The rapid development of globalization, interconnectivity, and the increasing complexity of technologies and concepts like Artificial Intelligence, the circular economy, and sustainable technologies require reshaping the science itself to better adapt to new circumstances in an unevenly developed world. This editorial paper examined the existing state of modern science and how it corresponds to these tendencies and identified some promising directions of science development to effectively respond to the societal challenges of the 21st century. Particularly science can benefit from adopting more inter- and transdisciplinarity, shifting from narrow specialization to more polymathy, and integrating theory and practice. We shaped the scope of Aurora: A Journal of Contemporary Science to advance these scientific directions by supporting high-quality research within corresponding areas.

Keywords: science, interdisciplinarity, sustainability, overspecialization, polymathy.

1. Science of a narrow specialist

In the early days of modern science in the late Renaissance, research was innately practice-oriented and interdisciplinary. For the founding figures of science – including Copernicus, Galilei, and da Vinci, who were all polymaths – it was clear that understanding the principles of the universe requires wide knowledge across different disciplines. This tendency was preserved during the Enlightenment with Descartes, Newton, Voltaire, and Euler being prominent examples of distinguished polymaths.

The rapid growth of scientific knowledge resulted in a tendency for specialization with the idea that a single person cannot comprehend all emerging scientific areas in-depth. This understanding prevailed in the 20th and 21st centuries, resulting in deep diversification and isolation of different fields in science. Kuhn (2009) demonstrated that specialization advances existing knowledge by developing a deeper understanding of the local phenomena. According to Kuukkanen (2007) referencing the data from the study (Rescher and Michalos, 1979), only in Physics, from 1911 to 1970 the number of specialties grew from 19 to 205. Multiplication of specialties resulted in a situation when many scientific concepts and terms are understood only by limited communities of highly specialized researchers or interpreted differently in different scientific fields or their branches (Heinemeyer et al., 2022; Jin et al., 2013; Zukswert et al., 2019).

Indeed, common terms and concepts are required for effective communication in science and a holistic understanding of nature. Martínez and Mammola (2021) identified a clear interest in modern scientists for knowledge of progress in other scientific disciplines.

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They demonstrated that presenting research in a more communicable form results in more scientific citations.

Another non-obvious consequence of deep specialization in science is rising conformity (Binswanger, 2014). Park, Leahey, and Funk demonstrated in their recent and highly influential paper (2023) the rising trend in science that researchers lean to existing paradigms and assumptions established in a specific narrow field to build and advance their careers. This trend is significant and universal across different fields, resulting in slowing scientific progress (Park et al., 2023; Weatherall and O'Connor, 2021). This negative tendency is reinforced by the scientific publication industry dominated by highly specialized journals publishing papers in very narrow fields with a specific understanding of correct and acceptable approaches and methods (Binswanger, 2014). Another issue is an overemphasized role of scientometric indicators in academic career promotion, contributing to the conformity trend.

The science of narrow specialists gave society many groundbreaking achievements that could not have been possible without it. However, it is difficult to overstate how much knowledge and synergy we are losing by having the dialogue between disciplines so limited (Araki, 2020; Debackere et al., 1996).

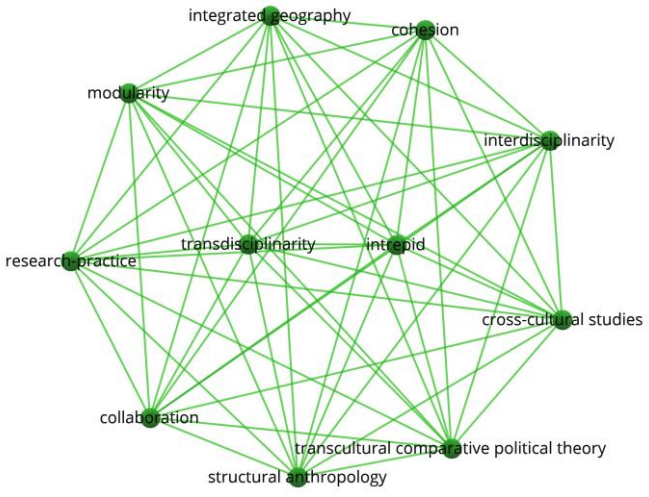

Figure. The most often terms appearing together in the abstracts and titles of the studied literature.

Another issue is an increasing gap between academic research, industry, and policy. Papers and manuscripts written by scientists for scientists are often either so theoretical that their application in practice is impossible, or written in artificial language difficult to comprehend even for highly-qualified industrial specialists and politicians (Li et al., 2023; Mohajerzad et al., 2021).

The Figure shows the results of the co-occurrence analysis, indicating the most often terms appearing together in the abstracts and titles of the studied literature. The identified terms are equally connected and related to high-level innovative applied research involving different perspectives.

2. Systemic issues require systemic solutions

The rise of globalization, interconnectivity, and the increasing complexity of technology and society in the 20th and 21st centuries made decision-making at most levels extremely difficult. Moreover, the issues are becoming more interdisciplinary and intellectually demanding, like the mitigation of global food and water shortages, climate change, building circular economies, and fighting contagious diseases (King, 2016).

For example, managing the COVID-19 pandemic required knowledge, innovations, and practical skills in healthcare, logistics, food production and supply, intellectual technologies, and effective law enforcement. Any potential solutions to such complex issues should be evaluated based on their projected impact on economics, societal prosperity, human health, equality, and environmental sustainability, considering available resources.

Modern challenges require policy- and decision-makers to have advanced technical skills, digital literacy, systemic thinking, and wide cross-disciplinary knowledge (Araki, 2020). The benefits of science-backed evidence-based decision-making are reported in healthcare (Choi et al., 2016; Gębska-Kuczerowska et al., 2020; Towfighi et al., 2020), green production (Krawczyk et al., 2023), management of natural resources (Greenhalgh et al., 2022), fisheries, agriculture, and transport (King, 2016).

Studies report that the practical impact of scientific findings depends less on their scientific credibility than on how they are communicated to decision-makers and the general audience (Greenhalgh et al., 2022). The complexity of language (Li et al., 2023), lack of reproducibility, openness, and transparency in research methods (Aguinis et al., 2020), absence of organizational infrastructure (Towfighi et al., 2020), competing interests (Cassola et al., 2022), cultural factors and practical political reasons (Woodall et al., 2024) are identified as

major factors preventing scientific research from being applied in practice.

3. The need for a new perspective in science

The present analysis has shown the need to adapt science to societal challenges of the 21st century. The major issue is the absence of productive dialogue between different branches of science, and between science, practice, and policy. We identified some corresponding inefficiencies within science that need to be addressed:

- overspecialization,
- lack of systemic thinking,
- unnatural and complex language, overuse of scientific jargon,
- excessive conformity within narrow fields,
- lack of reproducibility, openness, and transparency in research methods.

The issues of overspecialization, limited systemic thinking, and excessive conformity can be mitigated in two principal ways, which can be combined – supporting interdisciplinary and transdisciplinary research (von Wehrden et al., 2019) or supporting scientific polymathy in individuals (Araki, 2020). Interdisciplinary research is typically conducted by a team of researchers from different disciplines who synergistically apply their knowledge and skills to solve complex problems. Transdisciplinarity occurs when an interdisciplinary team is complemented by experts from the industry to provide practical feedback.

The second way to mitigate the discussed issues – supporting polymathy in individuals – is highly promising and can be effectively implemented by accepting the possibility of an academic career beyond the narrow specialist path and recognizing that the value of a polymathic researcher is no less than a specialist researcher. A study by Michele and Robert Root-Bernstein (2023) demonstrated that polymathy predominates among Nobel Prize winners and is strongly associated with scientific creativity. A study (Montgomery, 2025) shows that significant recent developments in Artificial Intelligence can result in steeper learning curves for polymathic and systemic researchers.

The use of complex or non-typical wording must be limited to situations when it is necessary for the precision, accuracy, and scientific credibility of a statement. Otherwise, it is recommended to use language understandable for highly qualified professionals and researchers from different fields. Finally, the researchers must aim for more reproducibility in research by detailed descriptions of the used methodology and data, with references to external sources if necessary, and better discussion of study limitations, resulting in better practical applicability and more trust.

4. Closing statements

We shaped the scope of Aurora: A Journal of Contemporary Science to advance scientific directions responding to the societal challenges of the 21st century by supporting inter- and transdisciplinarity, shifting from narrow specialization to more polymathy, and integrating theory and practice.

Aurora: A Journal of Contemporary Science is a multidisciplinary, peer-reviewed journal that publishes high-quality research in applied science, technology, and development. We particularly welcome studies that advance theory, methods, or tools for more efficient design, simulation, and decision-making. We value contributions offering fresh, interdisciplinary, or transdisciplinary perspectives. The journal also encourages critical analysis of relevant or controversial aspects of societal development, including topics such as Artificial Intelligence, Sustainability, and technological transitions. Submissions from diverse academic, technical, or geographic backgrounds are welcome, as long as they are scientifically and technically sound. We encourage open discussion and the exchange of informed, contrasting viewpoints.

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