# Problem Solving as a Key for Sustainable Future

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## ABSTRACT

Achieving sustainability in modern, complex world is a demanding, long-term task. In this paper we focus on the contribution of education to that sustainability. We argue about the urgent need for innovative and interdisciplinary modes of education, that are developed in such a way to optimally prepare students for majority of expected tasks in contemporary and future world. We extract leading problems accompanying that task, present related disciplines, and describe prospective starting point for future, education.

## KEYWORDS

problem solving, education, SDG, ESG, sustainability

## INTRODUCTION

There is a global agreement that sufficient resources should be devoted to preserving, and improving in the amount possible, our society. Having in mind the complexity of our society in total, but also of its many components, this is certainly a rather demanding endeavour. Currently, as a combination of the long-term goals and the operational prescriptions, the Sustainable Development Goals (SDG) were formulated [1]. Closely related to these Goals is the concept relating environmental issues, social issues and corporate governance – ESG [2]. One may argue that each of the three involved notions encompass rather complex and large substructures.

SDG is collection of 17 goals, spanning different aspects of our society [1]. The Goal 4 – Quality Education is specifically devoted to education. But along with it, education is important for all other goals, having in mind that generally education contributes to transferring knowledge and experience between generations. In that way, education contributes both to latency of values and good practices in our society, as well as to their evolution and gradual improvement. It is not just that the learning process is important, but awareness of it is crucial for the reflective thinking needed to address the challenges of sustainability and complex systems.

In this paper we focus onto the stated role of education. In section two we extract aspects of society that are currently too demanding for most of the education approaches, and are consequently insufficiently encompassed within needed, optimal form of education, as one may argue. In sections three and four we concentrate on education. In particular, in section three we extract starting points for development of optimal form of

education which substantially contributes to sustainability. In section four we additionally emphasise sustainability of education and relate it to systems thinking. We argue that inclusion of systems thinking significantly contributes to the sustainability of education. Section five provides the perspective and general guidelines for broader application of systems thinking into education. Last section concludes the paper.

## SOCIETY AS A COMPLEX SYSTEM

Researches of complexity and complex adaptive systems (CAS) broadened our understanding of characteristic dynamics in society and its parts, which includes cooperation and competition, emergence, bifurcations and deterministic chaos, to name some of the relevant notions [3, 4]. Dynamics of the CAS is characterized with nonlinear interactions, the important consequence of which is delay. That includes different aspects of dynamics, in particular the instabilities. Nonlinearity is a notion that can easily be described, yet deserves significant experience to be taken into account properly, whether that be for predictions or for analysis of past events. CAS is modelled on the micro-level, by characteristics of entities, usually called agents, and rules of their interactions [5]. The macro-level, system behaviour is obtained by simulations. There is no direct linking between macro-level and micro-level. Instead, one modifies micro-level characteristics of agents and rules of their interactions in order to obtain specific macro-level system behaviour. Models differ in the level of stylization, so some reveal generic system behaviour, trends that can be related to many diverse systems [5], while others are specific and reproduce expected dynamics in details but of a particular system. Some contributors emphasise anthropomorphic interpretation of quantities that are historically considered rather formal [6], while other develop formal approach to intrinsically human-related characteristics such as happiness

[7, 8, 9], to mention few examples among a myriad of existing scientific contributions.

All stated should be taken into consideration if one wants to make reliable predictions for a society or some other CAS. That requires a critical mass of competent people, to be formed within every new generation by a well-formulated, learning outcomes oriented, profound education.

## EDUCATION FOR COMPLEX SYSTEMS

World Economic Forum states top 10 skills, for different periods since almost a decade ago. Consistently, critical thinking and complex problem-solving top the list of skills that employers believe will grow in prominence [10]. These have been consistently emphasized as crucial since the first report almost a decade ago. Moreover, broader application of ESG standards within organizations will also have a significant impact [10, 11]. One aspect is that investments that facilitate the green transition of businesses and the broader application of ESG standards bring about net job-creation [11].

OECD monitors education and different aspects of transition from school to work. In addition, OECD formulated and organizes world-wide testing of skills and knowledge among students, in the form of PISA testing [12, 13].

UNESCO has contributed extensively to the development of competences of children and youth [14]. It was realized some time ago that education for sustainable development is a key instrument to achieve the SDGs [14].

The UN previously proclaimed Decade of Education for Sustainable Development (2005–2014), aimed at integrating the principles and practices of sustainable development into all aspects of education and learning [14].

One of the consequences of the extensive testing of alignment of education with society's needs is

that we have rather detailed and reliable insight into the fulfilment of the education potential. Yet, it is clearly stated in words by I. Bokova, General-director of UNESCO: "A fundamental change is needed in the way we think about education's role in global development, because it has a catalytic impact on the well-being of individuals and the future of our planet" [14].

All stated about the reached education level and characteristics of our society (and CAS as its models) point to the fact that an innovative, qualitatively different education is needed in order to include the complexity in formal curricula, so that students can grasp its fundaments in a significant portion.

As a particular aspect of education, we emphasize problem-solving. It is a set of actions aimed at solving a particular problem, no matter how complex, or interdisciplinary it is. However, that approach is not yet formulated precisely so its potential is realized only by a small part.

Along with the problem-solving skills, and critical thinking, it is crucial to embed metacognitive strategies in education. If students have learned to reflect on their own learning processes, they are better equipped to contribute meaningfully to the SDG-a and adapt to the complexity of modern society as a CAS.

## EDUCATION FOR SUSTAINABLE DEVELOPMENT

The ability to solve problems from the perspective of cognitive psychology is a crucial for achieving sustainability. Cognitive psychology, which studies mental processes such as perception, memory, thinking, and problem-solving, provides insights into how people make decisions and how they can be encouraged to adopt sustainable behaviours. Understanding how people process information and make decisions involves recognizing problems, generating possible solutions, evaluating those solutions, and selecting the most appropriate one.

In the context of sustainability, these problem-solving skills are essential for individuals and communities to identify environmental challenges, develop innovative solutions, and implement sustainable practices [15].

Research has shown that human behaviour is a significant source of uncertainty in the use of natural resources and a critical factor in local and global sustainability challenges [16]. By integrating insights from behavioural sciences into sustainability research, we can develop policies that promote sustainable behaviour. Cognitive psychology provides tools to understand how people perceive environmental problems and how they can be motivated to change their behaviour [17].

Education plays a pivotal role in fostering these problem-solving skills. Education for sustainable development (ESD) equips learners of all ages with the knowledge, skills, values, and agency to address interconnected global challenges such as climate change, biodiversity loss, and resource depletion [18]. ESD empowers individuals to make informed decisions and take collective action to transform society and care for the planet [19].

To further enhance these educational efforts, system thinking is another critical element for achieving sustainability. System thinking allows us to see how different parts of a system interact and how changes in one part can affect the entire system [20]. By understanding complex environmental problems through system thinking, we can develop holistic solutions that consider long-term consequences. This approach is integral to problem-solving as it helps identify the root causes of issues and their interconnections within the environmental system [21].

In addition to system thinking, STEM (Science, Technology, Engineering, and Mathematics) education is essential for sustainable development. STEM education equips individuals with critical thinking, problem-solving, and technical skills

necessary to address environmental challenges. By integrating sustainability into STEM curricula, we can prepare future generations to develop innovative solutions for sustainable development [22, 23].

Moreover, a transdisciplinary approach is vital for sustainability. This approach involves collaboration between academics from different disciplines and non-academic actors to co-produce knowledge and develop actionable solutions. Transdisciplinary research addresses complex sustainability challenges by integrating multiple perspectives and promoting holistic understanding [24, 25].

The ability to solve problems from the perspective of cognitive psychology, combined with system thinking, STEM education, and a transdisciplinary approach, provides valuable tools for addressing environmental challenges and achieving sustainable development.

Before proceeding it is to be noted that any new concept or other type of change in education needs to be implemented in real time and space. Regarding time, there is a significant literature about structuration of time and about leisure time of children and youth, see e.g. [26, 27] and references therein.

## STRATEGIES FOR ENHANCING CRITICAL THINKING AND PROBLEM-SOLVING SKILS

Sometimes it is difficult for educational processes to determine which actions/methods due to the complex systems are successful, especially when we are talking about climate changes, how to integrate them into everyday life and how to receive feedback on the impacts at individual and collective levels [28]. This calls for initiatives to strengthen the link between education and science. In order to achieve exactly such initiatives, educational systems should use cognitive and educational strategies to foster innovative

solutions, but in addition to this, implementation of gamification enhance engagement and motivation towards eco-friendly actions [29].

To be more precise, gamification can be a useful tool to teach students about sustainability in general [30], creating a gamified environment where students could be active citizens monitoring their impact on the environment and thus influence climate change and sustainability, which leads to fostering problem-solving skills, critical and analytical thinking and creating sustainable solutions.

Another strategy which can be implemented in educational system, which in its core supports the development of the individual as a critical participant of a particular system, is the metacognitive strategy. Metacognition as a concept of thinking about thinking [31], enhance critical thinking, problem-solving and finally adaptability in education [32]. Use of metacognitive strategies enables students to develop self-awareness, monitor their thinking process, and regulate their cognitive processes to be more accurate [31]. This is important when addressing complex, interdisciplinary challenges and CAS.

To be clearer, the following three dimensions of metacognitive strategies need to be implemented:

A) **Planning dimension**, students need to prepare themselves for problem-solving scenario and thought processes, which helps student to clarify their understanding of the problem and outline an approach to solving it.

B) **Monitoring dimension**, students need to check and validate their comprehension of the problem-solving scenario by self-questioning which sustains critical thinking. This step ensures students continuous reflection on their knowledge, adjusting strategies based on real-time insights.

C) **Reflection dimension**, after completing the task, students need to analyse what they learned,

reflect on the effectiveness of used strategy, and think about improvement for the future tasks. This helps student better understanding of complexity of the sustainability, and to develop deeper understanding of how their learning strategies can evolve.

Therefore, sustainable education should also rely on metacognitive strategies, because in its concept it contains the skills of critical thinking, problem-solving, but also the sustainability of both the problem-solving scenario and the ecosystem that created the sustainable solution.

## METODOLOGY FOR IMPLEMENTING SUSTAINABLE EDUCATION

According to all previous stated, strategy for empowering sustainable educational system and people involved in it (students, teachers, principals, parents, local community) was created. It is based on the enrichment of school curricula with ESG principles, which ultimately strengthens the school's ecosystem and makes it sustainable, and it is built on the basis of three dimensions. First dimension of the program are students, which includes students in the local community as active participants and those who contribute to development and innovation through an interdisciplinary and transdisciplinary approach of teaching and learning. In this way, the education system enriches the local community with individuals who are ready to face the complex problems of the CAS, to solve them, and to improve already existing solutions. Second dimension of the program are the teachers. By strengthening their knowledge and skills, as well as by raising their awareness of problems and the possibility of active participation in solving them, teachers provide students with support in an appropriate and sustainable way. Teachers need to collaborate with system beyond schools in the way that students can gather information, critically think about problems, give the scenario of solving specific problem and in the end implement possible

solution. For this, teachers should have a support and life-long education. Third dimension of the program are parents, principals and local community, which, by raising awareness of the needs, problems and possibilities of innovation within the school's ecosystem and beyond, provide significant support to students and teachers in their development.

The ecosystem is then complete, which with its way of functioning provides sustainability because all participants are aware of learning protocols as well as improving or changing existing solutions.

## CONCLUSIONS

This paper highlights the critical role that education has both in the achieving sustainability in complex, nonlinear systems and in finding solutions to the contemporary problems. It emphasizes the urgent need for innovative and interdisciplinary educational approaches that prepare students for challenges that are expected from them to deal with. Key aspects include the importance of problem-solving skills, critical thinking, and metacognitive strategies. By integrating these elements into education, we equip future generations to address the complexities of sustainable development and complex adaptive systems. Ultimately, sustainable education is essential for fostering informed, critical and capable individuals who can contribute to the well-being of society and the planet.

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