Position paper

Domain-general problem solving skills and education in the 21st century

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1. Executive summary

This position paper is aimed at highlighting the relevance of domain-general problem solving skills for a comprehensive approach to contemporary education. We argue that education in the 21st century needs to be comprehensive in the sense that it should equip students with *domain-general* problem solving skills in addition to *domain-specific* factual knowledge and problem solving strategies.

In this position paper, we argue that contemporary educational systems fall short of addressing the societal and individual needs to teach and to foster domain-general problem solving and that education needs to be extended. To this end, researchers face three main challenges: (1) to increase the relevant stakeholders' awareness of the existence and the importance of domain-general problem solving skills, (2) to optimize the ways in which such skills can be assessed, and (3) to explore ways to foster students in developing and maintaining these skills.

1.1. Accelerating changes in today's world and why a new focus is needed

The transition from the 20th to the 21st century has been accompanied by dramatic changes in virtually all areas of society. The globalization and growth of technology have led to fundamental and lasting changes in the societies of the 21st century, also labeled technological societies. Crucially, these changes are reflected in the types of problems encountered in everyday life and, thus, in demands for the skills students need in order to successfully master life's challenges. Whereas factual knowledge is almost instantly accessible nowadays, we are increasingly faced with dynamically changing, intransparent, and complex problem environments across a wealth of situations and contexts. It is the mission of education to adequately supply students not only with factual knowledge and domain-specific problem solving strategies (which are crucial in and of themselves as well) but also with a broader set of skills required in today's societies. We argue that, in their current state, many educational systems most likely fall short of fully exploiting the cognitive potential of their student population in the area of domain-general problem solving, which is particularly relevant for successful educational, professional, and personal development in the 21st century.

1.2. Domain-general problem solving skills in everyday contexts

Without doubt, domain-specific problem solving skills and specific factual knowledge have high explanatory power with regard to tackling a routine task or a problem in a specific field, but they are limited to narrow domains. Because of this,

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several cross-curricular skills have been in the spotlight and have been considered highly relevant for citizenship in contemporary societies in addition to domain-specific skills. Domain-general problem solving is arguably the most prominent of the cross-curricular skills that have a particular relevance for education. That is, domain-general problem solving encompasses the very skills set that are necessary for a person to adapt to the cross-curricular problem environments typical of contemporary societies. It touches on several cognitive and noncognitive skills such as information processing, representation and evaluation of knowledge, reasoning, self-regulation, metastrategic thinking, proactive planning, and decision-making. The 2012 cycle of the Programme for International Student Assessment (PISA), which is run on a triennial basis by the Organisation for Economic Co-operation and Development (OECD), recently adopted a framework for domain-general problem solving. This framework provides a theoretical conceptualization that might serve as an interesting starting point for how to integrate domain-general problem solving and its components into contemporary education and national school curricula. To this end, we argue that most educational systems are relatively efficient in transmitting knowledge that is organized according to the principles of specific disciplines. This is a significant strength of the current systems, but as teaching is organized within disciplinary boundaries, more general conceptual frameworks and intellectual skills do not receive enough attention. This should lead to some rethinking of how permeable these boundaries should be and the extent to which they allow for adequate teaching of the entire set of skills necessary for the next generation of citizens.

1.3. Domain-general problem solving and its current role in educational assessment

Several educational large-scale assessments have been launched worldwide over the last two decades. These large-scale assessments, among them the PISA survey, are an attempt to quantify the performance of educational systems and to monitor their development over time. Thus far, PISA and other large-scale assessments have tried to adapt to the emerging demands implied by societal changes to a greater extent than national school curricula. This is exemplified by a strategy adopted by the OECD to cover more general and transversal skills in the international PISA assessment cycles in order to complement domain-specific skills. Importantly, domain-general problem solving was assessed in the PISA 2012 cycle with international comparisons across more than 40 countries. The results of these international comparisons indicate that domain-general problem solving skills might have been neglected in contemporary education. We argue that these and results from other large-scale assessments have relevant implications for educational systems. We further argue that we need to put forth more focused efforts to understand and directly address some of the problem areas that have been revealed by such assessments.

1.4. How can we facilitate the learning of domain-general problem solving skills?

In the technology-rich and fast-paced societies of the 21st century, we encounter problem situations on a daily basis. These problem situations need persistent, self-regulated, cognitively complex, and planned actions in order to be solved. Besides domain-specific problem solving skills, students need to be equipped with a set of diverse skills and exploration strategies that can be transferred to a number of situations and that are applicable across several domains. We argue that this development is in line with the inherent assumption of any educational effort that skills can be transferred to other contexts and contents. We acknowledge that empirical evidence on the transfer of cognitive training and interventions is mixed or modest in magnitude but also indicates the value of facilitating general thinking skills. To this end, we argue that the teaching of domain-general problem solving skills needs to be more explicitly embedded in domain-specific curricula by incorporating such skills into national school curricula and national standards. This process can be facilitated by the use of intelligent and integrated learning and assessment tools and specific interventions designed to strengthen the domain-general components of domain-specific teaching.

1.5. Where are we headed? Engaging educators in the teaching of domain-general problem solving skills

We argue that it is the link between everyday teaching practices and scientific discourse that needs to be strengthened in order to initiate a lasting structural shift. We will explore how a comprehensive and joint approach might advance knowledge on how to develop domain-general problem solving and on how to ensure the necessary shift toward comprehensive education for the next generation of students.

2. Accelerating changes in today's world and why a new focus is needed

The world of today is changing rapidly, perhaps more rapidly than ever. In the labor market, for instance, assembly line jobs in the automotive industry or in manufacturing were common five decades ago. Today, the number of people working on assembly lines has diminished dramatically, and machines and computers carry out tasks previously performed by human workers. Whereas some jobs have almost entirely disappeared from the surface of the labor market, new jobs with new demands have emerged, and the task composition of many other jobs has changed radically. In an empirical investigation of these changes, Autor, Levy, and Murnane (2003) reported that in the 1960s, routine cognitive and manual activities that are characterized by the repeated practice of similar tasks and that are located within highly specified domains began