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Learning how to understand complexity and deal with sustainability challenges – A framework for a comprehensive approach and its application in university education

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ABSTRACT

Sustainability challenges such as climate change, biodiversity loss, poverty and rapid urbanization are complex and strongly interrelated. In order to successfully deal with these challenges, we need comprehensive approaches that integrate knowledge from multiple disciplines and perspectives and emphasize interconnections. In short, they aid in observing matters in a wider perspective without losing an understanding of the details. In order to teach and learn a comprehensive approach, we need to better understand what comprehensive thinking actually is. In this paper, we present a conceptual framework for a comprehensive approach, termed the GHH framework. The framework comprises three dimensions: generalism, holism, and holarchism. It contributes to the academic community's understanding of comprehensive thinking and it can be used for integrating comprehensive thinking into education. Also, practical examples of the application of the framework in university teaching are presented. We argue that an ideal approach to sustainability challenges and complexity in general is a balanced, dialectical combination of comprehensive and differentiative approaches. The current dominance of specialization, or the differentiative approach, in university education calls for a stronger emphasis on comprehensive thinking skills. Comprehensiveness should not be considered as a flawed approach, but should instead be considered as important an aspect in education as specialized and differentiative skills.

1. Introduction

We live in an epoch of the Anthropocene where human pressure on Earth is the driving force of planetary change (Crutzen, 2002), and societies all over the world are facing complex challenges such as climate change, biodiversity loss, land degradation, rapid urbanization, and conflicts due to resource depletion (e.g., Rockström et al., 2009). These issues are strongly interrelated in complex ways and can hardly be solved or treated only with specialized knowledge within one discipline (Jerneck et al., 2011). Instead they require combining specialized knowledge with comprehensive and systemic thinking, by which we refer to approaches that embrace and integrate multiple viewpoints, subjects, or issues and interrelations at the same time (see, e.g., Ferrer-Balas et al., 2010; Kates et al., 2001; Lewontin and Levins, 2007; Meadows, 2009; Ostrom, 2009; Waddington, 1977). Briefly, such approaches aim at seeing a wider perspective and the details simultaneously.

The disciplinary organization of academic knowledge creation has remained relatively unchanged (Holm et al., 2013; Nature, 2007; Warburton, 2003), and specialized skills dominate strongly in university education, whereas comprehensive, integrative skills are considered more marginal. To attend to this imbalance, this paper focuses on comprehensive skills, while recognizing the importance of the dialectical combination of both.

In order to more effectively teach and learn comprehensive approaches, we need to better understand what comprehensive thinking actually is. This paper addresses the question by introducing *a conceptual framework for the comprehensive approach*,

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called the *GHH framework* (see also Willamo et al., 2017a) after the three elements it consists of: generalism, holism, and holarchism. The framework is not an exhaustive description of comprehensive thinking, but the three elements under examination here are among the central ones. The GHH framework is a general framework that can be applied in university education of sustainability science and other relevant disciplines to increase the understanding of any particular complex phenomenon or situation. It has been created in the Department of Environmental Sciences in the University of Helsinki, Finland.

The approach presented here is mainly based on the "systemic" or "soft systems" thinking rather than the "systematic" or "hard systems" thinking (for the differences see, e.g., Flood, 2010; Ison, 2010, 22, 158). What is more, it is based on combining natural and social sciences as well as humanities and philosophy, and sustainability challenges are examined as processes in socio-ecological systems (see Ostrom, 2009) where human societies are understood as subsystems nested within ecosystems (Folke et al., 2016). That is, we emphasize that alongside physical, chemical, and biological processes, there also exists a range of cultural, societal, political, and even cognitive and psychological processes that need to be understood when studying socio-ecological systems (see also Hukkinen, 2014). Although the perspective of systems ecology (see, e.g., Odum, 1983; Hall and Day, 1977) is an important one here, this approach is based more on sustainability science (e.g., Kates et al., 2001) and the roots of our thinking go back, for instance, to *The Limits to Growth* (Meadows et al., 1972).

The paper is structured as follows: In Section 2, we define the key concepts and frame the topic by discussing complex sustainability challenges, comprehensive and differentiative thinking and their relation to education and sustainability science. Section 3 presents the GHH framework, and Section 4 presents practical applications of the framework in education in the Department of Environmental Sciences in the University of Helsinki. In Section 5, we discuss how the framework could be tested and developed further in the future. Section 6 concludes with some remarks on the role and future challenges of comprehensive thinking in university education.

2. Sustainability science and the comprehensive approach in education

2.1. The main concepts in this study

The terminology in literature covering complex sustainability issues and comprehensive approaches is not yet fully established. Therefore, we define and explain here the key concepts related to the approaches we use in this study.

The main concepts of this paper can be organized into three levels. The first level (1) is the most general one. At this level, the central concept is *comprehensive thinking* by which we refer to various approaches that are broad in scope and give strong emphasis on examining reality as wholes and on integrating various subjects and viewpoints. This kind of thinking is thousands of years old (Checkland, 1999, A3) beginning, for instance, from the dialectical thinkers of the Orient and Ancient Greece. Nowadays *systems thinking* especially in the form of *soft systems thinking* (Flood, 2010; Jackson, 2003) is perhaps the most prominent variant of comprehensive thinking.

As an antonym for comprehensive thinking we use the concept of *differentiative thinking* to represent all such approaches that focus on analysis, differentiation, specialization, reduction, mechanist thinking, etc. In these approaches, it is typical to choose only small details of a larger entity for a closer examination and to pay less attention to the links between the parts that create complexity. That is, analysis dominates synthesis (e.g., Cilliers, 2002, 1–2; Gershenson, 2013; Ulanowicz, 2009) and a narrow and deep scope of inquiry is favored against a broader one. Differentiative thinking has been the classical paradigm in natural science and engineering in Western cultures for the past centuries (Capra, 1982, 37–62; Midgley, 2000, 2–4; Ponting, 1992, 147–149).

Obviously, thinking is never purely comprehensive or differentiative; instead, all human thinking encompasses elements of both forms. Thus, the approaches create a continuum, and when we refer to comprehensive or differentiative thinking in this paper, we mean such forms of thinking that place a strong emphasis on either the comprehensive or on the differentiative end of this continuum.

At the next conceptual level (2) are all the different variants of comprehensive thinking, for example systems and systemic thinking, complexity thinking, chaos thinking, and dialectics and their variants. This paper focuses on one of these variants, namely our own approach from which we derive *the framework for the comprehensive approach,* which is a tool for examining any kind of system. In this paper, the main characteristics of this approach and of the concept of *system* are (on different definitions of systems, see, e.g., Backlund, 2000; Dubrovsky, 2004):

- the system is considered to consist of *parts* and *interconnections* between them
- parts and their interconnections build up *wholes* which are at a higher *systemic level* than their parts
- there are also relationships between the whole and its parts
- all systems can be examined from many *different perspectives* and none of these is better than the others per se.

At the most detailed level (3) of this work are the three main components of the approach: *generalism, holism,* and *holarchism* (see the definitions in Sections 3.1–3.3).

In this paper, the term *complexity* is central when describing the character of sustainability challenges. We use a simple definition of complexity: a system is complex if it is formed of strongly interconnected parts (Bar-Yam, 1997; Heylighen, 1996). The more interconnected parts there are in a system, the more complex it is. Already three decades ago Pagels (1988, 318) predicted that complexity would be the central challenge for science. We claim that the statement is also valid for education.

Other important concepts of this study are *sustainability science, sustainability challenge,* and *sustainability education*.[1] The concept of sustainable development was introduced in the 1970s and entered into the mainstream through the World Commission on Environment and Development (WCED, 1987). Since then the discipline of *sustainability science* has emerged in response to studying the shortcomings of current attempts to achieve sustainability and to create more fruitful approaches (see, e.g., Clark and Dickson, 2003; Jerneck et al., 2011; Kates et al., 2001). Sustainability science is a research field characterized by systemic and interdisciplinary research approaches that aim at promoting sustainable transformations and their research. It seeks to study and solve complex problems comprehensively and aims at recognizing value-boundedness and uncertainty (Clark and Dickson, 2003; Jerneck et al., 2011; Kates et al., 2001). We use the term *sustainability challenge* when referring to sustainability-related complex

[1] We are aware of the multiplicity of different definitions and the criticism towards the whole concept of *sustainability* (see, e.g., Barrett and Grizzle, 1999; Bond and Morrison-Saunders, 2011; Carruthers 2001; Mebratu 1998). Defining sustainability is a difficult task since it is a complex and value-bound concept and its definition is always subjective to a certain extent. In this paper, we do not offer our own interpretation of this concept. Rather, we present the GHH framework as a tool for understanding the interconnections between different elements and levels of sustainability. In this sense, we present a tool that could be utilized in creating more robust definitions of sustainability.