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Complexity: A Challenge for Education for Sustainability

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Abstract

Life on our planet Earth is complex. Uncountably many cycles are connected with each other, creating a system in which we are bound as well. If we change a small, but central piece of the structure, it may lead to essential changes in all other connected areas.
Much damage has already been done by human interventions. In order to prevent further deterioration, it is extremely important to promote a different way of thinking, a systemic thinking, a thinking in alternatives. This old claim has gained importance through the vision *Sustainable Development* (BLK (Hrsg.) 1998), which is itself a reduction of complexity.
But how can teachers put these demanding claims into action – in schools that are mainly characterised by strong structures (like separated subjects, lessons of 45 minutes, individual marks)? In order to find out more about the real situation at school, I accompanied three committed teachers of a German Gymnasium (high-school) who work on *Education for Sustainability*. I visited some of their lessons, examined their students via a questionnaire and encouraged the teachers in interviews to talk about their aims, occurring problems and proposals for improvement. This article summarises the results gained.

1. Why is Complexity a present phenomenon?

Looking carefully, almost every environmental communication has to deal with inherent complexity: First, the communicated topics are usually linked to many other ecological, economic and social topics, as life on Earth *is* extremely complex and interconnected. Therefore, it is necessary to constantly decide which of these aspects you want to include in or exclude from your communication. Second, communication itself is a complex process, as there are at least two different persons who have an individual background, an individual way of thinking and an individual way of communicating – but who still want to exchange information without being misunderstood. Therefore, it is necessary for the communicators to constantly check the other one's reaction and to adjust themselves to it. So, the call for *Network Thinking* and *Dealing with Complexity* might truly not be something really new (e.g. VESTER 1984), but: It is still crucial when communicating today's complex (environmental)

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problems – no matter if you work with new information and communication technologies or not (WERSIG 1996).

2. Scientific results and real-life restrictions

Already since the 1980s, there are results of psychological studies (DÖRNER 1989) which explain why humans have difficulties in dealing with complexity. Ever since that time, several books have been written about methods to improve the human way of dealing with complexity. Fig. 1 summarises typical problems mentioned in such studies and the respective recommendations for teachers.

But what exactly *is* "complexity"? I prefer to distinguish between characterristics of *complex systems* (which describe a system itself) and those of *complex decisions* (which refer to certain actors – here: humans – with their specific abilities and limitations). As Fig. 2 (next page) shows, complex decisions always include potential dangers that should be kept in mind as well as challenges to work on.

	Typical Problems	Recommendations
PSYCHO-LOGICAL OVER STRAIN	• Linear Thinking	• To practice thinking in networks
	• Thinking in simple causal-chains	• To practice the analysis of side-effects • To keep in mind those things that should stay the same
	• Assuming well-known effects in unknown contexts	• To practice thinking in alternatives
	• Retreat to well-known and graphic facts, avoiding the new	• To start from the well-known and concrete and to lead up to the new and abstract, enabling individual or at least several intakes to a subject
	• Paralysing fear when being confronted with something unknown or unfamiliar	• To dose gradually when confronting with something unfamiliar • To create a relaxed and enjoyable atmosphere • To arouse curiosity
PHYSICAL OVER STRAIN	• Limited ability of the human brain to perceive, process and memorise	• To discuss technology as a supplement for human abilities (e.g. computer simulations for a time-lapse effect)
	•	• To change overstraining structures (e.g. more tolerance to „mistakes")

Figure 1:
Typical problems in dealing with complexity and recommendations for teachers

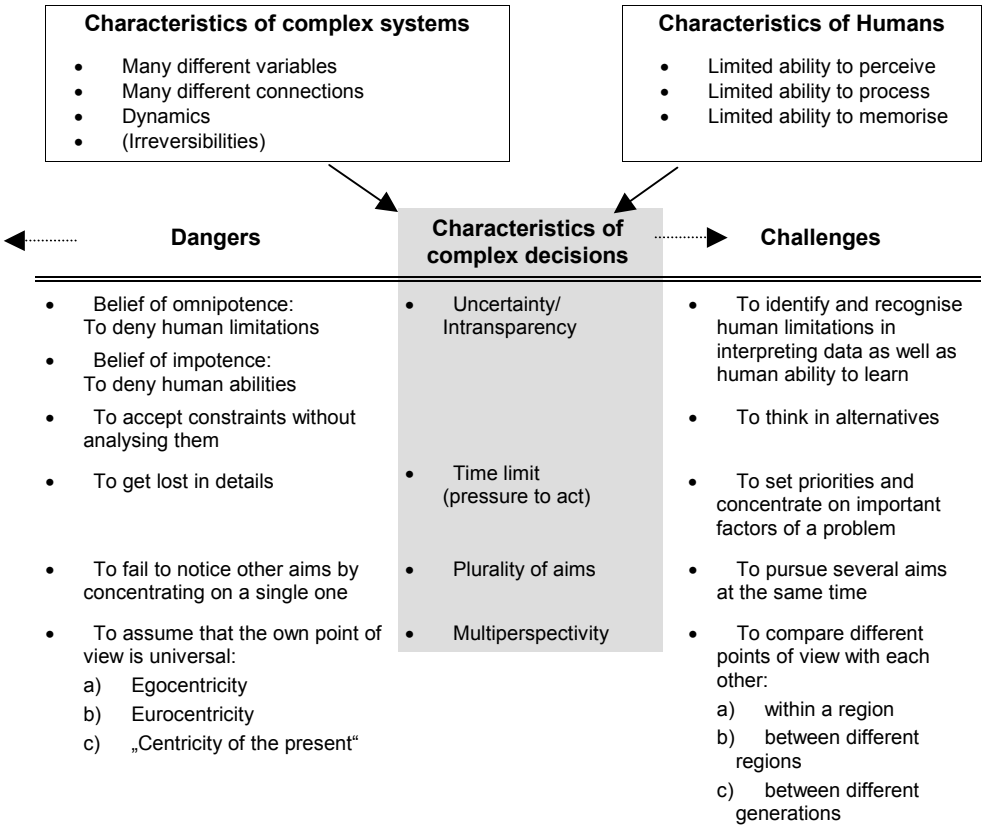

Figure 2: Characteristics of complex systems and complex decisions

Despite all the research work in the field of complexity, many politicians and educators still do not sufficiently reflect upon the complexity of problems they deal with. The reasons for this reach from a lack of consciousness to short-term personal advantages and rigid institutional structures. The crucial question is: Can we find an appropriate "balance" between these factors and an acknowledgement of complexity? Of course, this question is complex itself. Therefore, it can not be answered by just one scientist, politician or educator. It takes common efforts to develop and implement appropriate and realistic models for such a "balance".

3. Sustainable Development: An example for reducing complexity

The *Sustainable Development* discourse can be regarded as such a "common effort" to find and implement models for a balanced future. The concept of *Sustainable Development* reduces the complexity of global environmental and social problems by

providing a shared vision to act according to: To make sure that development meets the needs of the present without compromising the ability of future generations to meet their own needs (HAUFF (Hrsg.) 1987). Now, in order to realise this vision, two methods can be distinguished:

1. One method is to *analyse and categorise* the negative global developments, so that, in the end, an easily comprehensible number of starting-points can be deduced from it. Therefore, the final aim is to *reduce unsustainable developments*. A good example for this method is the concept of global "degeneration patterns" or "syndromes" developed by the WBGU[2]. These "syndromes" summarise similar causal nets for environmental degeneration and can therefore be found in different geographical regions – for example the syndrome of mass tourism (WBGU 1996).
2. The other method is to *develop further positive visions* that canalise the wish for a life worth living by formulating attractive sustainable alternatives – for example: "Living good instead of having much" or "De-acceleration" (BUND/ MISEREOR (Hrsg.) 1995). In this case, the final aim is to *put sustainable alternatives into action*.

These two methods both lead to more orientation in the whole by being fuzzy and shapeable in detail. And they are complementary: We need to find out what we don't want and how we can prevent it, *and* we need to find out what we want instead and how we can achieve it. In order to be motivated for a change, we need negative feelings like fear as well as positive feelings like anticipation.

4. Education for Sustainability – A complex but important challenge

If a society really wants to change its orientation towards a more sustainable development, it is also necessary to change the education of young citizens, because they are the *decision makers of tomorrow*. Now, society has always held the requirement that school prepares the students for real-life and for the future. But especially industrial societies tend to become more and more complex, and the future tends to be more and more unpredictable. Therefore, this old claim is actually becoming a real challenge (Table 1, next page).

5. How do teachers deal with that challenge?

In order to find out more about the real situation at school, I accompanied three committed teachers of a German Gymnasium (high-school) who participate in the program "BLK 21 – Education for Sustainability". I visited some of their lessons, examined their students via a questionnaire and encouraged the teachers in interviews to talk about their aims, occurring problems and proposals for improvement.

[2] WBGU = German Scientific Advisory Committee for Global Environmental Changes

Table 1:
The increasing complexity of industrial societies and pedagogical challenges

Driving Forces	Discourse	Pedagogical Challenges
Increasing differentiations within society	Discourse about „Individualisation“	• To enable individual intakes to a subject
Increasing internationalisation of economic affairs	Discourse about „Globalisation“	• To relate local and global phenomenons to each other • To encourage and qualify for a lifelong learning
Increasing scope of interventions into nature in terms of space and time	Discourse about „Risk Society“	• To learn to judge scientific results • To allow and overcome fears
Increasing connectedness within information and communication flows	Discourse about Information Society“	• To train the ability to judge the quality of information • To mediate and accompany the learning processes instead of passing on knowledge

In order to fulfill the official requirements, the teachers chose topics that were related to the guidelines for their subjects. And in order to deal with the complexity of the themes chosen, they created learning units that were characterised by different ways of openness:

Table 2:
The criteria “openness” (LSW 1992) and the three investigated learning units

Way of openness	Investigated learning units
Content-related openness *popular and interdisciplinary topics*	1. Sustainable mobility and advertising 2. Sustainable urban planning 3. Sustainable biotechnological food
Methodological openness *Participative methods, independent way of learning*	4. Students developed TV commercials for sustainable transportation services 5. Students developed sustainable settlement plans for a local region 6. Students presented and discussed several (biotechnological) food products and decided which food company is allowed to settle down in their community (roleplay)
Personal openness *New cooperation among teachers*	7. physics, arts and music teachers 2. geography/ biology teacher and trainee teacher 3. biology and politics teachers
Institutional openness *New cooperation with other (local) organisations*	8. Cooperation with the local public transportation office 9. Cooperation with the municipal urban planning office and a local office for environmental protection (BUND)

Although most of the research about "dealing with complexity" is done with computer simulations, none of the observed teachers used such computer simulations to analyse or illustrate their complex topics. But computers had to be used for Internet research and in order to develop the "mobility commercials".
Table 3 (next page) summarises further results.

6. A first insight – and many open questions

The observed lessons showed: It is already possible to give motivating lessons on complex sustainability topics that meet the interests of today's students. But the interviews with the teachers also made clear that this is not a matter of course and that there is still a lot to improve. In this case study, the main success factors were:

1. The teachers want to be "good teachers" and to give "interesting" lessons.
2. The entire teaching staff consists of many young as well as experienced and (still) committed teachers (→ "synergy effects").
3. The headmaster was very cooperative and enabled flexible timetables.
4. The teachers were allowed to give grades for oral group presentations instead of written exams.

Of course, during my research, I could accompany only a small group of teachers and students. Therefore, further research projects could deepen and broaden the results presented here. Further research questions could be, for instance:

- How do other teachers at other schools or even in other cultures deal with complex sustainability topics?
- What do students at other schools or even in other cultures *want* to learn at school? And how can we find an appropriate balance between their expectations and our claims?
- Which are the experiences of committed teachers when analysing and illustrating complex sustainability topics with the help of computer simulations?

Table 3: Research results (selection)

Category	Committed teachers	Students aged 16-17 years	Observed situations	Methods *by teachers*	Restrictions/ "To do" *by teachers*
Participative methods	Important and much more motivating for everyone, but: sometimes it is necessary to give information in a traditional way	Very important: teamwork, room for own ideas and initiatives, presentation techniques	In 5 of 6 double lessons the students worked and discussed independently in small groups In 3 of 6 double lessons the students had to give a formal presentation of their results	Brainstorming at the beginning of a new topic Teamwork To lend measuring and recording instruments for own investigations Roleplay	Teachers need training in mediation Participative methods often not applicable in single lessons (45 min.) More time for preparation is needed than is paid Lack of already prepared materials
Multiperspectivity	Unanimously judged as very important	Want to learn at school: to present and discuss own point of view	Multiperspectivity through individual preferences, different set roles (roleplay) and invited experts		
Critical usage of scientific data and concepts	Unanimously judged as very important, esp. for high-schools Rather with older students	Comparatively less important	Usage of data in only 1 of 6 double lessons	Confront students with contradictory data (e.g. compare historical explanations/ predictions with today) Encourage to look for hidden preassumptions and mistakes (e.g. by using articles)	Teachers need training in data interpretation Students need to be able to find out the main statements of a material used (→ PISA …)
Conscious inclusion of emotions ***esp. dealing with fears***	Important, but delicate aim Neither the sole nor the central aim of teachers	Comparatively least important, but: big differences among students (→ maybe not expected *from school*?)	Emotions were (partly) included in only 1 of 6 double lessons	Let express emotions in pictures Show interest in students, show own emotions	Teachers need to know students better Often not enough time for individual care
Cooperation with other institutions	Interesting, but difficult to maintain	Interesting and motivating	Invitation of representatives	Invitations Excursions	Neither teachers nor representatives get paid for the extra work → develop return services

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