A complex systems approach to education in Switzerland

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Abstract

The insights gained from the study of complex systems in biological, social, and engineered systems enable us not only to observe and understand, but also to actively design systems which will be capable of successfully coping with complex and dynamically changing situations. The methods and mindset required for this approach have been applied to educational systems with their diverse levels of scale and complexity. Based on the general case made by Yaneer Bar-Yam, this paper applies the complex systems approach to the educational system in Switzerland. It confirms that the complex systems approach is valid. Indeed, many recommendations made for the general case have already been implemented in the Swiss education system. To address existing problems and difficulties, further steps are recommended. This paper contributes to the further establishment complex systems approach by shedding light on an area which concerns us all, which is a frequent topic of discussion and dispute among politicians and the public, where billions of dollars have been spent without achieving the desired results, and where it is difficult to directly derive consequences from actions taken. The analysis of the education system's different levels, their complexity and scale will clarify how such a dynamic system should be approached, and how it can be guided towards the desired performance.

Introduction

The principles of complex systems have been successfully applied to a diversity of problems Bar-Yam (2004), including the health system, military warfare, international development and educational systems. Although still in its initial phase, the effects obtained through using a complex systems approach – also called "Enlighted Evolutionary Engineering" – are generally promising. At the moment, further validation to increase the credibility of this approach is still required. This paper thus applies the complex systems approach to the educational system in Switzerland. As it turns out, the Swiss system – which functions rather well in comparison with other education systems – already uses several of the recommended principles. Examples include offering a variety of ways towards professional qualifications, and using a diversity of actions to provide for the individual students' needs. To address remaining or new problems, the complex systems approach should be applied consequently, as detailed in this article.

Complex systems can help us improve our educational systems by making us understand the differences between diverse levels within the educational system and the respective approaches they require. We will understand why certain educational systems perform better than others by discussing the "one fits all" uniform large-scale approach as compared to diversity and individuality.

The motivation for applying complex systems thinking to educational systems is that our societies are becoming increasingly complex and intertwined. The modern globalised world needs mainly specialists – people who are particularly good at a few things, which often do not correspond to classical school teachings; some "all-rounders", who are good at many things, will make connections between them. When educating today's and tomorrow's generations – enabling them to be valuable citizens that contribute to a successful society[1] – the educational system must provide people with a certain minimal common background. Moreover, and potentially even more important, the educational system must help specialists acquire their particular skills and knowledge which will make them the valuable resources of society.

Building and maintaining a well-performing educational system, which is able to cope with varying conditions and stresses given through migration, economical crises, changing professional requirements and other factors, is a very challenging task. Growing difficulties in the educational systems manifest themselves all over the world, and it is time to find innovative solutions.

The author of this paper has thorough knowledge of the Swiss educational system, not only through her own experience, but also because over the last 6 years she has been closely involved with primary schools and in touch with universities of teacher education in Switzerland, through the

[1]Although, according to Davis and Sumara (2006), there is considerable philosophical controversy about the purpose / effect of education. For the scope of this paper, we will assume that the purpose of education is to enable people to become valuable citizens that contribute to a successful society which includes the dignity and welfare of as many citizens as possible.

KIDSinfo project, http://www.kidsinfo.ch. It was launched by the Swiss Association of Women Engineers, SVIN, to pique school children's and particularly girls' interest in technology.

Organisation of this article: The second section details the typical problems of many educational systems. The third section explains relevant system characteristics. The fourth section looks at scale and complexity found at different levels in the educational system. The fifth section brings up several controversial issues. The sixth section introduces the case study made on the educational system in Switzerland. The seventh section presents related work. Finally, the eighth section draws conclusions and makes further recommendations.

Problems in educational systems

It is a widely supported observation that in almost all countries – to a varying degree – young people increasingly have problems finding their ways in society. Another indicator of trouble is that in standardised tests applied across one or several countries, such as the PISA tests (the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment), performance is often poor. Well-regarded schools or countries frequently fail to meet the expectations.

Generally speaking, many educational systems are high in cost but low in efficiency, and lots of social problems surface with or without observable trigger. Many schools complain about disruptive behaviour, violence, cheating, students dropping out, etc.

Reforms of the traditional type have shown close no improvement; multi-billion $ projects such as "No child left behind" in the USA were abandoned after years of efforts in vain because the large scale actions taken failed to bring the desired effects.

The point is that people have diverse backgrounds, skills and preferences; therefore, a "one fits all" approach does not work well in many cases because it fails to take people's individuality and their different ways of interacting and learning into account. While the "average" students may react well to an "average-fitted" approach, there will always be plenty of students that will not – for instance, because they are overstrained, under-challenged, because their interests are not met, or because they do not understand the importance of education for their life.

In this situation, insights gained from complexity science may help. Such an approach takes into account the importance of scale and complexity at various levels in the educational system, and may help provide the system with suitable tools at the right level.

Learning is itself a highly complex process which involves many different factors and perspectives, such as individual sense-making, teacher-student relationships, classroom dynamics, school organisations, community involvement, bodies of knowledge, and culture (Davis and Sumara, 2006); knowing, knowing how to do, and knowing how to be (Lelouche and Morin, 1997). Bar-Yam (2004) discusses both the inherent complexity of learning itself as well as the different levels of complexity in educational systems; concrete examples generally refer to education in the USA. Other authors are cited in the related works section of this paper; our main focus here is on the system which provides the students with opportunities for learning while motivating their curiosity and creativity.

System characteristics

The original Latin word *complexus* signifies *entwined* or *twisted together* (Heylighen, 1996). A complex system is thus made of more than one part, and the parts are at the same time distinct and connected. It is therefore inherently difficult to model them. Often, there are circular causal relationships: one part influences the other, which in turn influences the first, and so on. This description definitely fits educational systems, with their multi-lateral interactions between teachers, students, their parents, families and friends, teachers' and students' associations, politicians, economy, and the society in general.

Due to its distributed nature, the educational system has weak interdependences between individual classrooms and between individual schools. What happens at one local school does not automatically have much to do with what happens at other schools, in other neighbourhoods or other cities. Schools are strongly influenced by local conditions, and within a certain school, what happens inside a certain classroom is strongly dependent on the teacher, the course to be taught, the students, and their parents. This leads to random quality (influenced by many local and some global factors).

Many system behaviours are local and fine scale – at the level of the individual student or teacher and the interactions they engage in with others. The difficulties encountered are often very particular to a certain case; an action successfully taken in one case may fail in another similar case.

Generally speaking, systems with high variety perform well when faced with complex challenges. This means that a system which is itself complex enough and has a variety of ways to address individual problems will be successful when facing a situation of high complexity and variety, as taught by the *Law of Requisite Variety* (Ashby, 1956). This certainly also applies to educational systems and the challenges they must cope with.

Many different ways of learning exist, including visual, auditive, tactile and other stimuli, and "learning by doing". Learning in diverse ways provides people with diverse ways of addressing challenges, which in turn often triggers innovation and thus economic growth. This means that it should be in the educational system's very best interest to provide

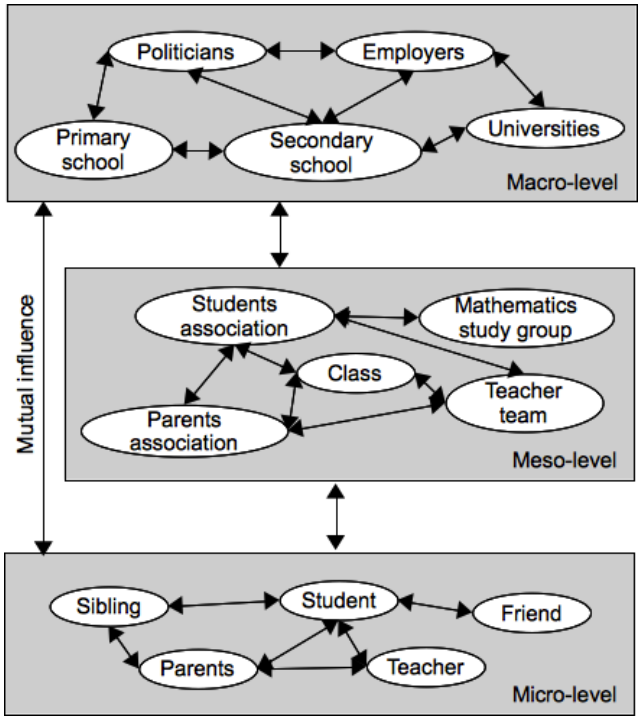

Figure 1: Examples of entities and their interactions at different levels of the educational system (non-exhaustive)

a variety of ways for people to learn. The goal should be to achieve a great variety of skills with consistently high quality, in whatever area of expertise.

The guideline should be to think globally – in terms of the entire educational system and the goals to reach for the benefit of the society – but to act locally – at the level of the individual students, teachers, or groups of them, and taking into account their individual conditions, problems, goals and influencing factors.

Complexity at different levels

As already mentioned, educational systems typically have several levels of diverse complexity and scale. We discern three of them (although more differences might be made in-between). Figure 1 illustrates this with some examples; other levels and other entities and relations between them exist but have been omitted for the sake of readability.

- **Micro-level / local level:** Education is highly complex at the level of the individual student, his / her capabilities and interests. Many different interrelations are important, including those between student and teacher, student and parents / family / close social environment / other students, and parents and teacher. Actions to take effect at this level must be small-scale and individual. Higher level uniformity of the local tools and actions is not indicated; what works in one case may fail in another.

- **Meso-level / intermediate level:** The complexity at the level of groups of students with similar interests and capabilities is medium, and effective actions can be of medium scale, as they will address student associations, study groups, parents associations or teacher teams. A certain coordination at the meso-level makes sense, as is actions at this level concern groups of people.

- **Macro-level / global level:** Large scale uniform approach can be used at a higher level, including the definition of minimal educational standards for the society to function, teacher education which provides a set of skills for individual action, and teacher support, giving them tools and organisations as required to fulfill their tasks. A lack of coordination or uniformity at the macro-level puts a system in danger of becoming disorganised and confusing.

Taking these differences in scale and complexity into account assures an effective approach to the existing difficulties at each level, because the actions taken are suitable in scale, scope and complexity.

Issues to be addressed

This section discusses several aspects of importance for a successful education system.

The right moment for specialisation: Certain aspects of the educational system are known to be very controversial; among others, the right age for specialisation. It is known from cognitive research that key connections and processes in the brain are established at an early age. This would speak in favour of an early specialisation, so that children would develop their special skills under optimal conditions. On the other hand, children may need enough time to learn a broad variety of skills and develop large general knowledge before even being able to decide which their favourite area shall be. A scientifically sound and generally accepted answer to this topic has not been found yet.

People's critical attitude towards teachers: It is an interesting observation that we are highly critical of teachers, but very little critical of medical doctors, although the latter ones have just as much responsibility for our well-being as the former ones, and both of them are human and thus prone to errors. While teachers carry a good part of the responsibility for our positive development on the mid- and longer term, doctors' interventions are ofter on the shorter term (we typically ask for their help when something is wrong; only few of us consult doctors for advice while everything is fine).

One possible reason for these different perceptions of responsibility and well-doing may be that (in most countries) we have a certain freedom to choose who to take as our doctor; if we are not happy with one, we can move on to the

next, until we are satisfied. There is thus a certain competition between doctors of the same specialty. Teachers, however, do not compete with each other, and people have mostly no possibility to choose which once we want to trust with our / our children's education. In some countries, people can choose to which school they want to send their children, but there, the selection possibilities end, and they must accept the teachers they are given. On the other hand, private and higher level schools get to select their students by specifying minimal performance requirements or through other selection proceedures.

A way of changing this situation would be to introduce mechanisms for competition and mutual selection of students and teachers in the educational system. The following versions are imaginable:

- Let schools choose students. Let students choose schools. Both versions already exist for private schools and higher / specialised education institutions.
- Let students choose teachers. Let teachers choose students. Neither version does usually exist, to the best of the author's knowledge. If two or more teachers offered exactly the same course, the students' way of choosing a teacher would depend on his / her teaching style and personality. Some teachers might be much more popular than others, and their classes would very quickly be fully booked. They may then either accept students on a "first registered, first served" basis, or select students based on their performances and characteristics. This would naturally lead to inequalities and tension, which may be morally controversial. Competition for sparse resources is, however, also an important principle of how biology and healthy economies function. It would be very interesting to study the effect of such a mechanism on education.

The problem with introducing competition between teachers is that it would add an additional and potentially deceptive performance criterion. Popular teachers are not automatically those which succeed best in transmitting the required knowledge and skills; the most popular teachers may simply be the best entertainers or those which challenge their students less than their fellow teachers. An analogue phenomenon was observed by Ficici and Pollack (1998) when studying the similarities between co-evolution and some educational systems. In their case, each "team" ranks the performances of the other. They showed that this kind of setup can get stuck in mediocre stable states. Indeed, competition may just lead to teachers modifying their content to get good ratings from students. As a consequence, they do well in the competitive environment imposed upon them, but do poorly at fulfilling the wider social goal of producing bright students. This, of course, would be completely contra-productive.

A solution to this problem would be to introduce performance criteria which measure how well teachers reach the main goal – that is, enabling their students to succeed in their further education, and maybe also on the mid- and longer term, that is, in their professional life. Students and their parents would certainly understand that it makes sense to choose a teacher which assures the further academic and/or professional success of their students as opposed to providing good entertainment (although both is relevant for efficient learning).

Performance evaluations: An important aspect of the educational system is that it needs to evaluate students. The typically used large scale standard tests fail to thoroughly reflect on people's capabilities and skills. Classical school knowledge cannot be equaled to success in life; very good students may fail in life, whereas weak students may gloriously succeed. Society needs people with a great diversity of individual skills, knowledge and characteristics, including manual skills, emotional intelligence, the ability to collaborate in teams, etc. Often, the required skills and knowledge do not correspond to classical school disciplines, and are thus badly reflected by standard examinations in those disciplines.

An alternative and more sensible way of assessing students may be so-called "portfolio assessment", meaning that not only single written exams count, but also individual and group projects, self-motivated studies, applications scenarios, and other studies. Typical arguments of educational institutions against such forms of assessment is, for instance, that is is more challenging to define success criteria, and that these assessment forms require more human resources, which are often sparse due to financial pressures.

Moreover, not only the standard skills which everybody needs must be assessed, but also and especially the particular skills needed for particular activities. This is called "niche selection" in biology, and it means comparing similar students with each other. The assessment of "non-classical" skills is not straight forward but well worth the effort of elaborating useful metrics.

Yet another aspect of introducing competition and mutual selection to the educational system is that not only students need to be evaluated, but also teachers, respectively the quality of their teaching. This is difficult because there is a lack of real comparison possibilities: it is impossible to test the same students on the same topic, using a different teaching method / a different teacher. Further efforts to find ways of evaluating teachers and teaching are required, in particular related to the issue of "deceptive goals" discussed in the subsection above.

Case study: Switzerland

In general, Switzerland and the Swiss educational system are doing very well. Although the country has very few

natural resources, the economy is fairly stable and hardly affected by economic crises. The unemployment rate has for many years remained around 3.5 - 4%, which is very low in comparison with other countries. Switzerland faces high amounts of immigration, and its population currently consists of 22% of foreigners, speaking many different languages in addition to the 4 official languages. Nevertheless, the difficulties surging in the educational system are well coped with. Given that many of the actions recommended by the complex systems approach – for instance having high diversity at the right levels – are already implemented in Switzerland and that the systems works well, we can conclude that the approach is valid. A few problems, however, persist in the educational system, and we will look at them subsequently.

Switzerland has a highly diverse educational system which is in many aspects governed by what we call the "Kantönligeist" – the spirit of the little cantons (of which small Switzerland has 26!) – which means that every canton can autonomously decide about their school system. This fragmented attitude is due to the nature of the Swiss state, which is a federation, and due to the populations appreciation of old ways and traditions; conservatism prevails.

Remarkably, the country has almost exclusively public schools, and they generally are of high quality – as just about everything in Switzerland; the few private schools have particular characteristics as following Rudolf Steiner's teachings or being international / foreign.

One of the strongest points of the Swiss educational system is that many ways lead through education to profession; some of the ways focus on academic achievements, others provide solid manual and profession-specific training. Details are given in the next subsection, followed by an analysis of the Swiss educational system and recommendations derived from the complex systems approach as introduced earlier in this paper.

Ways to professions in Switzerland

As illustrated in Figure 2, children enter the educational system at the age of 4 or 5, starting with 1-2 years of the recommended but not mandatory public Kindergarden. Some private Kindergarden establishments accept children much earlier, in some cases even as early as from the age of 4 months. The mandatory nine school years start with primary school at age 6 / 7. There are diverse forms of primary school (4-6 years) and intermediary "cycles" (1-3 years under diverse names), after which the adolescents around age 13 either go to some form of secondary school. It takes about 2-3 years and comes in several levels, according to the students' capabilities. Assessment is continuous, and there are no major final exams at the end of secondary school.

Those students which show sufficiently good performance in primary school and already know that they are headed towards university may attend the so called "Pre-gymnasium" (2 years), which then leads to the "Gymnasium" (4 years). Several specialties are available, preparing the students for university. Assessment is continuous, and there are also major examinations at the end, called "Matura". Succeeding them gives direct access to any university in Switzerland – except for medicine, where are *numerus clausus* takes place.

For those ending their school education at age 16, there is an excellent way of acquiring well-founded professional qualifications: an "apprenticeship" is a vocational training on the job, accompanied by 1-2 days per week at a specialised professional school. Assessment is continuous and includes both practical and theoretical evaluations. The final examinations lead to a nationally recognised diploma, which is crucial for future employment. About 70% of the adolescents choose this option, which gives them a solid practical education while already receiving a small salary (which is a considerable advantage in comparison with those who are still in full-time school!). In case the young adults with professional diplomas wish to acquire further qualifications, they can either attend technical schools or top-up their education with 1-2 years of general education which leads to a "professional Matura" and gives them access to the universities of applied sciences.

Further information about the educational system in Switzerland is available on:
`http://www.swissworld.org/en/education`.

Current state of the Swiss educational system

On the **positive** side, as mentioned before, the general state of the educational system in Switzerland is rather good. Already at primary schools, individual support tutoring is offered to students with special needs, no matter what it is: the local language, mathematics, reading, writing, keeping their attention focused, general learning skills, or something else. In some cities, senior citizens accompany school classes several days per week and provide support to teachers and students. Evaluations in most primary schools and some secondary schools include talks between child, parents and teacher for the assessment of the child's performance and the setting of individual learning targets.

While there are national standards for education, there are also many individual ways of achieving them, based on the student's characteristics, interests and performance. As it turns out, with this plentitude of possibilities, there really is a way for everybody to receive suitable education.

On the **negative** side, many primary school teachers complain about their massive work load, trouble with parents, too much responsibility, too many diverse objectives to achieve, and difficulties with the coordination of their students very diverse time tables which must include all their support tutoring and special lessons.

Over the last 2 decades, male teachers have become a rarity at primary schools, whereas at secondary schools, the

<table>
<tr><td>Approx. age</td><td colspan="3">...diverse ways, ranging from manual professions to academic professions...</td></tr>
<tr><td>4 - 6</td><td colspan="3">Kindergarden (1-2 years)</td></tr>
<tr><td>6 / 7-12</td><td colspan="3">Primary school (4-6 years) (+ intermediary “cycles”), diverse names !</td></tr>
<tr><td>13-15</td><td colspan="2">Secondary school on 3 levels (2-3 years);
continuous evaluations but no final examinations</td><td>“Pre-gymnasium” (2 years)</td></tr>
<tr><td rowspan="2">16-19</td><td colspan="2">Apprenticeship / vocational training (2-4 years):
training on the job + 1-2 days / week at specialised school;
continuous practical and theoretical evaluations,
final examination gives nationally recognised diploma
...about 70 % of people choose this option! (*)</td><td rowspan="2">“Gymnasium” / high school
(4 years), diverse specialties; final examinations (“Matura”) give university access except for medicine

...also other types of schools (nurses, teachers, business)</td></tr>
<tr><td>Work</td><td>Professional “Matura” (1-2 years)</td></tr>
<tr><td>20 - ...</td><td>Work

...further courses at diverse higher schools</td><td>Universities of applied science,
B.Sc. (not valid at universities)</td><td>Universities</td></tr>
</table>

Figure 2: Swiss education system overview

ratio between male and female teachers is still quite equilibrated. It has not been finally determined what the reasons for this development are, but it has been suggested that it may go hand-in-hand with the declining prestige which society attributes to primary school teachers. Again, the reasons are not known, but they may well be related to the previously mentioned total absence of competition and selection possibilities.

Another difficulty which people face in the Swiss educational system are the complications that come with moving from one canton to another, which is in todays dynamic society a rather frequent necessity. The transition from one canton’s educational system to another does often not go smoothly. The time when a second language of the country and English are introduced differs considerably, even from one city to another. Some insist that English should be the third language the children learn, and only address it in secondary school, while others start their “early english classes” already in the first year of primary school or even Kindergarden, and before the second language of the country. Similar inconsistencies exist also in the areas of mathematics or natural sciences.

Interestingly, the B.Sc. which the universities of applied sciences award do not provide direct access to M.Sc. studies at academic universities; conversion courses are required. Similarly, people with a classical Matura do not have direct access to the universities of applied sciences; practical experience in industry is necessary. As it is, a B.Sc. from an academic university is thus not equivalent to a B.Sc. from a university of applied sciences. These difficulties are one of the drawbacks of such a diverse system.

Recommendations of the complex systems approach

Based on the general analysis of the different levels derived from the complex systems approach to educational systems as detailed in the fourth section – entitled “Complexity at different levels” – and the analysis of the Swiss educational system in the above subsections, the following concrete recommendations are made:

- **Micro-level / local level:** The diversity of actions and measures available for supporting the individual student already being very high, the system has sufficient complexity for addressing the diversity of needs. However, the responsibility for the students’s education could be distributed over a team of teachers and experts, including psychologists; Davis and Sumara (2006) also suggest this. Forming teams would relieve the currently high pressure on individual teachers, and transfer the coordination of the task from the micro- to the meso-level.

- **Meso-level / intermediate level:** Some elements of competition and selection may both increase the prestige attributed to the teacher profession (and thus its attractiveness for male teachers) and mitigate the critical attitude of the public towards teachers. A way to introduce competition without drastically changing the school system would be the have publicly available teacher and school ratings; maybe a bonus part of the teachers’ salaries could depend on their rating my students, parents and peers. Such ratings would need to include both popularity, which is related to entertainment value and freedom of choice, as well as the short-/mid-term achievement of academic

goals and mid-/longer term professional success. More important changes could be made in later steps.

Where necessary, more support for groups of immigrants could be offered. Immigrants not only need to learn the local language but should also familiarise themselves with the local culture to assure a smooth integration.

- **Macro-level / global level:** To improve the consistency of the scholar system, the cantons should finally bring themselves to agree on a common school structure. There is no objectively sensible reason to keep the differences. The HarmoS project[2] aims at this, and about two third of then cantons have accepted to join, but the other third sadly refused. Similarly, it is necessary to agree on when to introduce English and the second language of the country; additional languages are optional and therefore not problematic.

Related work

The application of the complex systems approach to learning and education has been pursued by a variety of researchers mainly over the last two decades. A working group first met at the NECSI – New England Complex Systems Institute – in 1999. Kaput et al. (1999) state that their intention was to apply the complex systems approach to education in content, teaching, learning, cognition, and the educational system itself. They started by asking the plenty of questions; some answers are given by Bar-Yam (2004).

Lelouche and Morin (1997) emphasise the difference between three education-related knowledge types: knowledge about the domain and problem-solving, which are both to be acquired by the students, and tutoring knowledge, used by the system to facilitate the students' learning process. These three types are modelled at different levels of abstraction, to shed a uniforming light on the educational system's operation and performance.

Vanderstraeten (1997) studies the discrepancy between an economic perspective on the educational system, which focuses on manpower-planning / cost-benefit analysis, and a social perspective, which wishes for an educational system than satisfies the "voice of the people". Both perspectives, however, neglect the fact that education is a composition of complex circular processes between the educational system and society. Policy-makers need to take this into account when designing educational systems.

Davis and Sumara (2010) point out that learning is complex, and education is one of the most complex of human enterprises. Most complex systems are also learning systems. The authors review insights gained by researchers looking into a holistic and action-oriented complexity. Classrooms can be described as knowledge-producing networks, rather than contexts that are centered around a teacher or student. Similarly, curricula should not be seen "in terms of basics and foundations in discrete disciplines, but rather as nodes, hubs and links in decentralised networks of human knowing". Also, learning is not so much the achievement of an individual, but rather something that emerges from the participation and implication of others.

In their book, Davis and Sumara (2006) look into the importance of complexity for various aspects of education, including learning, teaching and research, and suggest complexity thinking as an appropriate attitude for people involved with education. Among other findings, they conclude that teams can considerable out-perform the sum of the team members individual actions. This is a fact which has implications for the classroom, school boards, associations, communities and societies.

Complexity and education has received an increasing amount of interest over the last few years. A rich resource about this topic is `http://www.complexityandeducation.ualberta.ca`. An annual international conference has been held since 2003 under the name of the "Complexity science and educational research conference", and a corresponding journal is published under the name of "Complicity: An International Journal of Complexity and Education".

Discussion and conclusion

Findings from complexity science can help solve problems in man-made complex systems, including educational systems. A key point is to recognise the importance of complexity and scale at different levels, and to adapt the available instruments, tools and measures to be taken accordingly. For instance, a large scale uniform approach is ill-suited to address a problem which requires diversity at a smaller scale. On the other hand, missing standards at the global level can cause inconsistencies at lower levels and thus lead to unnecessary turbulences.

Some may argue that education is merely complicated and not complex. True, the fact that different people have different learning preferences and abilities is not specifically a complex systems idea, and is probably better described as effectively the theory of individual differences from psychology. Teachers and the educational systems must then compromise to build a system which is reasonably well-suited for most students and provides society with individuals that have the necessary skills and knowledge for society to function. However, taking the working definition (Frei, 2010) that a complex system is composed of many multilaterally interacting individuals, where changes in one place my have consequences at another place, educational systems very well qualify as being complex. The question investigated in this paper is wether the complex systems approach may provide useful hints at how to improve educational systems, and this has been confirmed so far. Further practical investigations, however, are certainly indicated.

[2] Information about HarmoS is available in German and French on: `http://www.edk.ch/dyn/11659.php`.

In the case of the Swiss educational system, the great diversity of tools and intervention possibilities at the micro-level allow the teachers and school psychologists to find a suitable approach for every child; responsibility, however, should be distributed among a team instead of being on one teacher alone. At a meso-level, groups and associations for students with similar characteristics and interests would provide support and incentives for maximising performance, both for students and teachers. At the macro-level, Switzerland has a very diverse system in two senses, with only one being helpful: the diversity of ways to a profession, including vocational education in the form of an"apprenticeship", specialised technical schools, universities of applied sciences, and academic universities, is certainly a strength of the Swiss system and assures the high quality of professionals. On the other hand, the differences in the school systems between the cantons is rather disturbing and hinders people who move from one canton to another from advancing as desired, and more nation-wide uniformity at the macro-level would make sense.

Concrete measures to be taken to improve the educational system in Switzerland include the shifting of responsibility from individual teachers towards small teams which may include psychologists and other experts, and the agreement on a consistent education system structure across the country.

Generally speaking, for a complex adaptive system to function and cope with changing conditions and incidents, a multi-level approach with great diversity at the micro-level, many choices at the meso-level, and common standards at the macro-level is recommended.

Once the importance of complexity and scale at different levels has been recognised for the educational system, the next steps include persuading politicians and authorities in the educational system, which is quite a challenge in itself. The human reluctance to change is considerable, especially since the traditional approach was successful in the past. However, the world is changing rapidly – among others becoming increasingly connected and intertwined – and thus our approach to teaching must change, too.

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