TRANSDISCIPLINARITY AND THE DIDACTIC JET PRINCIPLE ENHANCE GLOBAL LEARNING

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This article defines the 'jet principle' of (e-)learning as providing dynamically suitable framework conditions for enhanced learning procedures that combine views from multiple cultures of science. Social and learning procedures are heuristically analysed based on experience in interdisciplinary learning settings in a multicultural environment with a critical approach to globalisation, while diverse paradigms and also diverse scientific disciplines are counted as 'cultures of understanding'. The outcomes of the analysis suggest that the negation-oriented web-supported five-level learning suite 'Surfing Global Change' (SGC) is capable of providing helpful framework conditions to multicultural learning that can suitably be applied in the 'Global Studies' curriculum as well as in other similar international curricula. Complexities of cultural diversity are also reflected by complexities caused by the origins of diverse scientific or political cultures. In order to construct thorough and practically implementable consensus solutions, dialogic processes and peer review are best mediated through web-based discussion for which this paper provides examples.

Keywords: *Globalistics, Global Studies, negotiation game, globalisation, curriculum, global studies, multi-disciplinary, trans-disciplinary, multi-paradigmatic.*

Introduction

One of the core approaches of e-learning and learning technologies community is the view that technologies should be used to *scaffold*, i.e. facilitate learning (Naidu *et al.* 2000). Such usage of web-based learning frameworks is presented here for global learning, more precisely for the case of a developmental and multicultural curriculum '*Global Studies*' (GS). In this text, *development* is understood as *growing jointly in responsibility*.

This article starts out by proposing that the indivisible elementary building blocks (*i.e.*, the atoms, explained in Fig. 1) of human reality are *perspectives* (Ahamer 2010a: 299), namely the act of cognising and understanding. In the following figures, such perspectives are symbolised by viewing angles.

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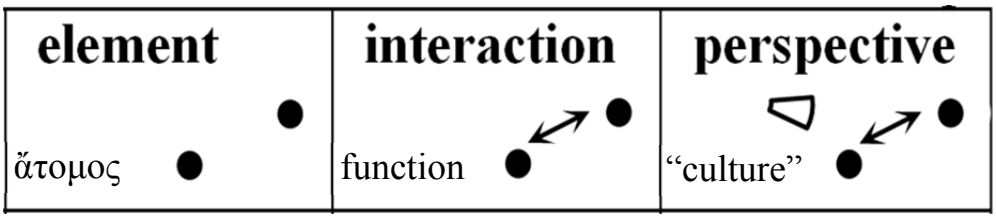

Fig. 1. Three primordial categories of reasoning: atoms (Greek: uncuttable, at left) are indivisible elements on the material level (alludes to materialism), single functions are indivisible categories when following the paradigm of systems sciences (centre, alludes to functionalism), perceptions via viewing angles (cultures of understanding, at right) are prime categories allowing for a multicultural approach to global realities

*In the present article, these '**perspectives**' are seen as more fundamental entities than 'facts'.*

The author's professional experience in developmental and international projects such as EU enlargement has shown that only an appreciation for different views, perspectives and paradigms can provide an overall picture of reality. *Values* (in the ethical sense, but as a result also in the material sense) are created by *appreciation* (perceiving a value ⇒ existence of a value).

The resulting necessity for a *multi-perspectivist approach to globalisation* can be facilitated by *dialogic procedures* on a web platform that is presented, described and analysed in this article using two case studies, namely in chapters **A** and **B**:

A. '*Global Studies*', a new developmental Master's curriculum at Graz University, Austria;

B. '*Surfing Global Change*', an original web-supported learning suite in five levels used for GS.

For these case studies A and B, this paper describes both

I. the *content* and

II. the *process*

related to both case studies. In chapter **C**, as one design of technology-based processes for global learning, it proposes the '*jet principle*' directed to enhance the comprehensiveness and effectiveness of such multicultural and global learning endeavours. Chapter **D** generalises its practical applicability to multicultural projects.

A. Global Studies

A.I 'Global Studies': A discursive process encouraging multiple paradigms

This *multicultural* venue of learners is dynamically structured by a web discourse (Fig. 2).

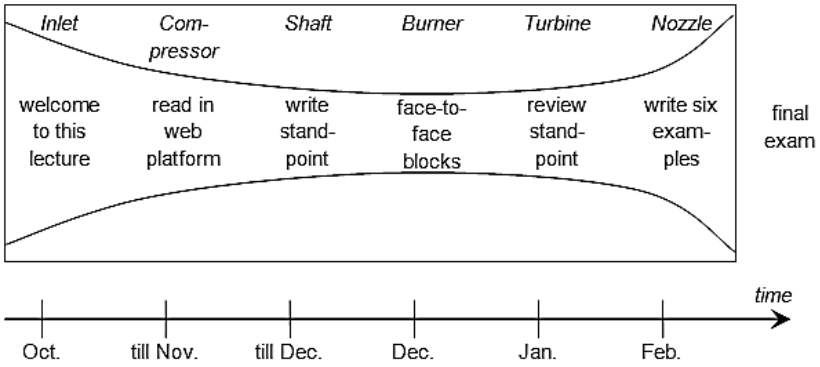

Fig. 2. Time steps of web-based discourse during the author's share of the basic lecture GS. In a symbolic way, these steps of the learning procedure are allocated to the steps of the combustion procedure in a jet turbine

For the purpose of this paper, the following definitions are made:

a. inter*disciplinary*: to look at *n* facets of reality (*e.g.*, physics, chemistry, meteorology regarding climate change);

b. inter*cultural*: to view reality from *m* standpoints (according to the roles of the actors defining different viewing angles, *e.g.*, as Armenian or Azerbaijani on Nagorno-Karabakh, compare BBC (2010), Global Security (2010));

c. inter*paradigmatic*: the combination of the above, namely to look at *n* facets of reality from *m* viewing angles (logically a *n*:*m* relationship) (Fischer *et al.* 2008; Sen 1999).

The author's share of the GS curriculum (which has been defined as multiparadigmatic, Ahamer 2011a: 2) covers for example 'Social and Cultural Geography', a recent branch of human geography that strongly adopts a *multiparadigmatic* stance (Gebhardt *et al.* 2011: V; Lefebvre 1992; Soja 2011; Harvey 1991; Rothschild 2011; Ahamer 2010b, 2019). During its genesis, human geography has lived several 'turns' (*e.g.,* the cultural or linguistic turn) and hence was nicknamed 'the Latin America among sciences.'

In the framework of the abovementioned course (Fig. 2), students follow a track of

- introduction into motivation based on professional realities in developmental projects,
- resulting necessity of in-depth analyses of multiple standpoints starting from a learning platform, including studying the products of students in earlier semesters,
- authoring a personal standpoint discussing the requirements and bottlenecks of global development from the perspective of different world views and paradigms,
- following the in-class face-to-face lectures by the author in the traditional sense which build on the lecture slides (Ahamer 2010b) but are not limited to it,
- writing peer reviews of two colleagues' standpoint papers mentioned above, following reflections during the lectures,
- as a facultative preparation for the final exam, writing six short documents on case studies regarding multicultural global development, out of 50 proposed themes,

- a final written exam, together with all other subject matters of the basic lecture (5 hours).

A full analysis of web-based student activities in the first year of GS was provided in (Ahamer 2011: 14–19) and can be summarised among others by diagnosing that by far the most web platform usage (90 % of web hits and 95 % of web time) was registered *after* the end of the traditional lectures. This finding underlines the capacity and *efficacy of technology-based scaffolding, especially by dialogue-oriented web platforms for multicultural learning*. Learning platforms are able to generate strong social and communicative dynamism among students which is consistent with a peer-oriented, discursive world view characteristic of modern democracies. By far the highest number of hits on a single page inside the learning platform was collected by a post containing comments on a peer review of a student standpoint which shows that 'learning on a meta level', that is learning from how others see the *perspectives* of actors (not only the underlying facts) does come true in a suitable, technologically enhanced learning environment.

Such experiences have given rise to the idea of inter-student activities being most crucial for the attainment of high academic quality. Peer interaction has inspired the concept of a *jet principle*.

In this paper, 'jet principle' means that a dynamic process strongly relies on peer interaction of actors among themselves who behave in a self-responsible, autotelic, autopoietic (Sterman 2000) manner (details in chapter C). Outer framework conditions only provide incentives to trigger and enhance such behaviour. Such a framework may be implemented by a web platform or by a system of rules defined for a course on how to reach a good mark or how to behave in game-based learning (Naidu *et al.* 2000). The jet turbine taken from engineering symbolises the discursive dynamics in multiparadigmatic learning.

Additional analyses of such dynamics from the second year of GS are given in the following section, in this issue's contribution by Bader and Zotter (2012a, 2012b).

A.II Analysis of web-based discursive activities during 'Global Studies'

The following data stem from the 'Interdisciplinary Practical Energy Revolution' held by the lecturers Karl Kumpfmüller (2007, 2009), Herbert Rauch (2012), Werner Weiss (2011) and the author by means of the WebCT platform, and can easily be transferred to any other learning platform. The twenty members of this course amount only to one tenth of the members in the basic lecture GS analysed similarly in (Ahamer 2011: 14–19), but they exhibit analogous behaviour (Fig. 3). During a recent guest professorship in Moscow at Lomonosov MSU, students were asked to perform the same didactic procedure, but deplorably, at that time learning styles were not yet adapted to interactive schemes (Ahamer 2020).

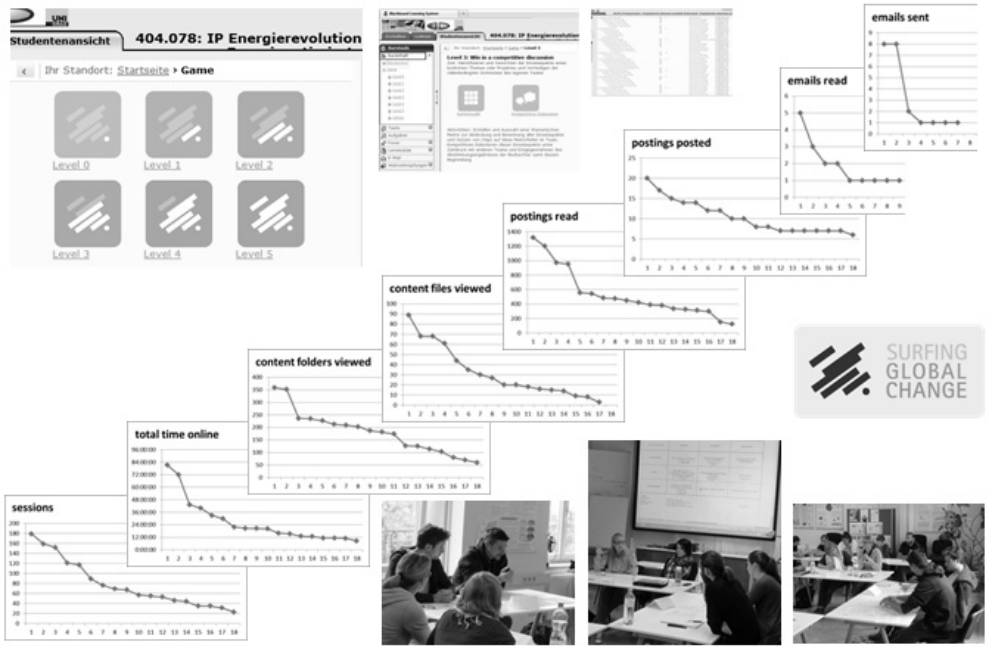

Fig. 3. Frequency distribution of web-based discourse activities of 20 students during the interdisciplinary practical on energy revolution at Graz University. Web discourse (above) supports face-to-face discourse (below). Statistics shows that most active students passed 80 hours in the learning platform during 180 sessions, viewed 350 content folders and 90 content files, read 1300 postings and wrote 20 postings during one semester. The negotiation game 'Surfing Global Change' is explained in Ahamer (2006, 2012)

B. Framing to Learn Multiple Cultures of understanding: Surfing Global Change

B.I 'Surfing Global Change': multi-perspectivist contents for consensus solutions

The – often surprising – conclusion of many multicultural projects is that providing *views on reality* is essential, namely mediation among different and diverse perspectives of realities. Such attempts can be very crucial in cases of disagreement on what 'real truth' is, for example, in cases of fundamentally different approaches mediated by religion (Tulku 1977) or political ideology.

Each human action can be seen as taking place and creating effects on several factual, personal, or strategic levels at a time. The learning suite and social procedure presented in this article, *Surfing Global Change* (SGC), will later give rise to comparing any enhanced learning endeavour with a *jet engine*: the walls of the combustion chamber mean the learning framework, and the accelerated gas masses represent the learning activities.

Social procedures could be professionally designed in a way so as to allow for convergence of opposing world views, be it for spatial planning, peace negotiations (Rau 2008: 6), or (online) gaming. The breadth and scope of the (public) perception of realities (Chang and Liu 2011) appears as a decisive bottleneck for the durability and ability to implement solutions. Regarding an earlier Caucasian conflict, Huseynov (2010) says

that 'as a result of these perceptions, the dynamism in the peace process (…) does not resonate well with the wider population.'

The web-based negotiation game '*Surfing Global Change*' (SGC) is one example of a structured dialogue that allows taking and understanding opposing views. Its rules (© G. Ahamer) have been explained and published in detail (Ahamer 2006, 2012), including a notation in the artistic style of musical scores (Ahamer 2010a). This present paper proposes an additional methodology using technological symbols to write graphical information on social procedures.

Since 1999, the author has given lectures on Technology Assessment at the Graz-based University of Applied Science FH Joanneum for students of civil engineering, architecture and of industrial electronics as well as at Graz University for 'Environmental Systems Science'. Since 1993, the social process constituting these lectures has been fundamentally reshaped according to this web-supported discursive procedure 'Surfing Global Change' (SGC), intended to build consensus among stakeholders with diverse 'cultures of understanding'. Most of the 30 themes selected for discussion so far include highways, power plants or regional development plans, or said 'energy revolution' (USW 2012).

The practice of playing SGC during one semester shows a highly interactive and communicative social process (around thousand web clicks per student and per semester).

Starting out from a highly technologically oriented understanding, a *symbolic comparison* of social processes with the technical process of a jet engine is held appropriate. The *gas flow* through this fabricated structure is governed by *border conditions* such as width, compression and ignition. In the following text, the *functioning of a jet engine* will be used as a symbol for the *functioning of social and learning communication processes*.

B.II Inventing a jet engine for smoothing learning processes

Seen from a physical and technological point of view, a jet engine accelerates gas particles in an optimal manner. As a principle, an engineer's mechanical design sequentially arranges distinct parts of machinery. Such a geometric structure produces distinct but well-defined aerodynamic regimes along sections of the horizontal axis (Fig. 2). A jet engine hence consists of identifiably designed building blocks resulting in a smoothly accelerating mass flow.

We use this array of design in mechanical engineering as a symbol for the *design of social border conditions during learning* in a university course that might employ the five level negotiation game 'Surfing Global Change' (SGC) or any other dialogic design (*e.g.*, as in Figure 2) enhancing self-responsibility. SGC defines distinct social procedures along the numbered levels (Ahamer and Schrei 2006; Ahamer and Mayer 2013).

We interpret the vertical axis of Fig. 2 as 'tightness of *structures*' in the mechanical sense, which translates to 'a corset by *rules*' in the social sense. As Figure 2 suggests, the social flow of SGC has the same design as a jet engine, namely gradually and smoothly tightening border conditions, while allowing results to develop in an unrestricted manner. This is demonstrated by the curbed lines in Figure 2, which we can – at first sight – interpret as 'degree of freedom' for the participants of SGC (Csikszentmihalyi 1994). The reader will match the 'social actions' of SGC expressed in technological terms in the central row of Figure 2 with the learning and gaming actions described in Table 1 – or in more detail in the game rules.

The gas stream in a jet turbine (and generally any dynamic process described by a system of differential equations) is largely defined by external forcing (e.g. geometrical shape of the jet) and by the fundamental laws, theoretically by the ideal gas law ($p.V = \nu.R.T$). This gas law (Clapeyron 1834) controls the timelines of the respective basic variables to describe the system, observable for 'state variables' pressure p, temperature T and amount of substance (number of moles) ν.

Similarly, any learning and teaching indicates the suitable design in and of these substrates: *time*, *space* as well as possibly *structures* in a more general way.

In analogy to a thermodynamic system, a social system will also exhibit regular and smooth behaviour of social 'state variables' along an entire social procedure. Such 'social state variables' remain to be defined. One suggestion in Ahamer (2010a) was to symbolically use the four vocal ranges soprano, alto, tenor, and bass.

C. The 'Jet Principle' Applied to Social and Learning Processes

C.I Symbolic interpretation of the analogy with a jet engine

The jet engine was invented in the second half of the 1930s and exhibits some features that can also be made use of in learning and teaching – if these features are interpreted in a symbolic manner.

A very decisive technological innovation consisted in replacing the four-stroke cycle engine of an internal combustion engine (first column in Table 1) with a jet engine (second column in Table 1). The earlier engineering concept of 'each (combustion) phase has its proper place in time and space' was replaced by the jet concept 'as a package of air proceeds through the installation, it is led into suitable boundary conditions for performing the foreseen procedures.' Instead of revolving pistons separating the flow of time into four distinct phases located in geometrically well-defined chambers with four distinct border conditions of pressure, volume and temperature, where one phase explicitly 'hands over' the system state into the next phase (by moving its material parts, namely the piston); in the jet engine one and the same material installation (with still standing parts) allows the procedure to pass through.

Whereas in a traditional approach matter had to move in order to *squeeze* the process through, in later approaches matter stood still and allowed the process to '*flow*' along its appropriately designed wall structure. We will call this fundamental idea the 'jet principle' explained in detail in Table 1

Table 1

Comparison of joint features in engineering (left two columns) and in education (two columns to the far right). For both of these disciplines the traditional approach is always found at left and the progressive approach always at right

In engineering		**In education**	
Four stroke engine	**Jet engine**	**Traditional education**	**SGC concept of education**
Closed combustion chamber	Open-ended combustion chamber	Closed learning setting	Open learning process setting
Combustion finished when piston at far point	Combustion finished when gas has left jet area	Act of cognition successful, when issue is 'learned'	There is no final state of knowing that can be 'learned'

Table 1 continued

In engineering		In education	
Four stroke engine	**Jet engine**	**Traditional education**	**SGC concept of education**
Result is properly working through the 'stroke'	Result is equal to preparation for the next phase	Result in exam is underlined by double line	Result is maximum step forward measured from step in advance
Matter acts	Stream acts	Content orientation	Process orientation
Design lies in geometrically co-ordinating moving combustion room	Design lies in physically co-ordinating gas properties	Design lies in feeding students with proper learning material	Design lies in letting students' autopoietic hunger come into force
Concomitance through connecting rod and axis	Concomitance through engine walls and axis	Concomitance: one teacher acts for different students simultaneously	Concomitance: one student acts on different levels simultaneously
Four distinct phases impressed from the 'outside'	Sequence of phases, one evolving from the other	Discontinuous process: asking and answering	Continuous process: learning from iterative situations
Boundary conditions stamped on from outside by camshaft	Boundary conditions result from preceding phase state	Learning objective imposed from outside teacher or curriculum	Learning objective formed by student: constructivist, autopoietic, self-responsible

'Surfing Global Change' is a *booster*, not a final solver; SGC is a problem handling jet. SGC *channels* perceptions of issues in a transitory way and frees them again after compression.

D. Generalised Practical Applicability to Multicultural Projects

The hypothesis is made that social processes are analogous in game-based learning and real-world projects. In the previous chapters, the understanding was presented that the needed social processes are similar and exhibit an analogous rhythm in four types of tasks and projects (Table 2):

- Endeavours of multicultural, global learning, for example dwelling on an evolutionary view on organisational development and any real-world projects that are open to public participation;
- The negotiation game *Surfing Global Change* implementing web-based discourse and consensus-finding;
- Discursive procedures in any *real world (developmental) project* that aim to train administrations of new member states in self-responsibility such as Twinning projects (EU 2011). These can be enhanced by communication technologies;
- Multicultural, multidisciplinary and multiparadigmatic learning processes as advocated by the 'Global Studies' Master's curriculum (compare KFU 2009, 2010).

Table 2

Inner dynamics in the relationship of challenges and resulting social processes in organisational multicultural learning, in Surfing Global Change and with a development cooperation or Twinning project

Social processes	**Multicultural and multiparadigmatic learning**	**Surfing Global Change SGC**	**Development discourse & Global Studies**
Be interested	Guide to a world view	0: Create empathy	Estimate what exists
Learn	Foster earlier vision	1: Analyse contents	Go own ways
Reflect	Open to a new vision	2: Peer review	Look at this country
Debate	Struggle between old – new	3: Debate	Compare methods
Give space	Convene old + new	4: Consensus	See opportunities of both
Balance out	Weave the new synthesis	5: Global vision	Integrate partner's values

If the social process is envisaged, the cycle appears as a continuous re-defining of values and creating values anew (Figure 4, numbers relate to the levels of SGC, see explanation of levels and social dynamics of levels in Ahamer (2006, 2012, 2019) or Rauch (2003).

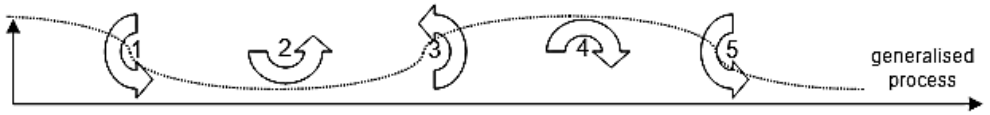

Fig. 4. A symbolic evolutionary approach to the continuous and fresh generation of values by discourse

As with the jet principle, *each subsequent system state is defined by the result produced by the preceding state*. This applies also to developmental cooperation (rightmost column in Table 2). Structurally, such an iterative structure of reality resembles the differential equation of an oscillation – see the structure suggested in Fig.4. – Mathematically, societal *values* might be seen as correlated with the second order derivative in time of classical scenarios, similar to the state equations of an electromagnetic wave as described by Maxwell. Such inner dynamics of society might create an 'intrinsic oscillation of societal values,' presumably following a hypothesized '*Maxwell equation for social processes*' (*i.e.*, the second derivative of a descriptor is proportional to the minus value of the descriptor itself).

E. Conclusions

(A) The Master's curriculum *'Global Studies' (GS)* established in 2010 at Graz University offers multiparadigmatic learning for sustainable global development. During the first decade of its existence, one hundred (partly migrant, from Central and Eastern Europe) learners were included each year by dialogic learning frameworks that empowered their intrinsic learning styles, also supported by e-learning methods.

This article describes the genesis of the multicultural, multidisciplinary and dialogic curriculum 'Global Studies', earlier reported in detail by Ahamer *et al.* (2011). Some fifty sessions of the peer-oriented 'Steering Committee Global Studies', presided by its founder, Karl Kumpfmüller and comprising members of all departments of Graz University, have provided a guiding document for the new curriculum. Its interdepartmental character is symbolised by the coloured logos presented in this article (in German 'fac-

ulty', hence the term 'interfaculty' is used). An originally very comprehensive draft curriculum later had to be streamlined into the existing GS curriculum in force (KFU 2010), apparently for resource reasons. Only *highest quality standards* (Ahamer 2020) safeguard required results from future GS.

Regarding academic contents, all departments of the university are included. Didactically, this curriculum is based on the triad of 'inclusive learning culture,' 'multicultural and multiparadigmatic education' and 'collaborative, peer-oriented digital communication tools,' and hence is much in line with the orientation of the present journal. Analogous initiatives in Austria exist also in Vienna (the very elaborate curriculum 'International Development' IE (2012) has long had very high-quality standards and several publishing series: JEP, GEP, HSK, see MK (2012)), more recently Salzburg (bundle of electives 'Global Studies'), Linz and Innsbruck.

Discourse-oriented application to *Global Studies* are the *basic lecture GS*, the *interdisciplinary practical energy revolution* and the lecture *analysis of practice*, all having taken place since winter semester 2011/12 with the author's contributions. The latter example shows that after a dialogic review process and after using earlier lecture material, students are able to formulate academically well-informed questions inquiring about the reasonability of two of the most contested large dam construction projects in the world: the Ilisu dam in Turkey (Aschemann *et al.* 2008) and the Belo Monte dam in Brazil (Duraković *et al.* 2012). Both hydroelectricity projects have a strong developmental and multicultural component and necessarily touch the core of the issue of restructuring the global energy system.

(B) Practical implementation of a web-based dialogic structure occurred in manifold ways in the case of *Global Studies* and in the case of the web-supported negotiation game *'Surfing Global Change' (SGC)* yielded among others the following results: Statistical results on monologic and dialogic communication activities during an elective course for Global Studies which has the target of convening students from diverse disciplinary backgrounds (economics, business administration, geography, chemistry, and physics, in the case of 'Environmental Systems Science,' and all disciplines leading to the Master in Global Studies) for profound dialogue. Original student feedback is continuously positive (Bader and Zotter 2012a, 2012b).

Within the online course design community, the procedural dimension of e-learning courses might have been analysed only to a certain but unsatisfying degree to date. This paper has proposed several highly symbolic approaches to describe dynamics of individual and societal learning.

Graphical Information on Social Procedures (GIS^P, Ahamer, 2013) is suggested to visually facilitate understanding of interconnected procedures taking place in the mental and pedagogic spaces of both individual and societal learning, that is the '*space of flows*,' as named by Manuel Castells; thus complementing the commonly known Geographic Information Systems and Sciences (GIS^S), seen as a technology providing perspectives on *geographic spaces*. According to Manuel Castells (2001), a *network society* is characterised by a space of places and a space of flows. In this light, GIS^S and GIS^P represent two tools and two metrics for these two different but conjugate spaces.

(C) In order to underline the importance of structural design and the provision of border conditions for dynamic learning procedures, the *'Jet Principle of Learning'* is coined as a new notion in this paper. The technological 'jet revolution' was opening the

combustion chamber. The 'jet revolution' in (e-)learning should bring the opening of still-closed, pre-defined processes into open, discoursive, self-steered, autopoietic, individually responsible learning processes.

This structural analogy of an educational process with the jet engine sheds light on the basically interlinked structure of reality: it is never possible 'to do only one thing at a time': if temperature is intentionally changed (*e.g.*, in a burner), *nolens volens* the parameters interlinked to temperature by the gas law are changed at the same time (concomitance, that is their principal interconnectedness). Only a suitable design of the outer walls of the chamber is able to guide the process in harmony with the overall aim, 'propulsion'. Similarly, a student acting in class always does 'several things at a time': when criticising a colleague (part of the fact-based world), (s)he exerts jointly an impact on the social world by disagreeing with the colleagues' view. Thinking in structural analogies would suggest that suitable educational design is able to facilitate relatively more synergies between the fact-based and social worlds than unsuitable educational design. The web-based five-level negotiation game 'Surfing Global Change' (SGC) was offered as a case.

Regarding global civilisational evolution, (a) the mechanical 'four stroke engine' type of understanding and (b) the jet principle could be understood to be embodied by the views of (a) neo-classical growth theories and (b) by evolutionary economics.

When learners tread suitably designed online course rules, they may reify their potentials and act simultaneously on all levels of reality. When walking along the level of facts, any human being also inextricably walks along the level of community building and other metrics.

(D) *Lessons learned* from societal learning can be applied to suitable individual learning. These are, among others:

- allow for a *path* of individual development for learners,
- allow for *(self-)adaptability* of learners' profiles,
- allow for restructuring of learners' *self-conceptions* during learning,
- allow for a *wide variety* of learning situations for individual profiles.

The above (**A**) conceptual, (**B**) symbolic, (**C**) technical and (**D**) practical approaches are combined in this paper in order to give a clear outlook on the needs of global learning and how it could be facilitated by suitable online learning design.

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