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International Symposium „Research on Teacher Education for Sustainable Development – Insights, Perspective and Future Directions"

Programme

Thursday, March 21, 2019
University of Vechta, Germany
Building Q, Driverstr. 22, Vechta

10:00	Arrival *Lecture Hall Q015*
10:30 – 11:00	Welcoming Address *Lecture Hall Q015*
11:00 – 12:00	**Keynote "Teacher Education as Sustainable Development: what are the chances?"** (Paul Vare, University of Gloucestershire, UK) *Lecture Hall Q015*
12:00 – 13:00	**Develeopment of ESD competencies in Teacher Education** *Lecture Hall Q015* Becoming a competent teacher in education for sustainable development – Learning outcomes and processes in teacher education (Jan-Ole Brandt, Lina Bürgener, Matthias Barth and Aaron Redman, Leuphana University of Lüneburg, Germany) Preparing biology teachers for sustainable development: Contexts, competencies and future trends (Alexander Büssing, Alina Weber and Florian Fiebelkorn, University of Osnabrück, Germany)
13:00 – 14:00	Lunch *Room Q110*
14:00 – 15:30	**Education for Sustainable Development in Schools** *Room Q113* International Application of Intensive, Project-Based Sustainability Professional Development for In-Service Primary School Teachers (Erin Redman and Matthias Barth, Leuphana University of Lüneburg, Germany)

	Framework curriculum for vocational education and training schools for education for sustainable development (ESD) (Lukas Scherak and Detlev Lindau-Bank, University of Vechta, Germany) Developing Complex Thinking Skills. How do practicing teachers understand sustainability and education for sustainable development? (Alain Pache, University of Teacher Education State of Vaud, Switzerland)
15:30 – 16:00	Coffee break *Room Q110*
16:00 – 17:30	**Theoretical and Conceptual Reflections on Education for Sustainable Development** *Room Q113* About the Role of Scientific Thinking in Science Education for Sustainable Development (Thorsten Kosler, Pädagogische Hochschule Tirol, Innsbruck, Austria) Digitalization and Sustainability in Language Teaching (Christian Hoiß, Ludwig-Maximilians-Universität München, Germany)
17:30 – 18:00	Closing session

Develeopment of ESD competencies in Teacher Education

Becoming a competent teacher in education for sustainable development – Learning outcomes and processes in teacher education

Jan-Ole Brandt, Lina Bürgener, Matthias Barth and Aaron Redman
Leuphana University of Lüneburg, Germany

Education – and education for sustainable development (ESD) in particular – play a central role in building society's capacity to address the most pressing societal challenges we are facing today (Barth *et al.*, 2016). To ensure adequate implementation of ESD into curricula and school practice strongly depends on teachers' competencies and commitment towards sustainability (Barth, 2015). Consequently, UNESCO's Global Action Programme (GAP) emphasizes "building capacities of educators and trainers" as one of five priority areas (UNESCO, 2014). However, to prepare teachers for the challenge of implementing ESD, teacher education programmes must embrace pedagogies that foster the competencies needed to take action and act as competent change agents (e.g. Bertschy *et al.*, 2013). Referring to Shulman´s (1987) categories of what constitutes a competent teacher, Baumert and Kunter (2013) designed a model of teachers' professional competence, identifying professional knowledge, beliefs, motivation, and self-regulation as its core elements. Regarding the successful integration of ESD at school level, various approaches emphasize the role of educators and provide different competence models for teachers in ESD (e.g. Warren et al., 2014). However, Bertschy et al. (2013) initially linked the discussion on competencies in ESD to the broader discourse on professional competencies of teachers, introducing an integrative model for *"ESD-specific professional action competency in Kindergarten and primary school"* (Ibid., p. 5075).
This paper operationalizes the concept of teachers' professional action competence in ESD, breaking it up into content knowledge (CK), pedagogical content knowledge (PCK), and attitudes and takes drivers and barriers to the learning processes of student teachers into consideration. Focusing on sequential modules in the 2nd and 4th semester of the teacher education program in "Sachunterricht" (basic social and science studies) at Leuphana University in Lüneburg (Germany) – both with an explicit focus on ESD – this study aims to answer the following research question (RQ):

- *In how far can specific learning settings in teacher education contribute to the development of professional action competence of teachers in ESD?*

  Sub-questions are:

(i) What did the students bring to the two courses under investigation (i.e. relevant (non-) cognitive dispositions)?
(ii) What did the students learn in the two courses under investigation (what impact did the modules have on students´ abilities, knowledge and attitudes)?

(iii) *How do the students perceive their learning processes in connection to their learning outcomes?*

Research Design

Both learning outcomes and processes were investigated in a comparative case study (Stake, 2008) based on two sequential ESD modules of the teacher education programme 'BA Lehren und Lernen' at Leuphana University in Lüneburg, Germany. The different educational approaches and structural designs of the two courses make this study particularly interesting.

Data collection and analysis

Data was collected during the summer 2018 (April-July), using a mixed method approach to capture a rich picture of the students´ learning and cover a broad range of aspects related to ESD competence for teachers with a special focus on PCK and attitudes (motivation & non-cognitive dispositions).

Pre- and post-course surveys were conducted to gather data on students' individual backgrounds, motivation to become a teacher, and ecological worldviews as well as to identify changes in their attitudes and understanding of sustainability. Furthermore, instruments to assess the development of CK and PCK were specifically designed and applied. The CK assessment included MC questions on various sustainability challenges, covering sustainability key competencies according to Wiek et al. (2011). The PCK assessment consisted of different case studies dealing with scenarios of ESD-related school projects. To provide insights into learning processes and outcomes from the students' perspective, focus groups were conducted mid-term and at the end of the semester. Here, the PhotoVoice method (Wang & Burris, 1994) was implemented to support reflection. Finally, written reflections on the learning process – as part of the students' assignments – were analyzed.

The *analysis of quantitative data* from surveys and assessments was conducted with SPSS. The pre-post comparisons of content knowledge (CK), pedagogical content knowledge (PCK) and attitudes (self-efficacy and perceived relevance of ESD) was conducted by using paired sample t-tests (72 participants). The *qualitative data* included material from focus groups (45 participants) and written reflections (92 participants) was fully transcribed and coded by at least two researchers to ensure inter-coder reliability (ICR). The qualitative analysis oriented to the coding paradigm of qualitative content analysis (Mayring, 2014). Following the familiarization with the material, both in vivo and theoretically derived categories were tentatively deduced using a shared code book. Several feed-back loops were incorporated to revise and reduce main categories and check their reliability (Ibid.).

Findings/Conclusion

For our three primary research interests of (i) what students brought to the modules, (ii) what they learned in the modules, and (iii) how they learned, a number of interesting results emerged. Findings show, that both cohorts started their semesters with relatively strong pro-ecological worldviews. Yet, students in the 2nd semester were more experienced in professional environments than their older fellow students and to a higher share motivated by social utility values that go beyond their future students – willing to make a change at institutional or societal level. Considering the different intended learning outcomes, the results further demonstrate that both courses under investigation supported the development of all elements in line with professional action competencies for teachers in ESD. Both cohorts showed a significant increase in the complexity of their sustainability understanding (CK). Also their self-efficacy and motivation to implement ESD in the future career (attitude) have risen. Even the results related to PCK deliver first indications that both courses help developing various pedagogical skills, in accordance with their individual structure and thematic focus. Shedding light on the link between learning outcomes of processes, qualitative results provide valuable insights into drivers and barriers students have encountered while learning. *Exchange with others*, *perceived relevance of learning formats and contents for their future career* as well as *real-world connection* were frequently seen as driving factors, while the *overall workload* and *disconnection between different learning formats* are examples of perceived barriers to learning.

Providing a holistic approach to assess students' competence development in terms of ESD, this study is equally relevant to university instructors, administrators, and students. It delivers valuable information on how teaching and learning may be structured in order to ensure and foster the development of the required competencies for teachers in ESD.

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Preparing biology teachers for sustainable development: Contexts, competencies and future trends

Alexander Büssing, Alina Weber and Florian Fiebelkorn
University of Osnabrück, Germany

Biology teachers are obliged by curricular guidelines to integrate contexts of sustainable development into their teaching. Based on the UN's Sustainable Development Goals (SDGs) as a reference frame, in the proposed talk, we will provide an overview of current research from the field of biology didactics on student biology teachers' professional competence, with a focus on: (1) contexts, (2) competencies, and (3) future trends.

Contexts

Sustainable development is an integral part of the school curricula for biology (Menzel, 2010; Fiebelkorn & Menzel, 2013). Consequently, there are many points of intersection between the SDGs and the mandatory content within biology curricula. For example, the general topic of biodiversity and the more specific context of the return of wolves to Germany explicitly refer to SDG 15 ("Life on land"). Most recently, our working group uses sustainable nutrition (SDG 2) and climate change (SDG 12) as research contexts, which also constitute key themes for education for sustainable development (ESD; Rieckmann, 2018). In international science education literature, these topics are often denoted as socio-scientific issues (SSIs), which allow for decision-making processes and may foster student learning due to their contextual nature (Sadler, 2009).

Competencies

Due to their high complexity, teaching about these SSIs is challenging for teachers and requires a high level of teaching competence (Tidemand & Nielsen, 2017). While prior approaches to biology teachers' professional development were mainly based on teachers' knowledge about environmental issues (e.g. Summers, Kruger, & Childs, 2001), several studies already showed the relevance of non-cognitive competencies for sustainable development (e.g. Barth, Godeman, Rieckmann, & Stoltenberg, 2007). Therefore, our working group conceptualizes "teaching competence" based on the model of teachers' professional competence (Kunter et al., 2013). According to this model, biology teachers' professional competence to teach SSIs is considered not only to comprise their (1) professional knowledge, but also their (2) motivational orientations, (3) beliefs and values, and (4) self-regulatory functions (see Figure 1).

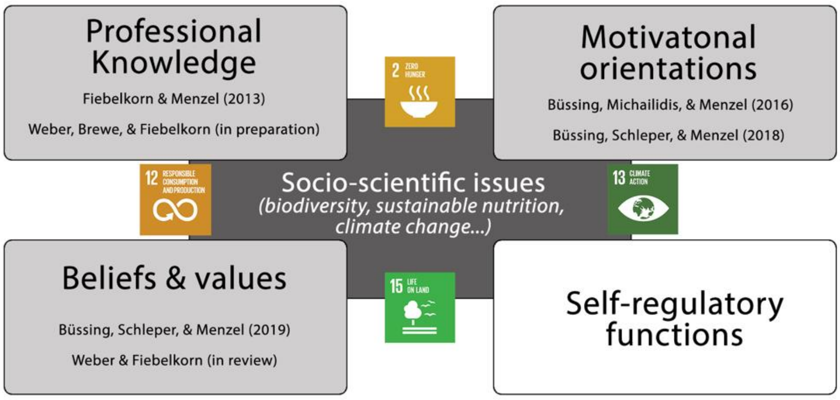

Figure 1 Overview of the main aspects of biology teachers' professional competence regarding SSIs such as biodiversity, sustainable nutrition and climate change (based on Kunter et al., 2013).

Professional knowledge is regarded as the foundation of teachers' professional competence. Therefore, one focus of our working group is the investigation of student biology teachers' subject-matter knowledge about biodiversity and sustainable development issues (Fiebelkorn & Menzel, 2013, Fiebelkorn & Menzel, in review/revision). At the symposium, exemplary results of an intercultural study of student biology teachers from Germany and Costa Rica and their understanding of the concept and distribution of biodiversity will be presented. In addition, insights into a current study with pre-service biology teachers and the development of a knowledge test on sustainable nutrition will be presented (Weber & Fiebelkorn, 2018; Weber, Brewe, & Fiebelkorn, in preparation).

As a second major research area, our group investigates motivational orientations of pre-service biology teachers. According to the model of Kunter et al. (2013), motivational orientations refer to the intrinsic motivation to teach certain topics in the biology classroom. Following preliminary results about in-service teachers' emotions in relation to the context of biodiversity (Büssing, Michailidis, & Menzel, 2016), further studies within this research focus investigated the connection of enjoyment for teaching with the desire to teach in the frame of the general socio-psychological model of goal-directed behavior as a theoretical framework and returning wolves as a specific biodiversity context (Büssing, Schleper, & Menzel, 2018). In this study, attitudes, enjoyment and perceived behavioral control for teaching were identified as major contributors to the teaching motivation for this specific ESD context.

Within our third research focus of beliefs and values, we further examined personality traits, which might be connected to these motivational variables. Building on the theory of cognitive hierarchy, we found protection motivation with underlying attitudes towards returning wolves and wildlife values as contributors to positive attitudes, enjoyment for teaching and perceived behavioral control of student biology teachers. Furthermore, students with a smaller psychological distance towards the issue showed a higher motivation to teach about it (Büssing, Schleper, & Menzel, 2019).

Future trends

Besides an extension of research on pre-service biology teachers' professional knowledge, motivational orientations and beliefs and values, in the future, we will additionally focus on self-regulatory functions. Initial approaches and considerations for selected biological contexts will be presented at the symposium.

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Education for Sustainable Development in Schools

International Application of Intensive, Project-Based Sustainability Professional Development for In-Service Primary School Teachers

Erin Redman and Matthias Barth
Leuphana University of Lüneburg, Germany

Education is a central part of the United Nations Sustainable Development Goals (SDGs) as, "education is one of the most powerful and proven vehicles for sustainable development" (2018). Beyond SDG 4, targeting quality education, schools shape the way youth think and act, hence impacting most other SDGs. For instance, by calling out sexist language and behavior in schools, we can set positive social and cultural norms that span beyond the classroom confines. In our sustainability education project, we use the SDGs not just as a framing for sustainability, but also as a guide to advancing sustainability operations, practices, and curriculum in schools.

Primary and secondary schools are formative environments for building the capacity of future generations to grapple with complex sustainability challenges and develop solutions to issues such as social justice, poverty, and economic disparities. Yet many teachers lack the confidence to educate their students about critical 21st century challenges, such as climate change (Plutzer et al., 2014). To integrate sustainability into our school system, we must collaborate with teachers as leaders of learning and educational change. Continuing professional development (CPD) programs provide an opportunity for teachers to engage with novel pedagogies and have been suggested as a key mechanism for improving teacher self-efficacy and pedogeological content knowledge (Redman, Wiek, Redman, 2018).

While there is great potential for creating positive change through CPD, most programmes fail to engage teachers in tangible and interactive ways that translate to the adoption of new classroom practices and curricula. A recent review of CPD programmes, found that most (over 90%) are still one-off, stand-alone workshops that are overly theoretical and use outdated 'sit and get' methodologies (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Popova, Evans, & Arancibia, 2016). In response to the short-comings of one-off CPD programmes, education and sustainability scholars have been developing, piloting, and evaluating long-term, intensive, real-world, hands-on approaches to CPD (Murphy, Smith, Varley, Razı, & Boylan, 2015; Redman, Wiek, & Redman, 2018). One such programme was created by sustainability scholars at Arizona State University and Leuphana University of Luneburg and piloted across the United States. Some key features of the United States based CPD are that teachers apply in teams, co-develop and implement school-wide projects, and collaborate with sustainability leaders in the community to demonstrate sustainability solutions through real-world opportunities. Through collaborations developed by the Global Consortium for Sustainability Outcomes (GCSO), we are building on the sustainability CPD model implemented by Redman et al. (2018) to scale the program internationally, piloting first in Mexico, Germany, and Ireland.

This paper explores the barriers and opportunities for translating and contextualizing such a model to new countries, cultures, and languages, while providing initial results and reflections on the programme in each of the three pilot countries. In examining the adaptability and efficacy of the sustainability CPD model, two research questions were pursued in this study:

1. How were the general sustainability CPD design principles translated and contextualized in each of the three pilot countries?
2. How successful was the translation of the sustainability CPD, based on an initial set of results from teachers in Mexico, Germany, and Ireland and what are the implications for further scaling?

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Framework curriculum for vocational education and training schools for education for sustainable development (ESD)

Lukas Scherak and Detlev Lindau-Bank
University of Vechta, Germany

Although the EU has supported numerous activities in vocational schools within the framework of the UN ESD-Decade, a structural integration into the vocational training system has only been possible to some extent. The development of an interdisciplinary and cross-occupational curriculum was the task of a three-year ERASMUS+ project at the University of Vechta in cooperation with vocational schools from Germany, Latvia and the Netherlands.

The challenge of the ERASMUS+ project to be illustrated in this presentation is the curricular anchoring of education for sustainable development (ESD) in vocational education and professional development as a permanent task. As a central solution, a competency-based, interdisciplinary and cross-occupational curriculum for ESD has been developed, which was tested in vocational schools and evaluated with a view to the implementation in the vocational training of the respective vocational schools and vocational education and training systems. To this end, the University of Vechta, in cooperation with various training providers, had developed a comprehensive training concept for vocational training staff and designed solutions for sustainable training centres.

The experience from the MetESD project shows that this curricular framework is helpful for teachers in deciding which competences have to be taught. Based on the work on the curriculum development of the participating schools and the systematic evaluation of the project, we have derived the following insights.

- Teachers are important agents for change. The successful implementation of topics and issues concerning sustainable development into the curricula of TVET is dependent upon teachers being motivated and skilled to deal with ESD.
- The first and most important step is a review of curriculum documents how far the teaching and learning of skills for sustainable work-life are already mentioned and seen as important for the vocational training. While textbooks and other educational materials should be reviewed to determine whether they reflect on ESD topics and are helpful for implementing ESD. Materials may need to be developed to implement ESD topics into the curriculum and further into the all-day-teaching.
- No school starts from point zero. Each vocational school has to identify and to develop connections and synergies among their projects, sustainability initiatives in order to focus on resources and good practice which is already there.

This means to integrate existing projects in the frame of such "global learning", "Education for All-outdoor learning", action-oriented teaching and Life-long Learning, among others.

- A whole-institution approach should be adopted for the curriculum development.
- It needs guiding principles for ESD. This set of guidelines could focus on the 17 Sustainable Development Goals (SDG´s).

The teachers reported that changes had taken place across a wide range of curricula including Politics, Business Studies, English, Physics and Engineering. One English teacher described getting into deeper discussions on nature topics; another teacher talked of being inspired to change his Politics curriculum as a result of the project; and to quote one Physics teacher "It completely changed my view on curriculum content". The combination of ESD and entrepreneurship has prompted a change by one Business Studies teacher to incorporate business culture, ethics and the philosophy of companies into his curriculum, as well as discussing the consequences of business activity.

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Developing Complex Thinking Skills. How do practicing teachers understand sustainability and education for sustainable development?

Alain Pache
University of Teacher Education State of Vaud, Switzerland

Understanding the major societal problems of today and tomorrow in the school context poses formidable didactic challenges. Their study assumes that students acquire the means to decipher the complex interactions that characterize them by linking a large number of factors from both the natural sciences and the human and social sciences, while raising political and ethical issues that are explicitly or implicitly referred to value systems (Audigier, Fink, Freudiger & Haeberli, 2011 ; Audigier, Sgard & Tutiaux-Guillon, 2015). This is particularly the case for themes such as energy, climate change, mobility, supply and migration, which can all be referred to the Anthropocene.
To this end, it is essential that the school allows students to build operational thinking tools to organize perceptions and knowledge by networking them. Such thinking tools - integrative concepts of disciplines, tools of the systemic, ability to problematize, etc. - are the ones that students need to appropriate to be able to understand and think about complexity. If we refer, for example, to the definition of complex thinking proposed by Edgar Morin (1990/2015), implementing complex thinking presupposes the ability to identify and mobilize causal links in a reasoning (not only linear causality, but also relationships with multiple causes or effects, as well as syllogisms), feedback or recursion loops, situations of dialogic tension, relationships based on the hologramic principle (the part is in the whole, and the whole is written in the part). Another central issue is that the proposed teaching units lead students from primary school onwards to appropriate tools that enable them to identify the constituent elements of a system and the types of links between these elements, for example by using graphical representation to report on their analysis (Assaraf & Orion, 2005; Rempfler & Uphues, 2012).
The research we want to talk about is conducted in French-speaking Switzerland by a multidisciplinary and inter-institutional team under the aegis of the LirEDD. The academic year 2017-2018 was devoted to the preparation of the project and the authorisation procedures for data collection. Data collection began during the 2018-2019 academic year and will continue until 2020-2021.
The research objectives are expressed through five research questions:
1) What thinking tools do partner teachers identify and implement in their teaching to enable their students to understand complex social objects or situations?
2) To what extent do students grasp these tools and are they able to implement “complex thinking”?
3) Do learning about problematization and the practice of scientific investigation approaches promote the development of "complex thinking"?

4) What are the contributions of graphic visualization approaches (mapping, modelling, conceptual maps, mental maps, ...) for students and partner teachers to understand complex objects or social situations?
5) What are the contributions of a collaborative research design to the development of teachers' professional skills?
This collaborative research will lead to the collection of various types of data: focus groups with partner teachers, student productions (written traces, posters, etc.), teachers' productions (lesson plans, course materials, various artifacts), video recordings of selected moments of the teaching units (problematization phase, moments in which "complexity is present", synthesis phase), as well as semi-directive interviews with groups of students (focus groups) that will take place a few weeks after the end of the classroom teaching sequence. In addition, the collaborative research design is based on an interdisciplinary discursive community of practices, which also allows data collection during times when partners (researchers and teachers) work together (recordings, written traces, artifacts). Data recorded in audio or video will be transcribed.
After a brief summary of the context of the research and the methodology used, the presentation will focus on the results of the analyses carried out on the first data collected during the 2018-2019 academic year, namely a focus group with three practicing teachers. The results show that representations of sustainable development, ESD and complexity are very different from one teacher to another. Our hypothesis is that it depends in particular on the degree of teaching and the subjects taught.

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Theoretical and Conceptual Reflections on Education for Sustainable Development

About the Role of Scientific Thinking in Science Education for Sustainable Development

Thorsten Kosler
Pädagogische Hochschule Tirol, Innsbruck, Austria

One of science education's key roles is to introduce students to scientific thinking. Yet, in the Anthropocene, scientific thinking has the potential to both serve as a tool for shaping the future sustainably and as an obstacle in reaching this goal. It seems clear that our decision making processes for issues such as climate change and biodiversity rely on scientific predictions. However it also seems clear that science plays an important role in enabling us to shape the earth in an unsustainable way. Consequently, reflecting on the potential consequences of scientific thinking should be part of science education in the Anthropocene. The nature of scientific thinking is not an explicit topic in science education debate but it is negotiated implicitly in the discourse about approaches to scientific inquiry (Osborne, 2014) and the nature of science (Lederman & Lederman, 2014). This study argues firstly that the mainstream of these approaches is inadequate to reflect the consequences of scientific thinking in the Anthropocene. Second, it shows how scientific thinking can be conceptualized in a more adequate way through a comparison of Western and Chinese thinking (Jullien, 2004, 2011). For that results from history and philosophy of science after the "procedural turn" (Gooding, 1990, p. viii) are referred to (Netz, 1999). The central finding is that a specific use of diagrams, which Galilei transferred in 1638 form Euclidian geometry to physics and a specific understanding of change in nature are essential parts of scientific thinking. With this it can be shown that the possibility of making predictions about the future and our inability to understand nature as a whole represent two sides of the same coin.

Introduction

To determine scientific thinking for purposes of science education, there is a frequent reference to approaches from psychology, especially to Kuhn (2014) and Klahr (2000). A closer analysis of these approaches (cp. Kosler, 2016) shows that, basically, they understand scientific thinking as coordination of theory and evidence. So both are putting scientific thinking in a way, which is not specific for natural science but could be formulated in the same way for social sciences. They do not specify tools for thinking, which are special for thinking in natural science.

It is reasonable to rely more on the research results of the disciplines conducting research about science, namely the history, philosophy, and sociology of science, to get a more detailed description of scientific thinking. But an analysis (Kosler, 2016) shows that the recent "procedural turn" (Gooding, 1990, p. xiii), in which many episodes in history of science are reconstructed in a very detailed way, lead to the idea that there is no single scientific method (Hacking, 1983; Rheinberger, 2010). For science education this is unsatisfactory. Why should it be impossible to explain the nature of scientific thinking and to distinguish it from social scientific thinking?

Approach

This paper uses Jullien's (2004, 2011) approach of comparing and contrasting Western and Chinese thinking to determine scientific thinking in a systematic way. Jullien reconstructs the basic assumptions of Western and Chinese thought. Because modern science emerged just in Europe, the comparison with Chinese thinking should help to detect particularities in Western thought that are developed in modern science. Two such particularities are identified (Kosler, 2016): The idea that models, in the sense of Euclidean geometry, are helpful tools for thinking and the idea of understanding change in nature following the example of the motion of a body. This results were analysed and interpreted with reference to the relevant results from the history of science.

Results and Discussion

With reference to Netz (1999) it can be shown (for details cp. Kosler, 2016) that a specific use of diagrams is essential to Euclidean geometry. The use of these diagrams has two advantages: on the one hand they reduce the "universe of discourse" (Netz 1999, 57), that is the realm of objects and relations which are referred to in a proof. On the other hand each diagram stands for an unrestricted number of similar geometrical objects, which share the properties that are assumed of the diagram in the proof. This means that at the end of the proof the reader can see that the proof is also valid for all geometrical objects that have the same properties the diagram in the proof is assumed to have. As a consequence the proof is general in the sense that it is valid for all geometrical objects that share the same properties. According to Jullien (2005) the orientation of European thinking at the model following the example of the Euclidean geometry unfolded in modern science, because Galilei found a way to conduct science following this example.

Galilei had to develop the concept of change further to transfer the usage of diagrams from Euclidean geometry to the study of change in science. For Aristotle change can be characterised by a state at the beginning, a state at the end and the object that is changing (Ackrill, 1981). Galilei altered this concept of change by introducing the concept of a velocity at a moment. While Aristotle only treated processes of change with a finite duration, Galilei was able to characterise change in a moment. With this he could characterise change itself as a state that can be subject of change. This concept of velocity at a moment made it possible for Galilei, in 1638, to draw a diagram to represent the fall of a body (Galilei, 1954, p. 173, Fig. 47). Here a vertical line represents the duration of the process. Perpendicular to this line Galilei drew lines which represent the velocity at distinct moments. With this he was able to derive the second law of falling and to prove it by experiment. The general problem of the usage of Euclidean diagrams in science before Galilei was the circumstance that since Aristotle science has been seen as an analysis of the movement of bodies whereas there is no movement in Euclidean diagrams. So Galilei's trick was to find two concepts of motion, which enabled him to conceptualize motion as a succession of states and to find a diagram representing successive states of motion.

To understand the usefulness of scientific thinking the use of diagrams is essential. It is the usage of these diagrams that reduces the universe of discourse to some particular relations of a manageable number. The connection of the phenomena of nature as a whole is not in the focus of this approach of thinking about nature. It is this use of diagrams that enables modern scientists to derive general laws from known or assumed relations and to make predictions about the future, which we can use in informed decision making. The questions of how far this description is also valid outside mechanics, and how this approach can guide reflection on scientific thinking as a tool to shape a sustainable future with students, are discussed in Kosler (2016). There it is shown how existing results from design based research (Lehrer & Schauble, 2012) can be reinterpreted and further developed in the sense of this approach and how the comparison of Western and Chinese thinking can be initiated in the science classroom.

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Digitalization and Sustainability in Language Teaching

Christian Hoiß
Ludwig-Maximilians-Universität München, Germany

The whole world is electrified by an exceeding number of opportunities due to an ever-growing number of digital technologies. While mainstream educational discourse suggests that digitalization is the key challenge for educational institutions in the 21st century (e.g. current efforts concerning the so-called *Digitalisierungspakt* in Germany), it can be argued that digitalization is – quite on the contrary – one of the key accelerators of global environmental damage. The billions and billions of electronic devices for example not only consist of numerous different materials which are often being mined in conflict areas using harmful chemicals, but they are also a strong contributor to the global energy consumption and at the end of their lifespans they frequently end up as electronic scrap in the Global South.

Using the concept of Critical Discourse Analysis, it can be detected in the field of German Language Teaching that digitalization has impacted all up-to-date concepts of media competence but basically none of them deal with the implications, perspectives, and challenges regarding the ecological and social costs. The analysis shows that the digital story we live by is far from being a sustainable one. This calls for a new critical approach which systematically integrates socio-ecological aspects in concepts of media competence. The contribution will present conceptual ideas on how the socio-ecological spheres can be addressed in media-oriented language teaching. By implementing aspects of Education for Sustainable Development in conventional definitions of media competence, the contribution attempts to close the persistent gap between subject didactics (in this case German Language and Literature) and research on Education for Sustainable Education.