# Competence Development in Teacher Education for Sustainable Development at Leuphana University and Arizona State University

Jan-Ole Brandt, Matthias Barth

**Working Papers in Higher Education for Sustainable Development Series**

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# Competence Development in Teacher Education for Sustainable Development at Leuphana University and Arizona State University

Jan-Ole Brandt, Center for Global Sustainability and Cultural Transformation, Faculty of Sustainability, Leuphana University of Lüneburg, Lüneburg, Niedersachsen, Germany
jbrandt@leuphana.de

Matthias Barth, Center for Global Sustainability and Cultural Transformation and Institute for Integrative Studies, Faculty of Sustainability, Leuphana University of Lüneburg, Lüneburg, Niedersachsen, Germany
matthias.barth@leuphana.de

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# Editorial

**"Working Papers in Higher Education for Sustainable Development"** is a series dedicated to delivering insights and discussions from *ongoing* research projects in the field of Higher Education for Sustainable Development. One major goal is to make detailed case-descriptions, notes on methods, research designs and related information available in a transparent fashion which usually exceeds the scope of journal articles. Fellow researchers, scholars and practitioners are invited to comment, discuss and contribute their thoughts and own experiences. This working papers series is published by the joint "Center for Global Sustainability and Cultural Transformation" (CGSC), a transatlantic academic collaboration between Leuphana University of Lüneburg and Arizona State University.

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Prof. Dr. Matthias Barth; Prof. Dr. Arnim Wiek

Center for Global Sustainability and Cultural Transformation
Leuphana University Lüneburg
Universitätsallee 1
21335 Lüneburg, Germany

# Abstract

**English**

Meeting the global ambition to implement education for sustainability at levels largely depends on competent and motivated teachers. Accordingly, teacher education for sustainable development (TESD) aims to equip future educators with specific content knowledge, the ability to implement adequate teaching and learning scenarios and increase their motivation to do so. Whereas previous literature has dealt extensively with concepts and empirical work around learning objectives, the TESD case study of the Educating Future Change Agents (EFCA) project links learning outcomes or WHAT student teachers learn to the learning processes or HOW they learn. To inform the empirical research of the case study, this working paper provides a detailed case description of individual TESD courses at Leuphana University of Lüneburg (Germany) and Arizona State University (USA). By describing contextual conditions, the teaching and learning environment as well as applied teaching formats and student cohorts we aim to increase the transparence of our research and help to better understand related empirical results.

**Key words: education for sustainable development, teacher education, sustainability, higher education, competence development, teaching and learning, drivers and barriers, case study**

**Deutsch**

Um das globale Ziel einer Umsetzung von Bildung für nachhaltige Entwicklung auf allen Ebenen zu erreichen bedarf es insbesondere kompetenter und motivierter Lehrkräfte. Entsprechend ist LehrerInnenbildung für nachhaltige Entwicklung (LBNE) bemüht, zukünftige Lehrerinnen und Lehrer mit spezifischem Fachwissen und Fertigkeiten auszustatten, angemessene Lehr- und Lernszenarien umzusetzen, sowie sie sie motivieren, dies auch in die Tat umzusetzen. Während vorangegangene Literatur sich ausgiebig mit Konzepten und empirischer Arbeit rund um die Lernziele einer LBNE beschäftig hat, verbindet die LBNE Fallstudie des Educating Future Change Agents (EFCA) Projektes Lernergebnisse oder WAS Lehramtsstudierende lernen mit den dazugehörigen Lernprozessen beziehungsweise WIE sie lernen. Um die empirische Forschung der Fallstudie zu informieren, liefert das vorliegende Working Paper eine detaillierte Fallbeschreibung einzelner LBNE Kurse and der Leuphana Universität in Lüneburg (Deutschland) und der Arizona State University (USA). Durch die Beschreibung der jeweiligen Kontextbedingungen des Lehr- und Lernumfeldes, angewendeter Lehrformate sowie der Studierenden-Kohorten soll die Transparenz unserer Forschung erhöht und die Einordnung empirischer Ergebnisse erleichtert werden.

**Key words: Bildung für nachhaltige Entwicklung, LehrerInnenbildung, Nachhaltigkeit, Hochschulbildung, Kompetenzentwicklung, Lehren und Lernen, Treiber und Barrieren, Fallstudie**

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# Part I

## Introduction

### 1.1 The Educating Future Change Agents Project

The *Educating Future Change Agents* (EFCA) project produced empirical insights on how higher education can support students' development of key competencies in sustainability. The project was conducted 2016-2020 as a joint research project between Leuphana University of Lüneburg, Germany and Arizona State University, Tempe, Arizona, USA. The project was structured into five studies, which conducted in-depth case studies and comparative studies on the course, curriculum, and institutional level. The specific cases were selected so as to have a high degree of both similarities and variances within and across cases and to represent the widely recognized fields of sustainability education, namely, education of sustainability professionals, teachers, and entrepreneurs.

All studies were grounded in a shared analytical framework that informed both data collection and analysis. Based on this framework, each study adopted its own suite of research methods appropriate for the respective research questions, while still coordinating and sharing insights on methods among the studies. Each study produced a set of results specific to the specific case(s) and contexts. In the final phase of the project, results from the individual studies were synthesized to offer general insights for researchers, educators, and administrators in the field of sustainability education.

Results of the EFCA project have been published and can be found on ResearchGate: https://www.researchgate.net/project/Educating-Future-Change-Agents. This working paper series provides previously unpublished background material and additional information to facilitate deeper understanding of the research carried out. The working papers offer thorough case documentation and in-depth information on instruments and analytical steps.

### 1.2 Case Research Project

Focusing on the micro-level of the EFCA project, this *working paper* complements the case study research on the cases of teacher education for sustainable development (TESD) at Leuphana and ASU, by describing the related course offerings in detail. Research on the course level (*micro*) is being conducted through multiple case studies, exploring "bounded systems" and offer opportunities to study the manifold factors that produced the unique character of each case (Stake 2005; Creswell 2007).

As a preferable strategy to answer 'how' and 'why' questions these studies allow contextual factors, and thus the singularity of a case, to be taken into account (Yin 1984). Multiple case studies and so-called cross-case comparisons (West und Oldfather 1995) are considered viable options to overcome limitations of single case studies: *"A number of cases may be studied jointly in order to investigate a phenomenon, population, or general condition"* (Stake 2005).

For a thorough understanding of the cases and increasing the reliability of the study, a detailed documentation is needed to provide insights into the case specifics (Yin 1984). Hence, this working paper describes the cases of TESD at Leuphana and ASU and their related course offerings along the individual 'course environment' (including *institutional support*, *structure of study programs*, *access to resources* etc.), the 'course structure' (including applied teaching and learning formats/ pedagogies), 'desired learning outcomes', and the different 'cohorts' under investigation (including descriptive information about the participants). To fully understand the uniqueness of each case but also the comparability between TESD at both institutions, some background information on the specific context of teacher education and the school system in Germany and the US is provided as well. The actual results of the case study research, mainly focusing on the learning processes and outcomes – in terms of competence development through the investigated interventions (courses) –, on the other hand, are covered in separate scientific articles (Brandt et al.; Brandt et al. 2019).

### 1.3 The multiple Case Study – Teacher education for sustainable development

The EFCA-TESD comparative case study addresses the overarching research question of how the development of sustainability competencies for teachers can be best supported in single courses as part of teacher education programs at Leuphana and Arizona State University, which are not primarily devoted to sustainability.

We purposefully selected the two cases to be able to compare and contrast two prominent examples of how ESD can be implemented in teacher education on a course level. The two cases display a variance with regards to the teaching and learning context, teaching and learning approaches (settings and formats), and desired learning objectives (variations of competencies composition), which will be illustrated at the end of the two case descriptions. Both courses investigated in this case study employ novel teaching and learning formats, namely hybrids of online and classroom activities. Furthermore, this multiple case study on TESD is focused on discursive learning, which implies that the focus here is on the more conventional pedagogy of learning through the reception of course material (online) as well as through reflections and discussions with the instructor(s) and peers (in the classroom).

## 1.4 Acknowledgements

We acknowledge support from the entire EFCA research team: Jodie Birdman, Jantje Halberstadt, Theres Konrad, Daniel Lang, Aaron Redman, Tamsin Foucrier, Jana Timm, Marie Weiss, and Arnim Wiek. Special thanks go to all course participants, i.e. students, instructors, and tutors as well as our student assistents Laura Geres, Jana Jeddeloh, Carina Köser, Johanna Kruse and Malte Rohe for their valuable contributions to the development of code books and countless hours of transcription.

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# Part II

## Description of cases

### 2.1 Teacher Education for Sustainable Development at Leuphana University (Case 1)

The first case in this working paper is TESD at Leuphana University in Lüneburg, which is delivered as a mandatory module in the second semester for students of Basic Social and Science Studies (BSSS) (Sachunterricht) within the BA (Bachelor of Arts) teacher education program of Teaching and Learning (Lehren & Lernen), preparing students to become teachers of BSSS in primary schools.

***Context of the Leuphana case study***

Teacher education in Germany is organized in consecutive Bachelor (six semesters) and Master (four semesters) programs. Teacher education reflects the staged German school system (Cortina & Thames, 2013) where children after primary education (4–6 years, depending on the state) can choose between three different secondary school forms: Hauptschule, with a final examination after grade 9 (Hauptschulabschluss) or grade 10 (Realschulabschluss), Realschule, with a final examination after grade 10 (Realschulabschluss), and Gymnasium, with a final examination after grade 12 or 13, depending on the state (Abitur), qualifying students for higher education. The fourth type of secondary school is the Gesamtschule, a combination of the Hauptschule, Realschule, and Gymnasium.

This case study focuses on teacher education for primary education at Leuphana University in Lower Saxony, where the academic phase of three plus two years is followed by an in-service training phase (18 months) organized by the respective state authority (Cortina und Thames 2013). As in all other universities in the federal state, student teachers at Leuphana are required to choose two instructional subjects for their BA studies while taking additional courses to develop their professional knowledge in general educational sciences.

**The Leuphana model of teacher education**

Leuphana University is one of eight universities in Lower Saxony in which teacher education is offered as a university degree. Originally founded as a teacher-training college in 1946, the University of Lüneburg was granted university status in 1989, making it a relatively young university in Germany. Since 2006, the university has been registered as Leuphana University of Lüneburg, with an academic mission that is primarily guided by the ideas of *humanism*, *sustainability,* and *application-orientation*. It is known for its strong sustainability focus, visible, for example, in the establishment of Europe's first Faculty of Sustainability.[1]

[1] https://www.leuphana.de/en/university.html

Since the mid-2000s, education in the four faculties at Leuphana (Education, Humanities and Social Sciences, Sustainability, and Business and Economics) is structured in three schools—College (Bachelor's studies), Graduate School (Master's and doctoral studies) and Professional School (continuing education for professionals).

Leuphana College offers students a unique introduction to their studies: the so-called Leuphana Semester. During the Leuphana Semester, students are engaged in interdisciplinary modules where they acquire the fundamental methods for a scientific course of study and learn how to write scientific papers and present results in an academic environment. One of those interdisciplinary modules is called Science Bears Responsibility (Responsibility and Sustainability). It introduces the students to key concepts of sustainability, such as the Sustainable Development Goals (Barth und Timm 2011; Michelsen 2013). At the same time, in subject-specific modules, the students receive an introduction to the content and methods of their main subject.[2]
As one of the three Bachelor programs in teacher education, Teaching and Learning (Lehren und Lernen) combines the study of two school subjects with educational science as well as psychological and socio-cultural topics. Integrated into the schedule of the overall 180 ECTS program are supervised internships in a school that allows students to analyze and reflect on the requirements of the teaching profession. Also, there are opportunities to complete a semester abroad. Figure 1 shows the structure of the entire program and how many ECTS[3] points are assigned to the different study modules.

As a BA program, Teaching and Learning has a standard study period of six semesters. However, students can also apply for part-time study. The program is only offered in German and is thus directed at prospective students with a good command of the German language. The program starts every year in October (Winter Semester) with an overall intake of 265 students. All applicants are recommended to take part in a self-assessment with a Career Counseling for Teachers (CCT), to get a realistic impression of the content, working procedures, and specific requirements of the teaching profession and to explore and reflect on their suitability for the job as a teacher. The results of the CCT are discussed in the subsequent interview, which is why this self-assessment is a key component of the application process at the College. The CCT results, however, have no direct impact on the final selection decision. Students can choose from 11 different school subjects: German, English, Mathematics, Biology, Chemistry, Religion, Art, Music, Politics, Sports, together with BSSS (Sachunterricht), with an emphasis on the following specific subject areas: Natural Science, Geography, History, or Politics.[4]

[2] https://www.leuphana.de/en/college/study-program/leuphana-semester.html
[3] European Credit Transfer and Accumulation System
[4] https://www.leuphana.de/college/bachelor/lehramt/lehren-und-lernen.html

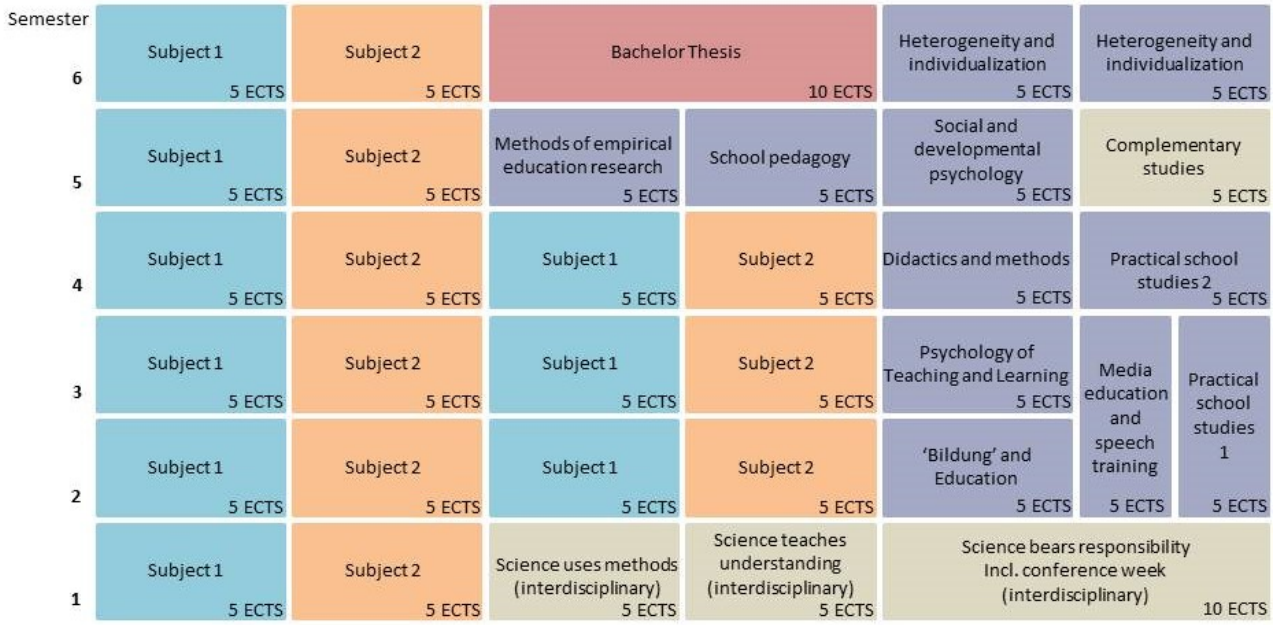


**Figure 1:** Structure of the teacher education study program Teaching and Learning[5]

**Subject – Basic Social and Science Studies**

BSSS, as a subject, is taught in primary education at German elementary schools. It deals with socially relevant issues in particular and is oriented toward ESD. The idea is to enable students to participate in societal processes and explore the world through social, cultural, natural, technical, historical, and spatial perspectives.[6] At Leuphana, the BSSS branch of the Teaching and Learning program offers places to 46 students each year. It introduces them to content knowledge and pedagogical content knowledge of the subject. It also covers a subject-related understanding of the term education (Bildung), including the elements of multi-perspectivity, problem-orientation, and the scientific approach. Furthermore, Leuphana's student teachers reflect on the role of schools in the (German) educational landscape as well as their duties as future teachers. The 662 applications for 46 spots (Winter Semester 2019/20) show the high level of interest of students in the program and lead to a selection of students with above-average final school exam grades.

In the context of project work and seminars, students get the chance to practice being a teacher in a research-oriented manner. As an interdisciplinary subject, BSSS offers students the opportunity to experience and discuss the interconnection of discipline-related approaches, which are deepened in the study of the reference subjects (Geography, History, Natural Sciences, and Politics), in all teaching formats of the subject (Ibid., see also Figure 2).

[5] https://www.leuphana.de/fileadmin/user_upload/college/Bachelor/2_Major_Flyer/Lehren_und_Lernen.pdf
[6] https://www.leuphana.de/college/bachelor/lehramt/lehren-und-lernen/sachunterricht.html

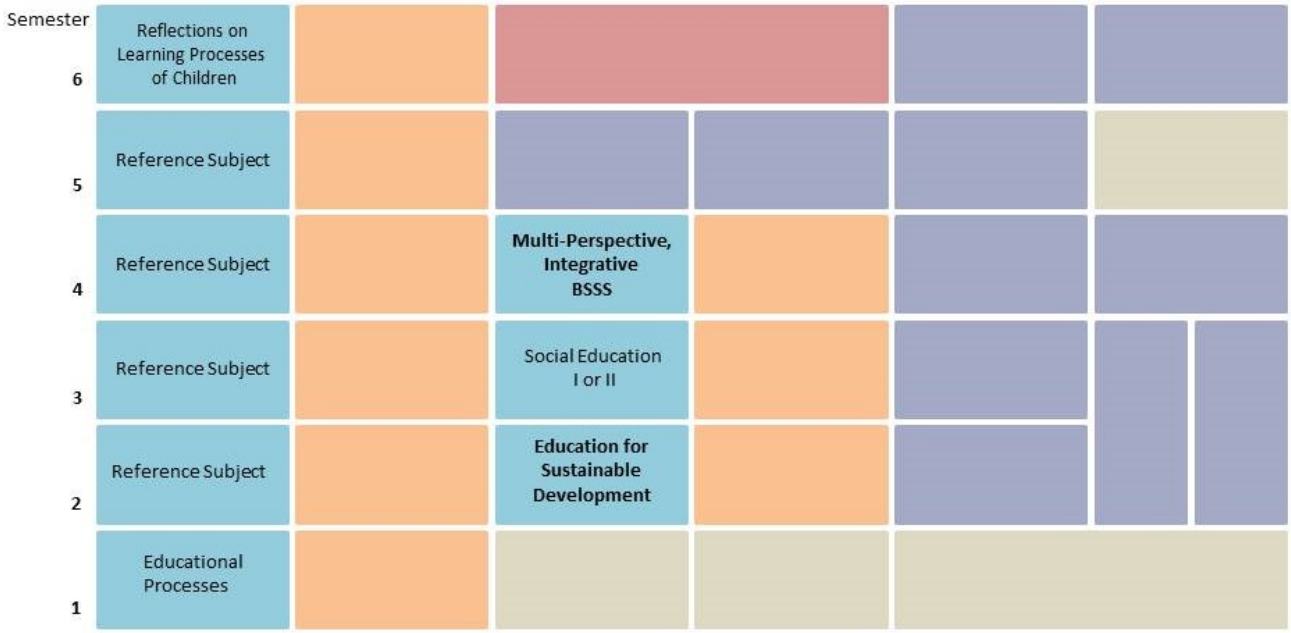


**Figure 2:** Overview of modules in Basic Social and Science Studies[7]

As part of the BSSS subject, students have to complete two sequential study modules explicitly dealing with sustainability and ESD: Education for Sustainable Development (2nd semester) and Multi-Perspective, Integrative Basic Social- and Science Studies (4th semester). This case study focuses on the first module.

***Module: Education for Sustainable Development***

The first module is called *Education for Sustainable Development* (Bildung für eine nachhaltige Entwicklung), and it takes place in the second semester of the BSSS branch in Teaching and Learning. It is a mandatory, 150-hour unit that is offered every year during the summer term (April to July). Table 1 summarizes some of the key characteristics of this course.

**Learning objectives**

This module builds upon students´ learning in the first semester, where they are introduced to BSSS and related educational theory. It introduces them to Education for Sustainable Development as a framework for the BSSS. It familiarizes them with the basic steps of the design of learning environments. Accordingly, at the end of this module, students are expected to have a basic understanding of how to select learning objectives, content, and methods against the background of the guiding principles of ESD and how to apply them in the design process of learning environments for primary education students.

[7] https://www.leuphana.de/fileadmin/user_upload/Aktuell/files/Gazetten/Gazette_15_15_Sachunterricht.pdf

**Table 1:** Attributes of the Education for Sustainable Development module (Leuphana)

| | |
|---|---|
| **Course Title** | ***Education for Sustainable Development*** |
| **Curriculum** | **Second semester –** Mandatory course in BA Teaching & Learning |
| **Structure** | **13 x seminar session (weekly)**<br>(incl. practical project implementation at a partner school)<br>**7 x lecture (online + live) + 7 x tutorial** |
| **Students** | **~80 students** (allocated to three seminars) |
| **Form of Assessment** | **1. Individual written assignment:**<br>Outlining a learning unit in ESD (30/100 pts.)<br>**2. Group presentation, incl. written report and individual reflection**<br>Presenting an individual ESD lesson incl. rationale (70/100 pts.) |
| **Key Learning Objectives** | • Understanding of ESD as an educational perspective in primary education<br>• Pedagogical content knowledge in ESD<br>• Ability to plan and implement teaching and learning activities in a given class setting |

## Pedagogical approach (teaching and learning formats)

Over the 14 weeks of the semester, students participate in a combination of (blended learning) lectures, tutorials, and seminar sessions. The design of the module follows a scaffold approach in four sequential steps:

(1) First, in a regular lecture format, students learn about the concept of ESD in general, its implementation, and how to design teaching and learning units in ESD. From week 3 to week 7, the lectures are recorded and offered in a flipped classroom setting to allow students to engage with the topic in their own time and at their own pace and to enable them to ask questions and interact in the additional face-to-face meetings each week.

(2) The lecturer uses the model of cognitive apprenticeship (Collins et al. 1991) to demonstrate how to create a learning environment that supports sustainability competence development in school settings.

(3) From week 3 to week 7, students are divided into tutorials and work individually, with the support of tutors, on the outline of such a learning environment. This work also represents their first official assignment in the course (seminar room).

(4) In three different seminars, student groups work on a case study, in which they collaborate with a school to implement an ESD lesson for primary-education students.

### Lectures and tutorials

The lectures introduce ESD, not as an additional topic or subject, but as an innovative concept with a new perspective on educational processes, having various consequences regarding desired learning outcomes, content, and methods for teaching and learning. Overall, the lectures focus on the question of what the concept of ESD implies with regards to school and teaching. The specific focus is on the potential of ESD for students and teachers to be highly motivated and qualified for the practical implementation of EDS. Furthermore, the lectures consider the foundations of educational policy, the international discourse on ESD, and forms of implementing ESD across educational areas that have an impact on schools and teaching. As mentioned above, the lectures teach students about the concept of ESD. They provide practical knowledge on the implementation of ESD and on related didactic principles, such as vision-orientation, participation-orientation, and connected learning (Künzli und Bertschy 2008). The lectures are followed by tutorials led by senior students. In the tutorials, the theoretical knowledge from the lectures is deepened, and students can implement what they learned in the lectures to develop a BSSS teaching and learning unit. Through the online platform Moodle, the students have access to the material (lecture slides) and additional literature. Table 2 shows the sequence of activities in the lectures and tutorials.

### Seminar

In the ESD seminar, students deal with the concept of ESD and try out a first practical implementation. In groups of 3–5 students, they design teaching and learning units around topics like mobility (e.g., car sharing), nutrition (e.g., package free breakfast) or the use of space (e.g., redesigning the schoolyard) to be implemented with children in a partner elementary school at the end of the semester. Students begin to look at these topics through the lens of ESD and learn how to design suitable teaching and learning settings that support children in developing their shaping competence (Gestaltungskompetenz) (Haan 2006). Table 3 exemplifies the sequence of activities in such a seminar.

**Table 2:** Sequence of activities – Lectures + tutorial 2018

| Session | Topic |
|---|---|
| 01 | ***Regular lecture:***<br>**ESD as an educational concept for Basic Social and Science Studies**<br>Content: After clarifying questions about the formalities of the overall module, the first lecture introduces ESD as an educational concept and provides an overview of the historical development and establishment of ESD. |
| 02 | ***Regular lecture:***<br>**Education for or as Sustainable Development?**<br>Content: The second lecture deals with the objectives of ESD, the contradiction between instrumental and emancipatory approaches, competence orientation as a possible solution as well as the development of a competence concept in ESD. |
| 03 | ***Flipped classroom:***<br>**Sustainability key competencies (KCS)**<br>Content: The third lecture introduces the model of Key Competencies in Sustainability (KCS), including the operationalization of individual sub-competencies, as a concrete approach for learning objectives in ESD.<br>***Tutorial:***<br>Content: The first tutorial introduces the goals of the tutorial (the clarification of open questions from the lecture and continuous support for working on the assignment). Furthermore, the tutors repeat and deepen the theoretical connection between ESD and related (competence-oriented) learning objectives, such as the KCS model. |

| | |
|---|---|
| **04** | ***Flipped classroom:***<br>**Important questions and basic foundations**<br>Content: Lecture four focuses on the question of how to select suitable topics and content for ESD units and introduces a relevant matrix of criteria.<br>***Tutorial:***<br>Content: The second tutorial session focuses on how teachers can find and select suitable topics and content for ESD units and aims to clarify open questions regarding the assignment and the content of the previous lectures. |
| **05** | ***Flipped classroom:***<br>**Serious tasks and adequate approaches**<br>Content: The desired learning objectives and suitable content call for a third step involving the selection of teaching and learning methods for ESD units. Therefore, the fifth lecture focuses on the question of how the selection of methods can be justified and introduces key principles for the didactic design of ESD units, such as constructive alignments.<br>***Tutorial:***<br>Content: The third tutorial reexamines the matrix of criteria for suitable topics and content for ESD units, the idea of a didactic triangle in education, and ESD-specific didactic principles and methods to convey the KCS. Also, the students discuss the overall dramaturgy of teaching and learning units. |
| **06** | ***Flipped classroom:***<br>**Competence-oriented tasks**<br>Content: The sixth lecture is focused on how to design and embed competence-oriented tasks into the procedure of a complete teaching and learning unit and introduces practical examples.<br>***Tutorial:***<br>Content: In the fourth tutorial, students can ask open questions, continue to work on their assignment, and receive feedback on their work in progress. Furthermore, the tutors present a sample teaching and learning unit to walk through the overall dramaturgy again. |
| **07** | ***Flipped classroom:***<br>**Material and design principles of ESD**<br>Content: The final lecture deals with summarizing the design principles for innovative teaching and learning scenarios. Existing material, selection criteria, and potential implementation scenarios are considered, and consequences for the project work in the seminar sessions of the module are discussed.<br>***Tutorial:***<br>Content: The final tutorial session offers students the opportunity to ask open questions, receive feedback, and finalize their assignments. |

**Table 3:** Sequence of activities – ESD Seminar "Package free breakfast" 2018

| Session | Topic |
|---|---|
| **01** | ***Regular lecture:***<br>**ESD as an educational concept for Basic Social and Science Studies**<br>Content: After clarifying questions about the formalities of the overall module, the first lecture introduces ESD as an educational concept and provides an overview of the historical development and establishment of ESD. |
| **02** | **The concept of ESD**<br>Content: In the second seminar session, the key principles, building blocks, and phases of designing ESD units are discussed. Also, an overarching guiding question for the seminar and future group work during the semester is jointly formulated. |
| **03** | **Objectives of ESD and the Core Curriculum for Basic Social and Science Studies in Lower Saxony**<br>Content: In this session, the building blocks of Lower Saxony's Core Curriculum (CC) for BSSS in elementary schools and the desired learning outcomes (KCS) are introduced. |
| **04** | **The Building blocks of the CM**<br>Content: In the fourth session, the students deepen their CC knowledge and form working groups around the individual building blocks of the CC for the upcoming project of implementing individual teaching and learning units at the partner elementary school. |
| **05** | **Selection of learning objectives and methods**<br>Content: In session five of the seminar, the working groups decide what KCS (learning objectives) they want to focus on in their teaching and learning unit as part of the overall project. They also discuss potential methods for implementation within the sub-groups before finally sharing their ideas with the seminar group as a whole. |

| | |
|---|---|
| **06** | **Further planning of the project concept (methods) + peer feedback**<br>Content: In this session, first, the criteria for suitable teaching and learning environments in ESD are reconsidered. Second, the selected methods are revised within the working groups. Third, the students form different groups and present their ideas to members of the other sub-groups for peer feedback. Finally, the students get back to their working groups to discuss and implement the received feedback. |
| **07** | **Criteria for examination and short presentations**<br>Content: In seminar seven, the instructor introduces the criteria for the final group presentation (Assignment 2), including (a) the theoretical foundations (concept of ESD + KCS) (b) the planning phase, and (c) reflections on the practical implementation. Then, the working groups present their intermediate project plans. |
| **08** | **Designing the project concept** (group work)<br>Content: In session eight, the students continue working on their sub-projects. They are explicitly asked to reflect upon success factors for general group work (communication, responsibilities, shared documents etc.) and think about what conditions need to be met to ensure a successful implementation of the overall project with the partner school (physical environment, material etc.). |
| **09** | **Dry run** (group work)<br>Content: In the ninth session, the students carry out a dry run for the overall project implementation, including the welcoming speech for the children and teachers. Finally, the students summarize what the children are expected to gain from the project (objectives) and how they plan to achieve that (methods). |
| **10** | **Implementation of teaching and learning units with the partner school**<br>Content: The students implement the ESD project in the form of individual teaching and learning units with primary school children from the partner school (1st-4th grade). |
| **11** | **Reflection round**<br>Content: In session 11, the students reflect in mixed groups on the implementation process of the teaching and learning units in preparation for the individual written reflections (second assignment). In several reflection rounds, the focus lies on (a) what went well, (b) what went wrong, and (c) possible improvements. |
| **12** | **Working on the final presentation**<br>Content: In session 12, the students can continue working on their final presentations and receive direct feedback from the instructor and their fellow students. |
| **13** | **Final presentations**<br>Content: In session 13, the project groups hold their final presentations – including a connection between their individual project ideas, learning objectives, and the concept of ESD. They are also asked to present and reflect the process of implementation. |
| **14** | **Final presentations**<br>Content: In session 14, the project groups hold their final presentations, including a connection between their individual project ideas, learning objectives, and the concept of ESD. Also, they are asked to present and reflect on the process of implementation. |

### *Participants*

The focus of the research within the EDFCA project at Leuphana University was on the cohort enrolled in the summer term 2018. The 2018 cohort consisted of 81 students, of whom 76 consented to participate in our research. The participants were predominantly female (88.5%) and aged 21 years on average.[8] More than two-thirds of these students had previous professional experience or had completed voluntary work in the social or ecological sector; a quarter of the students had engaged in additional educational activities, courses or certificates; and 10% had engaged in sustainability-related activities (data from pre-course survey, Table 4).

[8] The relatively high number of students in this year reflects a transition of the study program to a lower number of first semester students. This change took place after the 2018 cohort was enrolled.

**Table 4:** ESD cohort 2018 (Leuphana)

| | **Percentage** | ***N*** |
|---|---|---|
| **Number of students** (consented) | 100 (93.8) | 81 (76) |
| **Gender** | | |
| Female | 88.5 | 46 |
| Male | 11.5 | 6 |
| (No reply) | (31.6) | (24) |
| **Age** | | |
| 20 years or younger | 63.0 | 34 |
| 21-25 years | 33.3 | 18 |
| 26 years or older | 3.7 | 2 |
| (No reply) | (28.9) | (22) |
| **Previous work experience** | | |
| Started vocational training | 1.7 | 1 |
| Finished vocational training | 6.7 | 4 |
| Started a different study program | 16.7 | 10 |
| Completed a different study program | 3.3 | 2 |
| Internship of min. 6 months | 10.0 | 6 |
| Other professional activity for min. 6 months | 10.0 | 6 |
| Voluntary social year | 40.0 | 24 |
| Voluntary ecological year | 5.0 | 3 |
| None of the above | 28.3 | 17 |
| (No reply) | (21.1) | (16) |
| **Extra-curricular activities** | | |
| Care service/Nursing | 15.0 | 9 |
| Education/Courses/Certificates | 25.0 | 15 |
| Organization and planning | 21.7 | 13 |
| Consulting | 0 | 0 |
| Sport | 73.3 | 44 |
| Sustainability | 11.7 | 7 |
| Music/Art/Creative work | 41.7 | 25 |
| Health/Yoga/Meditation | 30.0 | 18 |
| Gardening | 16.7 | 10 |
| IT/Computers | 10.0 | 6 |
| None of the above | 0 | 0 |
| (No reply) | (21.1) | (16) |

In a pre-course survey, in addition to the basic socio-demographic data, work-related and extra-curricular experiences, we captured students' motivation to become teachers, using categories adapted from the FIT-Choice scale (Watt und Richardson 2007) (see Table 5). This table shows that the vast majority of students are motivated by values. Motivational aspects that can be assigned to student-focused social utility values were most frequently mentioned. However, only 26% of students referred to the societal level. The second significant type of motivation was intrinsic career values, which motivated 43% of the students. While the socialization influence impacted at least one in five students, personal utility values, the perception of a task, and self-perception were rarer as motivational factors in this cohort.

**Table 5:** Motivation to become a teacher (Leuphana), based on the FIT-Choice Scale (Watt und Richardson 2007)

| | **Percentage** | ***N*** |
|---|---|---|
| | **100** | **58** |
| Values | 96.6 | 56 |
| Intrinsic career values | 43.1 | 25 |
| Personal utility values | 3.4 | 2 |
| Social utility values (students) | 81 | 47 |
| Social utility values (society) | 25.9 | 15 |
| Socialization influence | 20.7 | 12 |
| Perception of the task | 6.9 | 4 |
| Perception of the self | 8.6 | 5 |
| (No reply) | (23.7) | (18) |

To further cover students' attitudes toward sustainability and ESD, we included several scales in the surveys, such as the new ecological paradigm scale (NEP) by Dunlap et al. (2000) and the perceived relevance of ESD scale by Tomas et al. (2015). We measured students' ESD and innovation-related self-efficacy, based on scales introduced by Tomas et al. (2015) and Emmrich (2009). Table 6 shows that the students started the course with strong pro-environmental attitudes. These attitudes are notably more positive when compared with other student cohorts, such as undergraduate psychology students at the University of Utah (Amburgey und Thoman 2012), Turkish pre-service German teachers (Alyaz et al. 2016), and first-year students from five different programs at Otago University in New Zealand (Harraway et al. 2012). These results may be linked to the fact that the students had already completed a module on sustainability in their first semester. This could also explain the relatively high values for students' perceived relevance of ESD (Table 7).

**Table 6:** NEP - New Ecological Paradigm (1-5 Likert scale) (Leuphana)—based on Dunlap et al. (2000)

| | *N* | *M* | *SD* |
|---|---|---|---|
| **Overall NEP scale** | 60 | **3.98** | 0.38 |
| *Sub-Dimensions* | | | |
| Balance of nature (Items 3, 8[R] & 13) | 60 | **4.10** | 0.52 |
| Eco-crisis (Items 5,10[*R*] & 15) | 60 | **4.26** | 0.66 |
| Anti-Exemptionalism (Items 4[*R*], 9 & 14[*R*]) | 60 | **3.71** | 0.50 |
| Limits to growth (Items 1, 6[*R*] & 11) | 60 | **3.60** | 0.78 |
| Anti-Anthropocentrism (Items 2[*R*], 7 & 12[*R*]) | 60 | **4.21** | 0.46 |

[*R*] = reverse-scored items from the scale

**Table 7:** Attitude scales (Leuphana)

| | *N* | *M* | *SD* |
|---|---|---|---|
| **Perceived relevance of ESD** (1–4 Likert scale) | 49 | **3.55** | 0.34 |
| **ESD-related self-efficacy** (1–4 Likert scale) | 49 | **2.98** | 0.37 |
| **Innovation-related self-efficacy** (1–4 Likert scale) | 48 | **3.13** | 0.40 |

## 2.2 Teacher Education for Sustainable Development at Arizona State University (Case 2)

Our second case study is TESD at ASU, a course delivered at the Mary Lou Fulton Teachers College called Sustainability Science for Teachers (SSfT), a mandatory course for all students in K-8 education programs at ASU.

### *Context of the ASU case study*

Teacher education programs in the United States often focus their curriculum on a set of model core teaching standards developed by the Council of Chief State School Officers (2011). These Interstate Teacher Assessment and Support Consortium (InTASC) standards articulate what effective teaching and learning should look like in order to optimize development for K-12 students. Student teachers may learn these skills in a variety of study programs. Many students pursue an undergraduate degree in education and fulfill requirements for a teaching license. In contrast, others enroll in an MA program that leads to licensure. Due to the shortage of teachers in the United States, there are also several alternative routes to licensure, which include a combination of coursework and relevant experience. American schools are considered elementary schools if they include students in pre-school through sixth, and in some cases, up to eighth grade. Some districts have middle schools, which focus on grades 6–8, while secondary schools often include grades 9–12.

Each state has a great deal of autonomy in developing a curriculum for students in K-12 and higher education. In Arizona, pre-service teachers can pursue an endorsement in early childhood education (birth to age 8), elementary education (grades K-8), middle grades education (grades 5–9) or secondary education (grades 6–12, with a focus on a specific subject such as life science).[9] The students in this case study were undergraduates who attended the Mary Lou Futon Teachers College at ASU and were all pursuing a degree in elementary education. Some students were enrolled in a BA in Special Education with Dual Certification in Elementary Education, while others studied Bilingual Education and English as a Second Language in addition to elementary education.

[9] https://www.azed.gov/educator-certification/forms-and-information/certificates/

**The ASU model of teacher education**

ASU is a comprehensive public research university, *"measured not by whom it excludes, but by whom it includes and how they succeed; advancing research and discovery of public value; and assuming fundamental responsibility for the economic, social, cultural and overall health of the communities it serves."* (ASU Charter[10]). In 2002, ASU President Michael M. Crow unveiled his vision for a "New American University."[11] Since then, ASU has established more than a dozen new transdisciplinary schools and launched large-scale research initiatives. Today, the university is divided into 17 departments (schools, colleges, and institutes),[12] two of which—the School of Sustainability and the Mary Lou Fulton Teachers College, in cooperation with the Pathfinder Center (working at the interface of education, sustainability, and research)—are direct associates of the EFCA research project. Established in 2007, the School of Sustainability is the first of its kind in the United States and significantly contributes to ASU's reputation as one of the most ambitious and principled organizations for embedding sustainable practices into its operating model.[13]

The Mary Lou Fulton Teachers College, according to its website, has the mission of creating knowledge, mobilizing people, and taking action to improve education. It is subdivided into the Division of Teacher Preparation and the Division of Educational Leadership and Innovation.[14] The Division of Educational Leadership and Innovation offers Master's degree and PhD programs to those dedicated to the improvement of professional practice in pre-K–20 settings and those who wish to become full-time faculty at research institutions. In addition to a set of Master's degrees, the Division of Teacher Preparation offers a variety of undergraduate programs.[15] Here, we only list the degrees that students participating in the EFCA's teacher education case study were pursuing: Elementary Education, BAE; Elementary Education, (BLE/ESL), BAE; Elementary Education, (STEM), BAE; Special Education/Elementary Education (dual certification), BAE.

The innovative curriculum aims to equip teachers and educational leaders with the professional knowledge, skills, competencies, and dispositions that will positively impact children, young people, communities, and schools. Students engage with eminent faculty members, conduct high-impact research, and learn from an innovative curriculum that prepares them to teach in a diverse and interconnected world. In addition to the general first-year student college admission requirements (see Table 8), each of the programs has specific entry requirements that are set out on the Mary Lou Fulton Teachers College website.[16]

[10] https://www.asu.edu/about/charter-mission-and-values
[11] https://newamericanuniversity.asu.edu/home
[12] https://www.asu.edu/about/colleges-and-schools
[13] https://www.greenbiz.com/blog/2013/08/16/asu-sustainable-procurement-isnt-just-academic-exercise
[14] https://education.asu.edu/
[15] https://education.asu.edu/about/academic-divisions
[16] https://education.asu.edu/degree-programs/undergraduate-degrees

**Table 8:** Entry requirements (ASU)

| |
|---|
| **General course competency requirements**<br>- 4 years mathematics<br>- 4 years mathematics<br>- 4 years English (non-ESL/ELL courses)<br>- 3 years lab sciences (1 year each from biology, chemistry, earth science, integrated sciences or physics)<br>- 2 years social sciences (including 1 year of American history)<br>- 2 years same second language<br>- 1 year fine arts or 1 year of career and technical education |
| **General aptitude requirements:**<br>- Top 25% in high school graduating class<br>- 3.00 GPA in competency courses (4.00 = "A")<br>- ACT: 22 (24 non-residents)<br>- SAT: 1120 (1180 non-residents) |

### *Module: Sustainability Science for Teachers*

EFCA's case study on TESD at ASU is focused on the SSfT course. This course was designed by an interdisciplinary team of scientists, educators, and design experts and launched at ASU in the fall of 2012. It is a three-credit, 15-week course that is mandatory in all elementary education programs (K-8) at ASU and usually takes place in the fifth semester of the above-listed undergraduate programs.

**Table 9:** Attributes of the Sustainability Science for Teachers course (ASU)

| | |
|---|---|
| **Course Title** | ***Sustainability Science for Teachers (SSfT)*** |
| **Curriculum** | **Fifth semester** - Mandatory in all elementary education programs (K-8) at ASU |
| **Structure** | **13 x weekly seminar sessions**<br>(incl. practical project implementation at a partner school)<br>**7 x lecture (online + present) + 7 x tutorial** |
| **Students** | ***~120 allocated to six seminars*** |
| **Form of Assessment** | **Participation** (150/1000 pts.)<br>**Quiz** (130/1000 pts.)<br>**Reflections & contributions on Blackboard** (online platform) (200/1000 pts.)<br>**Assignments** (150/1000 pts.)<br>**Group presentation—Sustainability in the news** (50/1000 pts.)<br>**Final project outline** (60/1000 pts.)<br>**Peer review** (Final project) (60/1000 pts.)<br>**Final project—creating a learning unit** (200/1000 pts.) |
| **Key Learning Objectives** | • Understanding of ESD as an educational perspective in primary education<br>• Pedagogical content knowledge in ESD<br>• Ability to plan and implement teaching and learning activities in a given class setting |

**Learning objectives**

The SSfT course aims to prepare pre-service teachers (K-8) as sustainable citizens and educators who will implement ESD with their future students (Merritt et al. 2019). The primary objective is to develop sustainability literacy among pre-service teachers (a) by providing ESD-related content knowledge and fostering students' understanding of sustainability concepts and their application (CK) and (b) by providing pedagogical content knowledge for ESD and developing students' ability to apply the ways of thinking (WOT) to explain sustainability concepts (PCK). The four WOTs—strategic, futures, values, and systems thinking, which relate back to the KCS (Wiek et al. 2011)—provide the overarching "sustainability education framework" (Warren et al. 2014), engaging the students with the course content.

In keeping with existing goals for general teacher education, the SSfT course is oriented toward learning standards formulated by the International Society for Technology in Education (ISTE),[17] Interstate Teacher Assessment and Support Consortium (InTASC) standards,[18] and national ESD K-12 student learning standards proposed by the US Partnership for Education for Sustainable Development (USPESD).[19] Furthermore, the course planners explicitly consider recent curricular reform initiatives in the US including, for instance, the Common Core State Standards (CCSS),[20] the Next Generation Science Standards, (NGSS)[21] and the College, Career and Civic Life framework for social studies.[22]

**Pedagogical approach (teaching and learning formats)**

The SSfT course is conducted in a hybrid environment, which is divided into thirds:

- Short digital stories considering the global and national issues of sustainability (online material).
- Homework assignments that consider local sustainability issues and lesson plans on sustainability topics.
- In-person or virtual classroom discussion sections centered on the digital stories and course homework.

The course uses a flipped learning approach, where the content is shared in the online portion through "digital storytelling" (Robin 2008). Students watch videos related to the weekly topics, take quizzes to check for understanding of content and work on reflective assignments. As a second course component, students come to class for 75 minutes each week to discuss concepts and learn pedagogical strategies to integrate the content into their future teaching. While the class is divided into several cohorts, all instructors use the same online content, are provided with weekly lesson

[17] https://www.iste.org/standards/for-educators
[18] https://ccsso.org/sites/default/files/2017-11/InTASC_Model_Core_Teaching_Standards_2011.pdf
[19] https://s3.amazonaws.com/usp_site_uploads/resources/123/USP_EFS_standards_V3_10_09.pdf
[20] http://www.corestandards.org/
[21] https://www.nextgenscience.org/get-to-know
[22] https://www.socialstudies.org/sites/default/files/2017/Jun/c3-framework-for-social-studies-rev0617.pdf

plans, and meet monthly to discuss pedagogical strategies. Through the exploration of sustainability-related topics, the students learn about sustainability concepts, develop ESD competencies, and engage with various pedagogical approaches, aiming to foster their ability to effectively teach ESD in K-8 settings. The in-class lessons vary each week and include specific activities, such as the "Hot Dog" activity—a systems thinking activity where students map out all of the inputs, outputs and components of the food system needed to produce a hot dog. The final project, the overarching assignment for the course, consists of a student-designed digital artifact that outlines a five-day learning unit on a sustainability topic of a student's choice. Table 10 shows the detailed sequence of activities in the SSfT course.

**Table 10:** Sequence of activities—SSfT course (as of Fall 2017)

| Week | Topic | Readings, Media and Assignments | In-class Activities |
|---|---|---|---|
| **1** | **Sustainability**<br>What is sustainability?<br>Why is the field of sustainability relevant to education? | **Sustainability Myths article in Blackboard**<br>**Sustainability Content Videos in Blackboard**<br>1. Big Themes video (5 min.)<br>2. History of Sustainability (4 min.)<br>• Read the Sustainability Myths article and respond to the discussion board.<br>• Review the materials in the course under the "sustainability" page.<br>• Please thoroughly review the syllabus and email me with any questions you have.<br><br>**Tasks and Assignments:**<br>• Sustainability Myths discussion | **Sustainability Scenario Exercise**<br>Students identify that many factors in human society and the natural environment are interdependent, by creating a concept map in cooperative learning groups. |
| **2** | **Population**<br>How many people can the Earth support? | **Population Content Videos in Blackboard:**<br>1. Futures Thinking (3 min.)<br>2. Beginnings (15 min.)<br>3. Regulation (12 min.)<br>4. Migration (12 min.)<br>5. Innovation (11 min.)<br>6. Eco-footprint (11 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Futures Thinking Reflection Global Footprint Assignment | **Population Scenarios**<br>Students discuss and the consequences of different population development scenarios in sub-groups and present their results to the class. |
| **3** | **Poverty**<br>What does it take to meet everyone's basic needs? | **Poverty Content Videos in Blackboard:**<br>1. Values Thinking (3 min.)<br>2. Basic Needs (9 min.)<br>3. Disparity (15 min.)<br>4. Relief Goals (14 min.)<br>5. Financial Inclusion (12 min.)<br>6. Education (14 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Values Thinking Reflection<br>• Kiva Letter Assignment | **Needs vs. wants activity**<br>In groups, the students are asked sort needs and want cards (that show different objects) according to their value. |

| | | | |
|---|---|---|---|
| **4** | **Food**<br>How sustainable is our food system? | **Food Content Videos in Blackboard:**<br>1. Systems Thinking (4 min.)<br>2. Standards (3 min.)<br>3. Feeding the World (14 min.)<br>4. Over- and Malnutrition (14 min.)<br>5. Agricultural Methods (12 min.)<br>6. Beyond Crops (15 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Systems Thinking Reflection | **Hot Dog Activity**<br>https://www.youtube.com/watch?v=FW6MXqzeg7M<br>The whole class discusses the different components and steps needed to produce a hot dog. Then, the class breaks up into sub-groups, each doing the same with the individual components of a hot dog. |
| **5** | **Water**<br>How can we provide water to meet human needs sustainably? | **Water Content Videos in Blackboard:**<br>1. Strategic Thinking (3 min.)<br>2. Next Generation Science Standards (NGSS) (2 min.)<br>3. The Water Cycle (4 min.)<br>4. Water Systems 1 (8 min.)<br>5. Water Systems 2 (8 min.)<br>6. Human Health (10 min.)<br>7. Environmental Health (8 min.)<br>8. Phoenix (7 min.)<br>9. Bali (7 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Strategic Thinking Reflection | **Water Cycle and Human Water Systems Activity**<br>In two different phases, the students are asked to develop a short input on the water cycle, based on their (a) most favorite and (b) least favorite learning style: kinesthetic (makers), visual (graphics), auditory (verbal), storytelling (writing) and musical (song). |
| **6** | **Fossil Fuels**<br>How do fossil fuels affect people? | **Fossil Fuels Content Videos in Blackboard:**<br>1. Introduction (3 min.)<br>2. Oil (7 min.)<br>3. Natural Gas (8 min.)<br>4. Coal (7 min.)<br>5. Social History (9 min.)<br>6. Equity (7 min.)<br>7. Climate Change Background (6 min.)<br>8. Climate Change Science (14 min.)<br>9. Geology (4 min.)<br>10. Technological Solutions (6 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Fracking Reflection<br>• Reducing your Footprint Assignment | **Renew a Bead Activity**<br>http://sse.asu.edu/robin/index.html<br>In pairs, the students draw ten beads from a bag with 90 black (non-renewable) and 10 white beads (renewable). While black beads are "used-up," the white ones go back to the bag. The students record the numbers of black and white beads on a data sheet and repeat drawing 10 beads (1 draw = 1 decade), until they only have white beads in one draw. Finally, the results are shared with the class. |
| **7** | **New Energy**<br>How can new energy be generated to meet human needs sustainably? | **New Energy Content Videos in Blackboard:**<br>1. Introduction (12 min.)<br>2. Wind (14 min.)<br>3. Solar (14 min.)<br>4. Tidal (12 min.)<br>5. Geo-thermal (15 min.)<br>6. Conclusion (12 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Reflection | **Solar Amusement Park**<br>https://qesst.org/wp-content/uploads/2018/05/Solar_Handbook.pdf<br>In groups, the students build their own miniature amusement park rides powered by small solar panels. They use a variety of materials (straws, paper cups, pipe cleaners, etc.) The activity includes the three phases of planning, constructing, and testing. |
| **8** | **Final Project Overview**<br>Technology Session | **Review Final Project Materials in Blackboard:**<br>• In-class time to go over the final project requirements in detail. | |

| | | | |
|---|---|---|---|
| **9** | **Ecosystem Services**<br>How strategic is our management of the biosphere? | **Ecosystem Services Content Videos in Blackboard:**<br>1. Introduction (5 min.)<br>2. Coupled Systems 1 (7 min.)<br>3. Coupled Systems 2 (11 min.)<br>4. Negative Effects 1 (9 min.)<br>5. Negative Effects 2 (5 min.)<br>6. Ecosystem Services (8 min.)<br>7. Trade-offs (10 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Tic Tac Tomework Assignment | **Philosophical Chairs Debate**<br>In randomly composed groups, the students debate about the environmental, social, and economic pros and cons of the mega project "The Dakota Access Pipeline." |
| **10** | **Instructor's Choice Week**<br>Specific research topics of interest related to sustainability and in-class activities. (Varies depending on instructor) | **Tasks and Assignments:**<br>• Final Project Outline | **SSfT 1:** Field trip to Tempe Town Lake<br>**SSfT 2:** Full class discussion<br>**SSfT 3:** Instructor's presentation on energy and sustainability at ASU<br>**SSfT 4:** Schoolyard habitat garden<br>**SSfT 5 & 6:** Extended Sustainability in the news activity + ingredients exercise |
| **11** | **Production**<br>How do systems of production and use affect people and places? | **Production Content Videos in Blackboard:**<br>1. Introduction (4 min.)<br>2. Clay Stove (8 min.)<br>3. Jeans (12 min.)<br>4. iPhone (12 min.)<br>5. Bottled Water (14 min.)<br>6. Conclusion (6 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Fast Fashion Assignment | **Production Cycle and Group Research Activity**<br>In groups, the students research and evaluate the production cycle (extraction, processing, packaging, inspection, distribution, sales outlet, use, energy input, labor input) and the triple bottom line of a product they frequently use/purchase. |
| **12** | **Disposal**<br>How is waste managed, and how does it affect people and places? | **Disposal Content Videos in Blackboard:**<br>1. Introduction (4 min.)<br>2. Landfills (14 min.)<br>3. Jeans (5 min.)<br>4. eWaste (9 min.)<br>5. Plastics (14 min.)<br><br>**Tasks and Assignments:**<br>• Quiz | **Candy Landfill Activity**<br>https://www.youtube.com/watch?v=uP9Tcf0CaV0&feature=related<br>In pairs, the students build a miniature landfill out of various types of candy (fruit roll-ups, Oreos, marshmallows, gummy bears, etc.) Test and evaluate it (did the liner leak? If so, why?) |
| **13** | **Governance**<br>How may we enact policies that improve sustainability problems at different scales? | **Governance Content Videos in Blackboard:**<br>1. Introduction (5 min.)<br>2. School Governance (7 min.)<br>3. Tragedy of the Commons (11 min.)<br>4. Policy: AIDS (15 min.)<br>5. Police: Ozone (15 min.)<br><br>**Tasks and Assignments:**<br>• Quiz<br>• Assignment | **Action Project – Letter Writing**<br>Students are asked to write a letter to a person in power, referring to a specific law or bill related to education and/or sustainability, stating their personal opinion. |
| **14** | **Translation/Peer-Review**<br>From theory to practice: How will you create a sustainable future? | **Translation Content Videos and Peer Review Materials in Blackboard:**<br>1. Infusing Sustainability (4 min.)<br><br>**Tasks and Assignments:**<br>• Discussion Board posting<br>• Final Project Peer Review | **Peer Review**<br>Each student reviews and provides feedback on the final project (status quo) of a fellow student. |

| | | | |
|---|---|---|---|
| **15** | **Change**<br>Why does sustainability matter for teachers? | **Change Content Videos in Blackboard:**<br>1. Introduction (7 min.)<br>2. Change Agents (7 min.)<br>3. Educational Change (20 min.)<br>4. Interdisciplinary Teaching (15 min.)<br>5. Integrating Sustainability (16 min.)<br><br>**Tasks and Assignments:**<br>• Quiz | **Lesson Plan Activity**<br>In groups, the students review existing lesson plans and discuss how to implement sustainability and the WOT in that specific lesson before sharing their thoughts with the entire class. |
| | **Online Wrap-up** | **Wrap-up Videos in Blackboard:**<br>1. Concluding the Course (3 min.)<br>2. Parting Thoughts (3 min.)<br><br>**Tasks and Assignments:**<br>• Final Project | |

Since its launch in 2012, the SSfT described above, has been further refined and developed in various iterations by an interdisciplinary team of scientists, educators, and design experts. With Nobel Laureate Leland H. Hartwell as the Director of the ASU Biodesign Pathfinder Center, and other external stakeholders on board, funding was available to set up a course with high-quality production of digital storytelling videos as well as consistent in-class activities.

### *Participants*

Students and instructors taking part in the research for EFCA's teacher education case study on the ASU side were those who enrolled in SSfT during the fall of 2017 and 2018. Data were collected during the Fall Semester of 2017 (August-November) following a mixed-methods approach to capture a rich picture of the students' learning processes and outcomes. Data collection was approved by the Institutional Review Board.

The fall cohort in 2017 consisted of *122* students—grouped into six sub-cohorts (SSfT-1-6)—of which *104* consented to participate in the research. The 2018 cohort at ASU consisted of *130* students—grouped into five sub-cohorts (SSfT-1-5)—of which *105* consented to participate in the research. This group was also predominantly female (95%) and, on average, a year older than the German students (22 years old). Only 14% of these students had professional experience before entering the SSfT course, and four participants had completed a year of social service. Roughly a third (31.7%) engages in education-related hobbies, and more than 10% of the students claim to engage with sustainability issues in their free time (see Table 11). Here, it is important to note that an explicit item asking for previous work experience and extra-curricular activities was only implemented in the survey for the 2018 cohort.

**Table 11:** SSfT cohorts 2017 & 2018 (ASU)

| | **SSfT 2017** | | **SSfT 2018** | |
|---|---|---|---|---|
| | Percentage | *N* | Percentage | *N* |
| **Number of students** (consented) | 100 (85.2) | 122 (104) | 100 (80.8) | 130 (105) |
| **Gender** | | | | |
| Female | 91.1 | 72 | 95.3 | 61 |
| Male | 8.9 | 7 | 4.7 | 3 |
| (No reply) | (24.0 | (25) | (39.0) | (41) |
| **Age** | | | | |
| 20 years or younger | 27.6 | 21 | 53.1 | 34 |
| 21–25 years | 59.2 | 45 | 39.1 | 25 |
| 26 years or older | 13.2 | 10 | 7.8 | 5 |
| (No reply) | (26.9) | (28) | (39.0) | (41) |
| **Previous work experience** | | | | |
| Started vocational training | | | 0 | 0 |
| Finished professional training | | | 1.6 | 1 |
| Started a different study program | | | 23.4 | 15 |
| Completed a different study program | | | 15.6 | 10 |
| Internship of min. 6 months | | | 7.8 | 5 |
| Other professional activity for min. 6 months | | | 3.1 | 2 |
| Voluntary social year | | | 6.3 | 4 |
| Voluntary ecological year | | | 0 | 0 |
| None of the above | | | 54.7 | 35 |
| (No reply)) | | | (39.0) | (41) |
| **Extra-curricular activities** | | | | |
| Care service/Nursing | | | 10.9 | 7 |
| Education/Courses/Certificates | | | 31.3 | 20 |
| Organization and planning | | | 35.9 | 23 |
| Consulting | | | 3.1 | 2 |
| Sport | | | 43.8 | 28 |
| Sustainability | | | 10.9 | 7 |
| Music/Art/Creative work | | | 51.6 | 33 |
| Health/Yoga/Meditation | | | 46.9 | 30 |
| Gardening | | | 14.1 | 9 |
| IT/Computers | | | 6.3 | 4 |
| None of the above | | | 9.4 | 6 |
| (No reply) | | | (39.0) | (41) |

Table 12 shows that the factors motivating students to become teachers were somewhat similar across the two SSfT cohorts. As with the Leuphana cohort, motivational aspects that can be assigned to student-focused social utility values were most frequently mentioned. Only slightly more than 17%, referred to the societal level. Again, the second major factor was intrinsic career values, which motivated 30.4% of the students in the 2017 cohorts and 24.4% of the 2018 cohort. With more than one in five students, the third considerable impact factor was previous teaching and learning experiences. While the socialization influence impacted almost 10% of students in 2017, only one student of the 2018 cohort was motivated by this factor. Personal utility values, perception of a task, and self-perception were uncommon motivational factors in both cohorts.

**Table 12:** Motivation to become a teacher (ASU)—based on FIT-Choice Scale (Watt und Richardson 2007)

| | **SSfT 2017** | | **SSfT 2018** | |
|---|---|---|---|---|
| | Percentage | *N* | Percentage | *N* |
| | **100** | **92** | **100** | **62** |
| Values | 90.2 | 83 | 96.8 | 60 |
| Intrinsic career values | 30.4 | 28 | 24.2 | 15 |
| Personal utility values | 1.1 | 1 | 1.6 | 1 |
| Social utility values (students) | 62.0 | 57 | 74.2 | 46 |
| Social utility values (society) | 17.4 | 16 | 17.7 | 11 |
| Socialization influence | 8.7 | 8 | 1.6 | 1 |
| Perception of the task | 5.4 | 5 | 1.6 | 1 |
| Perception of the self | 3.3 | 3 | 1.6 | 1 |
| Prior teaching and learning experiences | 21.7 | 20 | 22.6 | 14 |

According to the results of the pre-course survey, the ASU students show slightly less strong pro-environmental attitudes (NEP scale) than their comparison group at Leuphana (see Table 13). Their values for the perceived relevance of ESD (Tomas et al. 2015), on the other hand, resemble the results of the Leuphana cohort. With respect to students' self-efficacy (ESD- and innovation-related) the ASU cohorts again show lower values compared to the Leuphana students (Table 14). This might partly be explained by the fact that for most ASU students, the SSfT course was the first intervention dealing with sustainability and ESD. In contrast, students at Leuphana had already completed a module on sustainability in their first semester, introducing them to the relevant concepts. Here, it should be considered that the first pre-course survey conducted at ASU in 2017 did not include the innovation-related SE scale by Emmrich (2009) and only had the original seven items of the ESD-related SE scale by Tomas et al. (2015), while subsequently this scale was complemented by four items focusing on ESD-related pedagogical skills, as proposed by Bertschy et al. (2013).

**Table 13:** NEP - New Ecological Paradigm (1-5 Likert scale) (ASU)—based on Dunlap et al. (2000)

| | **SSfT 2017** | | | **SSfT 2018** | | |
|---|---|---|---|---|---|---|
| | N | *M* | SD | *N* | *M* | *SD* |
| **Overall NEP scale** | 85 | **3.68** | 0.43 | 59 | **3.68** | 0.40 |
| *Sub-Dimensions* | | | | | | |
| Balance of nature (Items 3, 8[R] & 13) | 89 | **3.78** | 0.59 | 61 | **3.77** | 0.59 |
| Eco-crisis (Items 5,10[R] & 15) | 89 | **4.02** | 0.67 | 62 | **4.03** | 0.68 |
| Anti-Exemptionalism (Items 4[R], 9 & 14[R]) | 87 | **3.45** | 0.51 | 60 | **3.43** | 0.52 |
| Limits to growth (Items 1, 6[*R*] & 11) | 89 | **3.18** | 0.73 | 62 | **3.23** | 0.64 |
| Anti-Anthropocentrism (Items 2[*R*], 7 & 12[*R*]) | 90 | **3.89** | 0.64 | 62 | **3.92** | 0.62 |

[*R*] = reverse-scored items from the scale

**Table 14:** Attitude scales (ASU)

| | **SSfT 2017** | | | **SSfT 2018** | | |
|---|---|---|---|---|---|---|
| | N | *M* | SD | *N* | *M* | *SD* |
| **Perceived relevance of ESD** (1–4 Likert scale) | 87 | **3.49** | 0.42 | 60 | **3.48** | 0.39 |
| **ESD-related self-efficacy** (1–4 Likert scale) | 87 | **2.54** (7 items) | 0.58 | 57 | **2.80** (11 items) | 0.47 |
| **Innovation-related self-efficacy** (1–4 Likert scale) | | | | 61 | **3.00** | 0.40 |

## 3 Case comparison

The two cases of TESD at Leuphana and ASU, represented here by the Education for Sustainable Development (Leuphana) and SSfT (ASU) courses, show several differences and similarities that make a multiple case study of a comparative character highly interesting.

The ESD course at Leuphana can be described as subject-bound, as it is only offered to students enrolled in the BSSS branch of the teacher education program BA in Teaching and Learning. The SSfT course, on the other hand, is mandatory for all K-8 education major students (at undergraduate level). In general, both courses follow the overall concept of a hybrid course structure yet include different teaching and learning formats. The ESD course at Leuphana complements a flipped classroom style lecture with student-led tutorials and project-oriented seminar sessions, where students gain their first practical experience in a professional environment (partner school). The SSfT course at ASU combines elaborate video content, quizzes, and online assignments with in-class activities providing practical examples of how to implement ESD at the school level. Interestingly, despite the different foci in terms of the overall course structure and content, in both modules, the students create their individual ESD-related teaching and learning unit as their key assignment.

As a result of the different time slots for the two interventions in the overall schedule of the respective study programs at Leuphana and ASU, the participants differ concerning age and previous experiences with sustainability and ESD. All students at Leuphana complete modules focused on sustainable development in their very first semester. However, for most ASU students, SSfT is their first encounter with sustainability and related topics and with ESD as an educational concept.

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