

Chapter 11

Education for Sustainable Development as a Challenge for Teacher Education: Implementation at the University of Tübingen

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This chapter focuses on Education for Sustainable Development (ESD) and its implementation in the education of academic high school (Gymnasium) teachers at the University of Tübingen in Germany. First, an overview is provided of ESD's political context and its implementation in Germany's teacher education, particularly in the state of Baden-Württemberg, where Tübingen is located. Then, the results of the analysis of ESD implementation and related concepts in teacher education at the University of Tübingen are presented. This is based on two different methodological approaches: i) an analysis of module manuals and an online survey of teacher education staff representatives; ii) an analysis of an exemplary course (Seminar) at the University of Tübingen, in which students of the school subject Science and Technology (NwT) are brought into contact with ESD, with regard to the conceptual framework and results from surveys of the participants. In sum, the findings indicate that there are still many challenges that arise when implementing ESD in teacher education and that further effort is needed to overcome them. On the institutional level, ESD is still mainly present in the relevant topics of study in the natural sciences, and there, mainly in the bachelor's courses. At the same time, however, there are promising approaches to a broader implementation that need to be strengthened in social sciences, as well as in literary and language subjects. On the individual level, future teachers interested in ESD profit from the approach, but often struggle with putting the theoretical perspectives into practice and therefore need further support. The results of this chapter build a bridge to the chapter „Education for Sustainable Development (ESD) classroom practices: A South African perspective”. Looking at ESD also widens the scope of the book, since it is a cross-cutting theme beyond the canon of ‘classical’ school disciplines.

<http://dx.doi.org/10.15496/publikation-76379>



1 Introduction

In 1987, the United Nation's World Commission on Environment and Development (WCED) coined the term “Sustainable Development” as a “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of ‘needs’, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs” (WCED, 1987, 41). To date, Sustainable Development has become increasingly important due to the worsening of environmental issues, like biodiversity loss and the climate crisis (IPBES, 2019, IPCC 2019), as well as socio-economic issues like poverty, malnutrition, and global ill health. In September 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development, “a plan of action for people, planet and prosperity“ (UN, 2015, p. 3). The Sustainable Development Goals (SDGs) are at the core of the 2030 Agenda. SDGs describe the global challenges and, in 169 sub-goals, propose tangible steps towards Sustainable Development for the entire world. Their aim is “to secure a sustainable, peaceful, prosperous and equitable life on earth for everyone now and in the future” (UNESCO, 2017, p. 6).

Due to the importance of the problems at stake and the political significance of the SDGs in international, national, and regional governance, Sustainable Development has also become a major issue for education on every level. In this chapter, the focus lies on Education for Sustainable Development (ESD), which is a challenge for teacher education, more specifically for the education of high school teachers at a particular German university. First overviews are provided of the political and governance framework internationally, in Germany, and in Baden-Württemberg (section 2). Regarding the implementation at the University of Tübingen, results are presented of an analysis of module manuals (“Modulhandbücher”) and of an online survey of teacher education staff representatives regarding the implementation of ESD (section 3). This is complemented by a case study of ESD implementation in a specific curriculum for the school topic “Science and Technology” (“Naturwissenschaft und Technik”, NwT; chapter 4). Conclusions on the current state of ESD implementation for high school teachers at the University of Tübingen and further challenges are drawn in the final chapter (5).

2 Education for Sustainable Development (ESD) in teacher education

2.1 Sustainable Development (Goals) and ESD

Since the late 1980s, education has played a crucial role in the international discussion about Sustainable Development, as shown by *Agenda 21* (1992), the *UN-Decade for ESD* (2005–2014), the *Global Action Program on ESD* (2015–2019), the *SDGs* (2015) and the new framework *ESD for 2030* (2020–2030)¹. Goal 4 of the SDGs promotes inclusive and equitable quality education for all. Thus, the SDGs are of special importance and interest for ESD and its implementation. Moreover, the SDGs stress the idea that ESD is an essential component of quality education (UNESCO, 2017). It must be ensured that by 2030, “all learners acquire the knowledge and skills needed to promote Sustainable Development, including, among others, through education for sustainable development”, as demanded in SDG 4.7 (UN 2015). ESD is an approach that encourages and promotes knowledge, skills, values, and attitudes that enable people to direct sustainable development (Leicht, Heiss & Byun, 2018; Rieckmann, 2019). But regardless of the direct link between ESD and the concept of Sustainable Development, the educational approach is not instrumental, but transformative, emancipatory, and competence-based (Rieckmann, 2018).

2.2 ESD and teacher education

In the international context (Leicht, Heiss & Byun, 2018) as well as in Germany (National Platform on Education for Sustainable Development, 2019), it is emphasized that ESD encompasses formal, non-formal and informal education. The implementation of ESD in schools is a major challenge and goal (UNESCO, 2014; National Platform on Education for Sustainable Development, 2019; KMK, DUK, 2007; Siege, Schreiber, 2016). Germany's National Action Plan on Education for Sustainable Development reads: “When it comes to successfully establishing Education for Sustainable Development (ESD) in the education system, school education is particularly important because of its formative influence on individual educational biographies” (National Platform on Education for Sustainable Development, 2019, p. 23). Teacher education is a prerequisite for achieving this goal and, accordingly, is demanded by UNESCO as the lead UN agency for ESD. This also holds for the national member states of the UN and signatories of the Agenda 2030, and

¹ The new framework „ESD for 2030“ was officially launched in May 2021. It was postponed due to the COVID-19 pandemic, the “Roadmap” being issued in Fall 2020 (UNESCO, 2020).

therefore also for Germany (UNESCO, 2014, p. 20; National Platform on Education for Sustainable Development, 2019; Qablan, 2018). In both the Global Action Program on ESD (2015–2019) and the global framework on ESD for 2030 (2020–2030), it is one of the five priority areas. The promotion of teachers' competencies for ESD involves two dimensions (Rieckmann, Holz, 2017, p. 6): teachers need to acquire sustainability competencies, and, moreover, specific teacher competencies for ESD that enable them to deal with issues of sustainable development in class, in a way that is appropriate in terms of content and didactics (Program Transfer-21, 2007, p. 9).² This entails, for example, the ability of teachers to help learners explore alternative possibilities for the future, or to help them act in situations of uncertainty (Scherak & Rieckmann, 2020).

2.3 Framework and state of implementation in Germany with a focus on Baden-Württemberg

The first phase of teacher training in Germany takes place at universities and colleges of education (Pädagogische Hochschulen; in some states, there is no more separation, but not in Baden-Württemberg). Thus, the topic “ESD in teacher education” is linked to the general discussion on ESD in higher education institutions (Bellina, Tegeler, Müller-Christ & Potthast, 2018; Rieckmann & Bormann, 2020). The German Rector's Conference has committed itself to the principle of Sustainable Development (HRK & DUK, 2009; HRK, 2018).

The following list provides an overview of important (educational) policy documents on ESD in Germany's teacher education:

- ▶ 2007: the KMK (Standing Conference of the Ministers of Education and Culture) and the DUK (German Commission for UNESCO) jointly published a recommendation on “Education for Sustainable Development at School”. The document addresses institutions for the training and continuing education of teachers. According to this recommendation, teachers should, during their initial training, acquire skills for covering Sustainable Development at school (KMK & DUK, 2007);
- ▶ 2007 and 2016: the KMK and the BMZ (German Federal Ministry of Economic Cooperation and Development) published the “Curriculum Framework Education for Sustainable Development”. The 2nd edition gives detailed information on

² For an overview of different concepts of sustainability competencies and concepts of competencies for ESD educators see Rieckmann (2018).

ESD in teacher education (requirements of ESD, steps of integration, examples). In the first phase, ESD needs to be integrated on the levels of subject systems (“Fachsystematiken”), subject-related didactics (“Fachdidaktiken”), and the educational science parts (“bildungswissenschaftliche Anteile”) of the study program (Overwien, 2016);

- ▶ 2008: the KMK published content-related requirements for subject systems and subject-related didactics in teacher education. Sustainable Development and/or ESD is explicitly reflected in the following subjects: Household and Nutrition; Technology; Textile; Economy; Biology, Chemistry; Geography (KMK, 2008);
- ▶ 2017: the National Action Plan on ESD is published by the BMBF (Federal Ministry of Education and Research). In this document, teacher and educational assistant training is described as a central action area for the integration of ESD at school. It states that “the Länder and teacher training institutions are committed to establishing ESD in initial and further training for teachers and will implement this on a Länder-specific basis according to their capabilities” (National Platform on Education for Sustainable Development, 2019, p. 30).

Baden-Württemberg is one of the 16 states that make up the Federal Republic of Germany, and the points listed above show important activities on the German federal level. Notwithstanding, it needs to be noted that school policy is, ultimately, a legislative and governance matter for the respective states. This leads to a somewhat heterogeneous landscape of school and teacher education in Germany. Since the University of Tübingen is located in Baden-Württemberg, the teacher training that takes place there relates directly to the requirements of the curricula relevant for this state. Hence the following steps and documents are important:

- ▶ 2007: Baden-Württemberg's sustainability strategy started in 2007. ESD has been anchored there as one central element. More specifically, the strategy states that ESD should be integrated in formal, non-formal and informal education. An integrated cross-departmental ESD strategy is currently being developed (UM BW, 2020).
- ▶ 2012: the university network on ESD in Baden-Württemberg (BNE-Hochschulnetzwerk)³ was established in 2012. This network strengthens both the anchoring of ESD in the university context (focus: teacher training) and the networking of actors in ESD.

³ <http://www.bne-hochschulnetzwerk.de>

- ▶ 2015: according to the legal framework for teacher education programs (“Rahmenvorgabenverordnung Lehramtsstudiengänge”) in Baden-Württemberg, ESD should be systematically implemented with the introduction of the new study programs for teachers (Bachelor and Master). The framework describes ESD as a cross-sectional competence of overriding importance, which therefore should be incorporated into the educational science part of all teacher education programs, as well as into the practical studies and the subject-related sciences and didactics.
- ▶ 2016: Baden-Württemberg's new formal curriculum was introduced, with six cross-curricular guiding perspectives. According to the curriculum, these guiding perspectives, including ESD, must be integrated into each school subject (see section 4 for an exemplary implementation).
- ▶ The principles of the so-called Beutelsbach Consensus explicitly apply to the new curriculum (Pant, 2016). Originally developed in the context of political education during the Cold War, the “Beutelsbach Consensus” declares the prohibition of indoctrinating school students with political and world views (“Überwältigungsverbot”), the imperative to present controversial standpoints, and the consideration of student interests. This underlines both the understanding and the task of ESD as a non-instrumental approach (see above and Pott-hast, 2019).

Regarding the integration of ESD in Baden-Württemberg's teacher education, the following should be noted: in 2014, before the new legal framework for teacher education programs and the new curriculum came into force, a study on the integration of ESD in Baden-Württemberg's teacher education was conducted. It turned out that in 2014, there was hardly any evidence of a structural anchoring of ESD in the study regulations (Mrazek & Siegmund, 2016). Three years later, in 2017, at half-time of the Global Action Program on ESD (2015–2019), the Conference of the Ministers of Education (Kultusministerkonferenz, KMK)⁴ published a report on the situation and perspectives of ESD in Germany. It was based on information provided by the federal states themselves. For Baden-Württemberg, it was reported that a comprehensive integration of ESD in teacher education for all subjects is ensured via the framework regulations (KMK, 2017, p. 53).

⁴ „The Standing Conference of the Ministers of Education and Cultural Affairs” is the oldest conference of ministers in Germany and plays a significant role as an instrument for the coordination and development of education in the country. It is a consortium of ministers responsible for education and schooling, institutes of higher education and research and cultural affairs, and in this capacity formulates the joint interests and objectives of all 16 federal states; <https://www.kmk.org/kmk/information-in-english.html>.

However, the academic monitoring of the Global Action Program shows that this is not entirely successful, although in Baden-Württemberg, the integration of ESD into teacher education seems to be more effective than in other federal states (Brock, 2018; Holst & Brock, 2020; Holst et al., 2020). Within the scope of the monitoring study, examination regulations and course handbooks from 15 higher education institutions in five federal states (Baden-Württemberg, Berlin, Lower Saxony, North Rhine-Westphalia, Saxony) were analyzed.⁵ The monitoring reveals a high discrepancy between the “structural implementation of ESD in curricula and its integration into teacher training. While no or very few references to ESD and related concepts were found within the documents from Lower Saxony, North Rhine-Westphalia, and Saxony, some subject-specific matches were found for Berlin and Baden-Wuerttemberg” (Holst et al., 2020, p. 8).

3 Empirical findings on ESD in teacher education at the University of Tübingen

To gain an overview of ESD implementation in teacher education at the University of Tübingen, two empirical surveys with different methodical approaches were conducted: a qualitative analysis of the module manuals for teacher education and an online survey of teaching staff within the University of Tübingen. The first approach shows the extent to which ESD is anchored in the various degree programs of teacher education. The second supplements this with an actor-related perspective and provides insights into the practical implementation of the curricular requirements. The combination of methodological approaches was chosen to get a multifaceted first picture. It should be noted that due to resource limitations, the studies are more exploratory than encompassing. Nevertheless, they allow for important insights.

3.1 Analysis of module manuals

The approach of the document analysis is based on classical procedures of educational monitoring. It was a central element in the German Monitoring of the Global Action Program on ESD (Brock, 2018; Holst et al., 2020). In accordance with this national approach, a total of 50 module manuals of the teacher education program at the University of Tübingen were analyzed. The study encompasses all 24 degree pro-

⁵ The three universities with the largest number of teaching graduates in Baden-Württemberg: PH Freiburg, PH Heidelberg, PH Ludwigsburg.

grams that can be studied as a first or second major for the Bachelor and Master of Education.⁶ In addition, the Educational Science Studies (“Bildungswissenschaftliches Studium”), which are compulsory for all teacher training students, were taken into consideration (Bachelor and Master). The analysis of module manuals consisted of four steps: 1. lexical content analysis, 2. differentiated analysis of the general qualification goals of all degree programs, 3. differentiated analysis of all course modules (without didactics) and 4. analyses of all the didactic modules. These steps are described below.

In the first step, a lexical content analysis of relevant terms was performed using MAXQDA. The keywords were selected in accordance with the methodological approach of the Global Action Program's monitoring on ESD. These are (translated from German):

- ▶ Education for Sustainable Development, ESD, shaping competency (“Gestaltungskompetenz”)
- ▶ Sustainable Development, Sustainability, Sustainable, Sustain (in German and English)
- ▶ Environmental Education/Pedagogy, Nature Education/Pedagogy, Ecological Education, Global Learning, Learning in Global Contexts, Global Development, Development Policy Education, Intercultural Education/Learning.

The lexical content analysis shows 25 matches relevant to the normative concept of SD in 10 (of 50) study degree programs. Without differentiating between the bachelor's and master's, these matches are found in Science and Technology (10), Geography (4), Chemistry (3), Economics (3), Educational Science Studies (3) and Biology (2). The results are shown in table 1.

Alternative suffixes were included in the analysis. The table contains only subjects and keywords with matches. In cases where the terms are used in other connotations (e.g., “sustainable” in the sense of long-lasting) the matches are shown in brackets.

⁶ Biology, Catholic Theology, Chemistry, Chinese, Computer Science, Economics, English, French, Geography, German, Greek, History, Islamic Religious Education, Italian, Latin, Mathematics, Philosophy/Ethics, Physical Education, Physics, Political Science, Protestant Theology, Russian, Science and Technology, Spanish.

		Sustainable	Sustainability	Education for Sustainable Development	Sustainable Development	Total
Biology	B.Ed.		1			1
	M.Ed.		1			1
Chemistry	B.Ed.		2			2
	M.Ed.		1			1
Economics	B.Ed.		3			3
Educational Science Studies	B.Ed.		1			1
	M.Ed.			2		2
Geography	B.Ed.	1		2		3
	M.Ed.			1		1
Political Science	M.Ed.	(1)				(1)
Science and Technology	B.Ed.		7		3	10
	M.Ed.	(1)				(1)
Total		1 (+2)	16	5	3	25 (+2)

Table 1 Results of the lexical analysis

These findings indicate three systematic insights. Firstly, Sustainable Development and ESD are only anchored in a minority of degree programs (10 of 50). Secondly, this mainly concerns degree programs that are closely related to Sustainable Development (i.e., Biology and Geography). Thirdly, it is noticeable that the concept of ESD appears increasingly, or in some cases even exclusively, in the bachelor's degree programs.

In the second step, a differentiated analysis was carried out regarding the sections in the module manuals where the general qualification goals (competencies and learning outcomes) of the respective degree programs are established. In addition to the lexical analysis, it was also examined whether the normative concept of SD is implicitly reflected in the qualification goals. This analysis shows matches of explicit / implicit SD use or the integration of key aspects in 18 (of 50) study programs. The results are shown in table 2.

Explicit use of the terms Sustainability / Sustainable Development / ESD (Total: 5)	Biology (B.Ed., M.Ed.)	
	Chemistry (B.Ed., M.Ed.)	
	Educational Science Studies (M.Ed.)	
Implicit use of the concept of Sustainable Development (Total: 2)	Geography (B.Ed., M.Ed.)	human-environment interactions; linking of ecological, economic, and social perspectives
Key aspects of Sustainable Development are included (Total: 11)	Computer Science (B.Ed., M.Ed.)	reflection on social impacts in the context of information technology
	Economics (B.Ed. / M.Ed.)	business ethics questions in economic education
	Educational Science Studies (B.Ed.)	social change processes and their relation to the teaching profession
	History (B.Ed., M.Ed.)	transformation processes in history
	Philosophy / Ethics (B.Ed., M.Ed.)	the ethical dimension of life-world topics / social issues
	Physics (M.Ed.)	the evaluation of social issues from a physical perspective
	Science and Technology (M.Ed.)	integration of perspectives from nature, society, natural sciences, and technology
	All language study programs and the theological subjects	interculturality, heterogeneity, diversity

Table 2 SD/ESD in the general qualification goals

These results show that it is worth going beyond the lexical content analyses. Sustainability, Sustainable Development and/or ESD are mentioned explicitly in the qualification goals of 5 study programs and implicitly in 2 other programs. But by broadening one's perspective, one can see that, on the level of the qualification goals' key aspects, Sustainability can be found in an additional 11 degree programs. Compared to the previous lexical content analysis (table 1, matches in 10 of 50 programs), this analysis of qualification goals shows ESD topics and connecting points in a total of 18 degree programs, including Philosophy / Ethics, Computer Science, and History.

In the third step, the implementation of Sustainable Development in the modules

(without didactics) was examined. As Table 3 shows, different groups could also be distinguished here.

Sustainability / Sustainable Development / ESD in module titles	Science and Technology (B.Ed.)	Energy, Environment and Sustainability
Sustainability / Sustainable Development / ESD in module descriptions	Geography (B.Ed.)	Regional Geography of Germany / Southern Germany
	Economics (B.Ed.)	Introduction to Business Administration Ethical principles
	Chemistry (B.Ed.)	General and Inorganic Chemistry for student teachers 1
	Educational Science Studies (B.Ed.)	Educational Science Studies 1
	Educational Science Studies (M.Ed.)	In-depth module
Highly relevant modules (without using the term explicitly)	Biology (B.Ed.)	Ecology and Biodiversity 1
	Biology (M.Ed.)	Ecology and Biodiversity 2
	Geography (B.Ed.)	Geo-ecology Climate and hydrogeography
	Geography (M.Ed.)	People and environment

Table 3 SD/ESD in the modules (without didactics)

A total of 12 sustainability modules in 10 different study programs (out of 50) were found. In addition, 31 modules in 15 study programs were identified that, in principle, offer immediate opportunities to integrate the perspective of sustainability. These 31 modules are listed in table 4.⁷

Module	Link to sustainability topic
Catholic Theology (B.Ed.)	Responsibility in Culture and Society
Catholic Theology (M.Ed.)	Systematic Theology and Theological Ethics
Chinese (B.Ed.)	Extension Module Sinology / Chinese Studies
Economic Sciences (B.Ed.)	Economic Education Political Science

⁷ It should be noted that ESD elements can also be integrated in subjects not listed here, and allegedly unrelated to SD; for example, in mathematics, the importance of understanding how to deal with statistics regarding climate change. See also for further potential in (E)SD below.

English (B.Ed.)	Basic Module Cultural Studies Literary and Cultural Studies Advanced Module Literary Studies
English (M.Ed.)	Literary and Cultural Studies
Geography (B.Ed.)	Economic Geography Basics of Human Geography Population and Social Geography
History (B.Ed.)	Deepening and Specialization: History of the Modern Era
Islamic Theology (B.Ed.)	Islamic Religious Education I Theoretical Approaches to Religion Islam and Society Islamic Religious Education II
Islamic Theology (M.Ed.)	Religion and Society Theoretical Approaches to Religion
Philosophy (B.Ed.)	Basic Module Practical Philosophy Basic Module Interdisciplinary Issues Advanced Module Practical Philosophy Advanced Module Interdisciplinary Issues
Philosophy (M.Ed.)	Advanced Module Interdisciplinary Issues Advanced Module Practical Philosophy
Politics (B.Ed.)	Policy Fields Political Theory International Relations
Politics (M.Ed.)	European Politics and International Relations Peace and Conflict Studies
Sports (M.Ed.)	Interdisciplinary Contexts

Table 4 Modules with links to sustainability topics

In the last step of the manual analyses, the didactic modules of all subjects were screened. Here, references to Sustainable Development were only found in geography, where ESD is explicitly addressed in both the master's and bachelor's programs. In addition, ESD plays an important role in "Science and Technology" (Course: Understanding and Teaching Sustainable Development). However, this course is not located in didactics. This shows that the topics of sustainable development and ESD have so far been given little consideration in the didactic training of teaching students.

3.2 Online survey of teacher training staff representatives

The online questionnaire was accessible to the invited respondents for a total of three weeks (from 20th August until 14th September 2020) on the Sosci-Survey platform. The interviewees were contact persons for the individual teacher education courses in different subjects at the University of Tübingen. A total of 21 data sets were collected, 16 of which could be used for evaluation. For the bachelor's and master's programs, 10 questions each were collected, 5 of them open and 5 closed questions. The closed questions also included a ranking question on the topic of students' interests in SD.

To summarize the results, we can distinguish three categories of ESD integration in the teaching subjects, namely established ESD, potential for ESD, and negated ESD.

1. **Established ESD:** there are subjects that already offer modules and courses on ESD. It can be clearly seen that ESD is still understood with a strong reference to environmental topics, which is why integration in subjects such as biology and Science and Technology (NwT) is pronounced. Consequently, sustainability issues such as the adequate handling of natural resources and biodiversity show the importance of ESD. This is also evident in sports, where a strong connection is made with questions of sport and nature, and with other topics, such as nutrition and the sustainability of big sport events or sportswear (e.g., environmental impact of different sports, production conditions for workers in the sports industry). At the same time, there are also ESD modules in the study programs of Islamic Theology and Economics. There, the view is widened, going beyond environmental references to topics like maturity and sustainable management.
2. **Potential ESD:** the second category consists of subjects that have no explicit ESD offerings, but where this topic could, in principle, have been included. Many teacher-training courses in language and literary studies (French, Italian, Spanish, English, German) do not currently offer ESD, but many of the participants in the survey do see opportunities and points of contact. Several references have been made to the possibility of dealing with the literature of so-called ecocriticism (humanity's place in nature, environmental issues etc.) and the reinterpretation of classical literature regarding current questions of Sustainable Development.
3. **Negated ESD:** some teacher education program representatives firmly reject the need to integrate perspectives on ESD and see no need for this topic. For example, it is argued that astronomy is a subject that deals with the cosmos, not the earth.

It should also be mentioned that in the given responses, there are no significant differences within the subjects between bachelor's and master's programs. The answers from the participants responsible for both types of courses are mostly identical. Another remarkable point is the students' interest in ESD issues, as perceived by the survey participants. This was rated as very high in both category 1 and category 2 answers. Only the answers from category 3 gave few or no points or left the question unanswered. The possible consequences for curriculum design, however, have not been dealt with in the answers.

4 Example of implementation at the University of Tübingen

In this section, an exemplary course (“Seminar”) that introduces elements of ESD into teacher education will be presented. In the context of this seminar, questionnaires were distributed among the students over two semesters. The results of these questionnaires suggest that the students have difficulties in transferring the theoretical perspectives of ESD into the practical implementation of teaching.

Science and Technology (NwT = **N**atur**w**issenschaft und **T**echnik) is a school subject which, besides the federal state of Saxony, is only taught in this form in Baden-Württemberg and was first implemented in 2007. The subject is designed for higher grades (mainly grades 7–10) and is therefore taught in secondary schools. The special conception of the subject comes with the idea of a connected thinking and of observing issues in an interrelated way. This means that the subject follows the idea of interdisciplinarity and therefore does not replace the linked subjects, e.g., biology, chemistry, and geography. The aim of NwT is to connect the knowledge the students have acquired in the natural sciences and to focus more on practical technological aspects and the everyday reality of the students (MKJS, 2015).

The NwT courses are oriented to different so-called central guiding perspectives (“Leitperspektiven”), which were introduced with the renewal of the school curricula. One of these principles is Education for Sustainable Development. By focusing on the needs and resources of current and future generations, it follows the Brundtland-Report understanding (WCED, 1987). Concerning the NwT curricula, the general idea is to transmit the relations of nature, technology, and society (MKJS, 2015, p. 4). Consequently, the structure of the teaching subject also determines the basic pillars (interdisciplinarity and practical orientation) of the NwT course. And because of the importance of ESD in the subject, seminars on this topic are also needed in the training of teachers for the teaching of NwT. This is where a seminar conducted by the

authors of this text is situated. “Nachhaltige Entwicklung verstehen, gestalten und unterrichten” (Understanding, Shaping and Teaching Sustainable Development) is a course within the Bachelor of Education for NwT. It was first developed within the University of Tübingen’s Competence Center for Sustainable Development. In a second step, it was connected to approaches and topics of the transdisciplinary research project “Energy Laboratory Tübingen” (see Albiez et al., 2018) and further adopted throughout the years in accordance with the students’ feedback. It was the topic of sustainable energy systems (see also SDG 7 “Affordable and clean energy”) that enabled the perspective of ESD to be integrated in the NwT module. The teaching staff was initially a co-teaching team from physics and pedagogy, later also in combinations of one person from natural science and another from social/ educational science.

The course is composed of two parts. In the first half of sessions (each unit 90 minutes), the participants get to know the theoretical background not only of ESD, but also of ESD teaching methods, the idea of transdisciplinarity, and the creation of a draft lesson plan (“Unterrichtsentwurf”). The view becomes more and more focused, so that from a very broad input on SD, the participants get to know several knowledge components and didactic tools, allowing them to shape their own teaching. They do so by preparing a lesson unit(s) plan on a course topic of their own choice, also selecting the student’s level (years 7–10). This draft is presented to the other participants at the beginning of each session in the second part of the course. The presenting group has time to practise a certain part of their lesson idea with the other participants, who simulate a school class. Afterwards, the presentation group receives feedback on their conceptual draft, their presentation of it, and their simulation of a lesson from the other participants as well as from the lecturers. The feedback focuses on certain criteria, such as: does the draft fit the target group (e.g., is it adapted to the grade level)? How are the relations to (E)SD presented? Is the planned draft feasible on a practical level, e.g., in terms of time and materials?

In two courses (winter terms 2018/19 and 2019/20), the participants (each term 21 students = 42 in sum) were asked to fill out an additional feedback form on a voluntary basis. Besides the generic and more formal evaluation sheets for courses by the university itself, the former focused on questions concerning the general conception of the course. The students had the possibility of answering the following open questions:

- ▶ What did you like about the seminar? What did you take home?
- ▶ What did you not like about the seminar? What was missing?
- ▶ What suggestions for improvement do you have for the seminar and the lecturers?

In the winter term 2018/19, we received 8 questionnaires, and 15 in the winter term 2019/20 (n=23). As they were open questions, the responses are, of course, quite diverse. However, there are some common threads in the questionnaires. The participants had positive views on the course in general and especially on the opportunity to create their own draft lesson plan, which is quite rare throughout their studies. They saw it as a chance to try something new. Several participants profited from and appreciated the setting (“*particularly good: working out lesson plans with feedback → first (and probably only) time in the degree course where you really get an insight into practical teacher work*”; “*we were allowed to experience, plan, and also carry out a teaching unit independently. This develops ideas/new perspectives for later careers*”)⁸ and the open discussions (“*Many discussions → have been thought-provoking*”). Others saw them as distracting and sought for more natural science input (“*Most of us are not versed in philosophical and ethical theory. It would have made more sense (would have taken me further) if the conclusions about sustainability had been drawn more from scientific methods and facts and less from ethical theory*”).⁹ Furthermore, most of the participants had the impression that the theoretical part did not directly prepare them for creating the lesson plan. This impression was shared by the lecturers: although the lesson plans were quite well prepared, hardly one of them was based on the theoretical input on ESD provided in the first part of the course. Especially when it comes to more nuanced aspects of SD, the presentation groups often neglected to integrate them. Yet this rather sobering impression should be viewed in its context: students of NwT are already located in a demanding interdisciplinary setting, between science and technology and its practical implementation. To successfully integrate ESD into this study context in and by just one course is an ambitious aim, both for students and for teachers not familiar with SD and ESD. At the same time, it is the opening of broader reflective perspectives by both SD and ESD that enables us to take another step towards SDG 4.

5 Conclusions

Although high on the political and educational agendas, and well-equipped with elaborate theories as well as practical suggestions (sections 1 and 2), the implementation of ESD is still a desideratum in large swathes of teacher education. This holds for

⁸ All translations from the student quotes in German by the authors.

⁹ The issue of inferring ethical or political consequences mainly from alleged ‘scientific’ facts, is a critical one for science education and indicates a lack of proper epistemological and ethical training.

Germany and, more specifically, for the state of Baden-Württemberg and the University of Tübingen¹⁰. This finding also matches the situation in South Africa, as described in the chapter by Mandikonza and Kawai (2022; this volume).

As our analysis of module handbooks and the online survey show, ESD is still mainly located—and thriving—in ‘classical’ subjects like geography and biology, where the relation to environmental education is direct and established (section 3). The analysis of the module handbooks revealed the inclusion of sustainability and/or ESD in about one fifth of the study programs. At the same time, promising potentials are visible in science and technology subjects, social sciences, and in literary and language subjects. Fostering these and implementing them more fully in the respective curricula shall be the next steps.

As the case example of a Science and Technology course showed, integrating ESD by means of just one course appears too high an expectation for both students and teachers (section 4). Explicit integration of ESD in more courses needs to be set in practice, which is in accord with the overall strategies for implementing ESD as a cross-cutting perspective (rather than only by one topical course). A first step may be emphasizing the links between ESD and environmental education, as Mandikonza and Kawai (2022; this volume) suggest. However, we strongly argue for not restricting Sustainable Development to environmental questions (cf. Albiez et al., 2018; Bellina et al., 2020).

Although, for reasons of limited resources, we could not investigate the didactics of ESD, we want to stress that ESD didactics training of students as well as university teachers is generally an issue and deserves special attention. In didactics of teacher education in general, ESD plays a rather subordinate role. ESD requires teaching students to reflect on the normative concept of Sustainable Development, to acquire solid knowledge on sustainability issues in their own subject, and to develop pedagogical competencies for implementing this transformative, emancipatory, and competency-based educational approach (Bellina et al. 2020). Again, the challenge of normativity is also noted in the South African context (Mandikonza & Kawai, 2022; this volume), and the following question remains open: how exactly can and should normativity be dealt with, especially by students not acquainted with academic philosophical or ethical reasoning?

In general, the challenge remains to teach ESD by integrating environmental and technical, as well as social and cultural perspectives. It calls for an attempt to integrate ESD in several—ideally all—courses throughout the curriculum. This also follows

¹⁰ It may be noted that the situation in Tübingen, compared to other universities in this state, is rather advanced, despite being beyond 50% implementation in the modules investigated.

the folk wisdom that repetition—or to be exact, variation of the same motif—shall bring about success in education. In addition, explicit integration of ESD into the didactics courses is desired. Advanced peer-to-peer and cross-disciplinary ESD training for teaching staff are therefore required to ensure successful and broad implementation.

Acknowledgements

We would like to thank the (anonymous) reviewers for their constructive and helpful remarks. Our gratitude goes to our colleagues from the Physics Department: Peter Grabmayr, for actively bringing ESD into the NwT curriculum and participating in the first courses, and Johannes Bleibel for his ongoing support. Marius Albiez and Andri König from the International Center for Ethics in the Sciences and Humanities (IZEW) have been co-teaching three runs. Last but by far not least, Jasmin Goldhausen and Luisa Böhm provided support in the survey activities, which proved to be extremely valuable.

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