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Education for Sustainable Development in Swiss Vocational Education and Training: A Curricular Analysis

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Structured Abstract

Background: The increasing ecological, economic, and social challenges have amplified the demand for Education for Sustainable Development (ESD). A significant challenge in the field of ESD is the absence of universally understood definitions for key terms such as sustainability, sustainable development (SD), and ESD itself. In the Swiss context, SD competences are not uniformly integrated into vocational education and training (VET) curricula. The lack of comprehensive studies on this integration indicates a need for further research. This study aims to systematically analyze and identify SD competences, dimensions and topics integration in six selected Swiss VET curricula.
Methods: Educational curricula for six VET programs focusing on multi-faceted occupations (Building Services Technician, Electronics Technician, Geomaticist, Physics Laboratory Technician, Road Builder, Chemistry and Pharmaceutical Process Technologist) were systematically analyzed for ESD dimensions, topics and competences through a structured qualitative content analysis. The curriculum analyses followed a pre-structured deductive content-analytical design. Based on Switzerland-oriented SD competences and general SD dimensions and topics, 23 codes were defined and qualitatively coded by three independent coders in a high inferential analysis procedure.
Findings: The analysis shows a diverse integration of SD competences, dimensions, and topics, with great variation in how each profession emphasizes these elements. Competences such as "Responsibility", "Systems", and "Act" stand out as most frequently identified across all professions. ESD topics are mainly grouped under environmental and societal dimensions, with "Climate and energy", "Health and well-being", and "Economic efficiency and value creation" being the most frequent topics across all occupations.
Conclusions: The study's findings indicate that while SD competences, dimensions and topics do appear in all analysed basic VET curricula, they are not labeled as such and are highly heterogeneous in terms of distribution and occurrence. Besides time to teach for an ESD, this makes it difficult for teachers to identify and integrate ESD and thus presenting a significant obstacle for the integration of ESD into basic VET. ESD may not be seen an add-on, it needs proper integration with existing content. The findings have been translated into profession-specific guidelines for VET teachers, school administrations, and professional organizations. These are intended to support VET teachers with concrete examples for their own teaching. Expanding the analysis to more basic VET curricula and examining ESD integration across different learning locations, including companies and inter-company courses, could provide a more comprehensive understanding of ESD's role in Swiss VET.
Keywords: *Education for Sustainable Development (ESD), ESD competences, ESD dimensions, ESD implementation, Vocational Education and Training (VET), curricula analysis, Switzerland*

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1 Introduction

Amid the growing urgency of ecological, social, and economic challenges, such as climate change, migration, pandemics, and economic inequalities, the holistic approach of Sustainable Development has gained increasing recognition and importance. In 1987, the World Commission on Environment and Development (WCED) tried to broadly define sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p.41). There have been numerous social and political efforts around the globe to address these multidimensional challenges mentioned above. Particularly, climate change has been on the plate since the 1980s. This perception has simmered constantly and by today has finally led to a global mobilization to express concern for the planet's future and highlights the demand for effective political action against climate change. Furthermore, social trends such as Neo-Ecology underline that values across our society are changing. Sustainability awareness and environmental consciousness impact individual lifestyles and porduct choices. This societal shift in values and awareness has thus also become a significant economic factor (Zukunftsinstitut, 2023) and attracts a lot of attention in industry, trade, and politics. In response to this drive, global political initiatives have been undertaken to promote Sustainable Development and an education for Sustainable Development, for example the UN Decade of Education for Sustainable Development (2005 - 2014) or the UN 2030 Agenda with its 17 Sustainable Development Goals (SDGs). Education is seen a way to address such challanges by empowering individuals to be critical and reflective on their behavior and values in terms of Sustainable Development (Riekmann, 2016).

The importance of Sustainable Development and education for Sustainable Development (ESD) has also been recognized by Switzerland. The Swiss 2030 Sustainable Development Strategy calls ESD an educational concept that should be applied across all subjects and the entire company/school (Schweizerischer Bundesrat, 2016, i.e. Federal Government). The Curriculum21 (Lehrplan21), the curriculum for compulsory school – used in the 21 German speaking federal states called cantons – has promoted ESD to a compulsory transversal learning cluster called ESD (D-EDK, 2016a). After completing compulsory school, approximately two-thirds of young people transition to vocational education and training (VET), highlighting its importance within the Swiss education system (Maurer et al., 2017). In Swiss VET, the State Secretariat for Education, Research, and Innovation (SERI) has declared ESD as an important topic (SERI, 2020) and added sustainability to the law of Vocational Education and Training (VPET Act, 2024). While ESD is firmly embedded in the Curriculum21 of the Swiss compulsory school, its integration into VET curricula is merely recommended by the SERI (2020). Even though there is a close relationship to the economic sector, which itself is significantly affected by sustainability challenges. The effective inclusion of SD or ESD in VET curricula is not a governmental obligation, but strongly recommended in the process of revising curricula. To date, it is still to be defined to what extent professional organizations have included ESD in the curricula and how much importance is assigned to ESD/ SD in their professional field.

In this study we analyse the importance of SD in VET curricula. We present comprehensive analyses of six basic VET curricula (Building Services Technician "Gebäudetechnikplaner/in Heizung EFZ", Electronics Technician "Elektroniker/in EFZ", Geomaticist "Geomatiker/in EFZ", Physics Laboratory Technician "Physiklaborant/in EFZ", Road Builder "Strassenbauer/in EFZ" and Chemical and Pharmaceutical Process Technologist "Chemie- und Pharmatechnologe/in EFZ").[1] The selected occupations are mostly attributed to be resource-intensive. Resource intensity can be one, but not the only reason, why the teaching of SD skills in the curricula appears to be particularly important. The context of house building serves as an exemplary illustration of the practical use of the occupation.

In the first section of this paper, we provide a brief overview of the relevance of ESD in VET. The second section defines ESD and briefly describes basic VET in Switzerland. In particular, the special situation of Swiss VET is focused. The methodological approach of the curricula analysis is explained in the third section. Section four presents the findings and answers the research questions. Finally, the fifth section summarizes and discusses the findings of this study, followed by limitations and challenges as well as further questions arising from the study.

2 Research Background

In this section, the current state of research on ESD is presented and defined in the context of this study. The Swiss VET system and its special factors, especially its multi-track approach and the collaborative partnership of different stakeholders, are subsequently presented.

[1] *EFZ= Eidgenössisches Fähigkeitszeugnis = Federal Diploma of Vocational Education and Training / Federal VET Diploma;* Translations taken from the graduate records translation on https://www.becc.admin.ch/becc/public/bvz/beruf/showAllActive (accessed April 03, 2024)

2.1 Education for Sustainable Development

In light of ecological, economic, and social challenges, it is argued that an education for Sustainable Development is indispensable for imparting the necessary knowledge and competences to present and future generations (United Nations Educational, Scientific and Cultural Organization, 2017). However, even the most central concepts of these global initiatives such as sustainability, Sustainable Development or ESD are not commonly understood (Wilhelm, 2021; Sinakou et al., 2019; Uggla & Soneryd, 2023). For example, while some do not differentiate between sustainability and Sustainable Development, others see sustainability as the goal of Sustainable Development (Sinakou et al., 2019). Possible reasons for this lack of consensus may be that Sustainable Development is regarded a dynamic process that changes over time (Sinakou et al., 2019) and can vary depending on the national context it is aimed to be implemented. What makes it more complicated is the issue that if one wants to promote ESD, one needs to decide on knowledge and competences in a today-perspective in view of an unknown future (Holfelder, 2019). In the folling three paragraphs we will privde a view on Sustainable Development, then elaborate on ESD, and ideas for ESD competences.

Even though there is no universally accepted definition of sustainability or SD (Wilhelm, 2021) the "Brundtland Definition" – provided by the World Commission on Environment and Development (WCED) – offers some clarity. This definition posits that Sustainable Development entails meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p.41). It is important to note, that despite its widespread acceptance, this definition can also be criticized for being broad and vague. A systematic understanding of Sustainable Development, as delineated by Ferguson et al. (2021), comprises three fundamental dimensions: Ecology, Economy, and Society. These dimensions are not only interconnected but also interdependent. The interdependence is manifest in an intricate interplay of economic, social, and environmental dynamics observable in global phenomena such as climate change, migration flows, the proliferation of diseases, and economic disparities.

From a pedagogical view, it is important to be clear in the notion of ESD, because it may determine the educational approach. In a social context, the concept of ESD can be differentiated into ESD-1 and ESD-2, as outlined by Vare and Scott (2007). ESD-1 focuses on fostering specific behaviors and values in learners, as exemplified by the UN Decade of ESD (2005-2014). In contrast, ESD-2 emphasises empowering individuals to critically reflect on their behaviour and values. Riekmann (2016, p.91) describes ESD-2 as enabling critical engagement with the complexities and contradictions inherent in sustainable development. In this context, Hannah Arendt's critique in "The Crisis in Education" becomes relevant. Arendt's warns of the instrumentalization of children for political purposes (Arendt, 1994). This critique resonates with the concerns of ESD, especially when considering ESD-1. For this reason, the present study aligns with ESD-2, as will be shown later on. ESD-2, as an individual learning process, can be viewed as a lifelong process occurring through the interaction between individuals and their context, forming the foundation for SD (Vare & Scott, 2007). The focus turns toward learners to acquire the skills for an active and self-determined role in shaping the present and the future and to share responsibility for society and the environment. ESD-2 therefore supports the development of personal, professional, methodological and social competences that allow learners to perceive their own place in the world and to engage critically and creatively with a complex, globalized world with different values, dynamic developments, contradictions and uncertainties. ESD-1 hardly implements autonomous and critical thinking, whereas ESD-2 includes the development of maturity in SD based on content knowledge and transversal competences. Therefore, in this paper we refer to ESD – in terms of ESD-2 – when we talk about the overall pedagogical arrangement, we refer to SD competences, dimensions, and topics when we point at content-specific issues that cam be implemented in an educational setting.

One frequently discussed question is how exactly education can lead towards a sustainable future. Many of the suggested approaches, as Hoffmann (2018) notes, are competence oriented. Competences can be defined as an interplay of cognitive skills and abilities, combined with motivational, volitional, and social readiness to responsibly solve problems in a variety of situations (Weinert, 2001). ESD-related competence framework vary slightly depending on the approach (Brand & Muheim, 2022). For instance, De Haan (2008) outlines 12 action-oriented competences that deal with SD issues. These are most commonly used in Germany and Austria. In Switzerland however, the approach by éducation21[2] is well established and includes ten ESD competences (éducation21, 2018). Both the approaches by De Haan and éducation21 and their competences align with the OECD Key Competences from the DeSeCo project (OECD, 2005). Thus, the intersections between the individual approaches are considerably extensive (Lindau et al., 2023). Other conceptualizations of ESD include topic-specific approaches, such as the sustainability analysis of the Swiss State Secretariat for Education, Research and Innovation (SERI) or the national compulsory school Curriculum21 (D-EDK, 2016a), both of which exhibit similar topics. In the national compulsory school curriculum, seven interdisciplinary topics of sustainable development have been incorporated (D-EDK, 2016b). These include “Politics, Democracy and Human Rights”, “Natural Environment and Resources” or “Health” to name a few examples (D-EDK, 2016b). These topics are integrated into various subjecs, particularly within "Nature, Man, and Society", where they are linked to the competences of the subject (D-EDK, 2016b). The sustainability analysis conducted by the SERI (2020) on the other hand, defines nine topics of sustainable development, which are highly

[2] éducation21 is the national competence and service center for ESD in Switzerland (https://www.education21.ch/de, accessed April 09, 2024).

relevant for the professional world and can be clearly assigned to the dimensions of "Economy", "Society", and "Ecology". Examples include "Mobility & Logistics", "Working Conditions", and "Climate & Energy" to name just a few (SERI, 2020). The analysis is intended to enable professional organizations to identify and highlight existing courses of action for their occupations using these topics, as well as to specify professional competences in the context of sustainable development (SERI, 2020).

2.2 Swiss Vocational Education and Training

In Switzerland, VET is conducted in various forms. Basic VET usually lasts two to four years. A two-year apprenticeship leads to a Federal VET Certificate and after a three- or four-year apprenticeship a Federal VET Diploma is obtained. The two-year apprenticeship programs provide learners with a greater practical skill-orientation whereas the three- and four-year apprenticeships also enable access to higher professional education tracks at tertiary level. Swiss VET is characterized by three factors (Maurer et al., 2017): One, vocational education and training is of great importance to the Swiss education system, two thirds of young people who graduate from compulsory schooling move into vocational training. Two, most VET programs are offered in a multi-track approach, i.e. the training content is spread across several learning locations (vocational school learning, in-company training, and inter-company courses). Sometimes the three learning places are referred to as trial-track, sometimes vocational school and inter-company courses are theoretically combined as academic track vs. the practical track which is then referred to a dual-track. To make it easier to read we will use the term multi-track. According to Gonon and Hägi (2019), the dominance of multi-track VET highlights both – the crucial role of businesses and the deeply rooted economic significance of VET in Switzerland. Three, apprentices can complete basic VET in a broad spectrum of occupational programs in various sectors, 245 professions in total (SERI, 2022). Despite this diversity, it is notable that in 2020, the ten most popular VET programs accounted for almost 50 percent of the signed first-year apprenticeship contracts (SERI, 2022).

In most cases, VET is carried out in a multi-learning locations approach, but also alternative forms such as school-only VET or training in public training workshops exist (Wettstein & Gonon, 2009). The multi-track approach reflects the integration of theoretical and practical components in the curriculum (SERI, 2022) and refers to learning at two or three different locations (see section above). Each of these learning sites fulfils a specific and unique function in the course of the apprentices' training (cf. Wettstein & Gonon, 2009). The vocational schools provide theoretical training. This includes lessons in vocational and general education in a school-like setting and in the form of a more academic learning. Practical vocational skills and competences are acquired in the company, where the apprentices are also actively integrated into the operational production process/ every-day work tasks. In inter-company courses, however, the aim is to impart basic practical skills and competences that are not adequately addressed within the scope of the vocational schools or companies (Goetze et al., 2002). Thus, they bridge the gap between theoretical knowledge and practical experience (Goetze et al., 2002). The inter-company courses are often carried out in training centers, which are usually financed either by professional organizations or are jointly financed by the public sector and companies (Wettstein & Gonon, 2009). Apprentices spend around 1.5 days a week at the vocational school and the rest of the week at the company. The time spent in inter-company classes varies considerably between the individual apprenticeships, ranging from a few weeks to 12 months within a three- or four-year apprenticeship program. Switzerland is split in three official language regions. And, although dual VET is by far the most common form of Swiss VET, in contrast to the German-speaking part of Switzerland there is a clear preference for school-based VET in the French- and Italian-speaking parts of the country. In 2020, the proportion of school-based VET in the German-speaking part was around 4% whereas in the other parts of the country it was between 20% (French-speaking part) and 30% (Italian-speaking part) (SERI, 2022).

Another important factor of Swiss VET is the involvement and collaboration of different stakeholders, for example the federal government, cantons and professional organizations. These stakeholders adhere to the principle of collaborative partnership (cf. SERI; 2022; SCCRE, 2023). The federal government functions as a national coordinator with the aim to standardize qualifications in order to allow apprentices to be highly flexible on the labor market. The federal government, for example, ensures the comparability of courses throughout Switzerland, the enacting of around 245 ordinances on VET and the recognition of foreign qualifications (SERI, 2022). The professional organizations define the curricula and educational content for VET in their occupational fields and are responsible to ensure a sufficient number of apprenticeship places. The cantons bear responsibility for the implementation and supervision of VET. For instance, they implement the Federal Vocational and Professional Education and Training Act, provide vocational, educational and career guidance services and supervise apprenticeships, vocational schools and professional education institutions (SERI, 2022). This diversity of stakeholders in VET is also reflected in its legislation. In addition to the major entities (federation, organizations, cantons), the Swiss VET is co-determined by the federal government, primarily through the Federal Vocational and Professional Education and Training Act (Maurer et al., 2017; VPET Act, 2024) which determines the framework for basic VET and standardizes it across Switzerland. Specific details then are outlined in VET ordinances and training plans for each profession. The VET ordinance sets the legal and organizational framework for VET programs, while the training plan elaborates on the specific learning content and competences to be conveyed in these programs. Furthermore, there are other binding documents, such as training programs and school curricula, for the vocational schools and inter-company courses.

The preceding section explored the key factors of Swiss VET. Due to a high number of admissions, VET is highly important in the Swiss education system. This is also reflected in the large number of professions in which apprenticeships are possible. One of the most prominent features of Swiss VET is its multi-track approach, which is characterized by a combination of theoretical and practical learning at various learning sites, including vocational schools, companies and inter-company courses. The federal government, the cantons and the professional organizations are jointly responsible to provide VET. Altogether, section 2.1 and 2.2 show that the Swiss VET system does not share a unified curriculum of ESD. Curricula are designed by professional organizations to educate their future workforce. From this, it is necessary to scan through VET curricula in order to draw a picture of the current situation of ESD within the curricula. A deeper insight into the status quo will allow VET organizations and agencies to evaluate and revise their curricla.

2.3 Integration of ESD in Swiss Vocational Educational Training

Despite the fact that the three key factors illustrate the significance of the Swiss VET system in society and economy (number of VET students, multi-track, number of occupations see 2.2), little is known about the integration of future-oriented and transversal competences like ESD. If a large number of occupations considered ESD in VET, it would address and educate a significant number of people in society and thrive the sustainable development processes. Also, with reference to the VPET Act, the VET includes the teaching and acquisition of economic, environmental, social and cultural knowledge and skills that enable learners to contribute to sustainable development (VPET Act, 2024).

Yet, ESD competences and topics are not uniformly integrated into VET programs. The federal government encourages the professional organizations – which are responsible for VET curricula – to consider ESD when revising or creating new curricula. Furthermore, teaching and learning in VET is to be further developed in the 2025-2028 funding period with regard to the promotion of basic skills, digitalization and new learning technologies, pedagogical concepts for sustainability, etc., with the aim of "creating optimal conditions for coping with innovation-driven change in the labor market." (SERI, 2023, p. 33). In this respect, ESD topics are of central importance for the VET of the future against the backdrop of social, technological and ecological change (Rat für Raumordnung, 2019, i.e. Federal Council for Spatial Planning).

However, the ESD competence orientation in VET is slow in progress. One reason for this is the exuberant number of curricula in VET. There are 245 curricula for basic education professions in 22 occupational fields. This means that identifying ESD content with ESD competences covering all professions and integrating it into lesson planning/put it to praxis requires a comprehensive initiative. In order to promote competences for ESD, VET teachers need to be supported, particularly considering the challenges faced by teachers in their day-to-day work in order to promote their skills in a way that ESD gains greater access to vocational education.

In contrast to the unified structure and the clear guidelines for school education, the VET organizations and agencies are independent and are allowed to individually decide whether they want to consider ESD, highlight a need for action or define ESD content (SERI, 2020). The lack of consistency and requirements leads to uncertainty about the extent to which ESD is truly embedded in the curricula of Swiss VET.

To date, there have been no comprehensive studies that provide detailed analyses or evaluations of this situation. This absence of specific research work and documented insights underscores the need for a deeper engagement with the role of ESD in Swiss VET curricula. In this study, ESD competences are defined with reference to éducation21 (2018). éducation21's framework is particularly suitable as it provides a comprehensive set of competences tailored to the Swiss educational landscape. Additionally, the perspectives of the SERI and the national compulsory school Curriculum21 were considered in order to incorporate topic-specific approaches to enrich the scope and practical relevance of this study. This multi-perspective approach allows to put the focus on the Swiss educational context and the transition from compulsory school to VET.

In sum, a significant challenge is the absence of commonly accepted definitions of key terms such as sustainability, SD, and ESD itself (Wilhelm, 2021; Sinakou et al., 2019; Uggla & Soneryd, 2023). This ambiguity partly originates from the dynamic and evolving nature of SD, which varies by philosophical, ethical, economic geographical and cultural factors. In the Swiss context, ESD competences are neither uniformly nor commonly integrated into VET curricula. Despite encouragement from the federal government, the integration of ESD in Swiss VET curricula remains uncertain due to varying approaches by the responsible agencies. The lack of comprehensive studies on this integration urges a need for curriculum research.

2.4 ESD and curriculuar analyses

Overall, the data analysis is based on a curriculum analysis approach. Curriculum analyses have been used to construct or revise curricula (Frey, 1969) and are useful when new educational themes or opportunities for change are considered

(Houang & Schmidt, 2008). In particular, transversal topics such as informatics education (Dagiene et al., 2021), media education (Möller & Tulodziecki, 2000), or education for economy (Fortunati et al., 2024) have a background in curriculum analyses that help to develop practical pedagogical approaches. Curricular content analyses are of particular interest in the devolepment of an ESD (Kioupi & Voulvoulis, 2020). What is more, content analyses also indicate the curriculum author's view on the topic that is subject to teach (e. g. Remillard et al., 2014).

From the above, it seems useful to understand how Sustainable Development is reflected in VET curricula and how it differs between curricula/ professions. To our knowledge most curriculum analyses that refer to ESD deal with the pedagogical and/ or theoretical implementation of ESD (c. f. Fekih Zguir, Dubis, & Koç, 2021), few try to identify content-oriented potentials of existing curricula, especially in post K-12 education. In most cases one can only find orientation frameworks, road maps or practical manuals that guide toward ESD (e.g. SERI, 2020; UNESCO, 2021; KMK, 2024; éducation21, 2024). This seems to be in line with the finding of a large document analysis from Germany that ESD has so far only been loosely integrated somehow like an add-on (Holst et al., 2024). However, Holst et al. mostly looked for the quality of references to ESD. With regards to VET, the authors state: "As of 2021, all new or updated documents include references to sustainability (not to ESD, which could only be expected inschool curricula" (p. 3916)).

Other curricular analyses from K12 school research show that academic disciplines share a potential to address ESD or SD topics. Yuan & Yu (2024) found that subjects like physical education and health, and biology share a lot of possibilities to address ESD/ SD, while other disciplines do not (Arts and Geography). Other curricula literally integrate SD/ ESD into the subjects geography, science, citizenship, and personal, social and health education (PSHE; Chatzifotiou, 2002). Transferring this to the context of VET, one could re-interpret "subjects" as occupations which represent integrated K-12 school disciplines.

One approach to identify SD/ ESD in curricula has been chosen by Lozano & Barreiro-Gen (2019). The authors were interested in the representation of SD in higher education institution curricula. Their self-report interviews-plus-survey study included questions about what content of SD and how SD was taught using the SD dimensions *economic, environmental, social, and cross-cutting themes*. Their results show that the participants report to mainly address economic, environmental, and cross-cutting themes like resource depletion, production, profitability, eco-issues, long-term thinking, ethics etc. The social dimension was raised less often with topics like health, demography, equity, human rights etc. Again, in terms of VET, we can transfer this and use VET and Switzerland-specific SD dimensions and topics and evaluate how they are reflected in VET curricula.

3 Methods

This section presents the methodological approach used in our paper. First, the research questions are presented in section 3.1, then the sample and data analysis procedure are explained in section 3.2.

3.1 Research Questions

The overall objective of this paper is to illustrate how SD competences are anchored in selected curricula of Swiss VET programs. To this end, the following research questions were addressed:

(1) Which SD competences are anchored in the selected VET curricula?
(2) Which SD dimensions are anchored in the selected VET curricula?
(3) How are the SD competences and SD dimensions reflected in the selected VET curricula?

3.2 Sample and Data Analysis Procedure

In this study we refer to a sample of six curricula for professional vocational education (see Table 1). We had to draw content-specific curricula from a total number of 245 VET professions which are assigned to 22 occupational fields (Zihlmann, 2023). As of research pragmatic reasons six multi-faceted occupations were selected in an informed-randomized procedure i.e. based on a process for house-building we randomly selected an occupation. With this we reduce sampling error and selection bias. With a view on representativeness, we did not want to systematically exclude unpopular occupations, nor was the idea to only anaylyze occupations from one industry branch. The six selected occupations are related to a house building context in terms of construction site work, as well as chemistry, electrical engineering and building services engineering which all are – generally speaking – intense in resource consumption and of considerable environmental, social, and economic relevance (see Table 1). The curricula of the occupations as well as their occupational field are listed in Table 1. All occupations to some extent refer to all ESD dimensions.

Tab. 1. Sample of curricula including original occupation name, translated names, and occupational field.
Source: Own depiction.

Original Name	English Translation[3]	Occupational Field
Gebäudetechnikplaner/in Heizung EFZ	Building Services Technician	Building services engineering
Elektroniker/in EFZ	Electronics Technician	Electrical engineering
Geomatiker/in EFZ	Geomaticist	Construction site work
Physiklaborant/in EFZ	Physics Laboratory Technician	Electrical engineering
Strassenbauer/in EFZ	Road Builder	Construction site work
Chemie- und Pharmatechnologe/in EFZ	Chemical and Pharmaceutical Process Technologist	Chemistry, Physics

Note. EFZ = "Eidgenäössisches Fähigkeitszeugnis" = Federal Diploma of Vocational Education and Training / Federal VET Diploma

In order to give an overview of the selected occupations and to understand their relation to house building, we want to briefly describe the occupations and indicate their house building relevance. Detailed information about the occupations, specializations, and distinctiveness can be retrieved from the official SDBB (2024) or SERI (2024) websites.

- Building Services Technician: Collaborates with architects and engineers/ technicians, calculates energy-saving heating systems. In contrast to the other occupations clearly orientwed toward environmental friendliness.
- Electronics Technician: Develops hard and software e.g. for telecommunication, household utilities or building technology. In contrast to the other occupations strongly oriented toward micro technology and computer processors.
- Geomaticist: Collects spatial information as a basis for planning and technical, economic, environmental and political decisions. In contrast to the other occupations strongly strategy oriented.
- Physics Laboratory Technician: Investigates and develops e.g. building materials, uses chemical and physical methods for quality control. In contrast to the other occupations strongly focused on quality control.
- Road Builder: Builds, finishes, and repairs roads, installs crash barriers, gutters and grates. In contrast to the other occupations strongly mechanical work.
- Chemical and Pharmaceutical Process Technologist: Develop and produce chemical products used in the construction industry, such as concrete additives, insulation materials, and **paints**. In contrast to the other occupations, which are more directley linked to construction site work and building engineering, they can be seen as a developer and supplier of materials and chemicals that are used in the construction industry.

The house-building context allows to align the occupations in the process of house building. Chemical and Pharmaceutical Process Technologist and Physics Laboratory Technician: Chemical development or analysis of construction material. Not directly working at a construction site. Geomaticist and Road Builder: Responsible for spatial alignment of housing and infrastructure. Building Services Technician and Electronics Technician: Installation of services and cable laying.

In order to develop a comprehensive coding system for ESD/ SD in the curricula, we used the competence framework given by éducation21 (2018, see Table 2) and integrated two perspectives on ESD/ SD (SERI, 2020, and Swiss national compulsory school curriculum= Curriculum21, D-EDK 2016b, see Table 3).

The éducation21 competence categories are commonly used in Switzerland because they share a profound basis in terms of praxis-orientation for teachers, compatibility to the curriculum in compulsory school which precedes VET education, and their clearly transversal and objective wording. Examples of ESD competences are "Cooperation" (working together on sustainability-related issues), "Participation" (shaping social processes) and "Values" (Reflecting on your own and other people's values). The ESD competence categories are listed in Table 2 where each category is followed by a short description.

[3] Translations taken from the graduate records translation on https://www.becc.admin.ch/becc/public/bvz/beruf/showAllActive (accessed April 03, 2024)

Tab. 2. ESD competences of éducation21 (2018)
Source: Own depiction.

Nº	**Competence Category**	**Description (éducation21, 2018)**
1.	Knowledge	*Building interdisciplinary and multi-perspective knowledge.* Identify sustainability-relevant knowledge and independently as well as collaboratively gather interdisciplinary and multi-perspective information. Be aware that knowledge is constructed, situationally and culturally shaped. It must be questioned and further developed with regard to sustainable development. Consider the spatial, temporal, individual, and collective dimensions of sustainable development. Recognize and analyze the incompleteness and contradictions of sustainability-related information. Question the quality and origin of information and relate different sources to one another.
2.	Systems	*Connected thinking.* Analyze and understand linear and non-linear relationships, dependencies, and interactions between people, various societal sectors, and the natural environment, both locally and globally. Manage complexity by analyzing and understanding the causes and effects of unsustainable developments.
3.	Anticipation	*Thinking and acting with foresight.* Develop visions for the future and relate them to reality and current development trends. Evaluate action strategies and decisions, along with their effects, consequences, and risks, and design forward-looking solutions for sustainable development.
4.	Creativity	*Critical-constructive thinking.* Develop independent ideas and flexibility to think beyond the current scope of experience and knowledge, and to invent (innovative) alternatives.
5.	Perspectives	*Change perspectives.* Identify different interests, recognize one's own viewpoints, and adopt the perspectives of others, as well as new perspectives. Use the ability to shift perspectives as a foundation for assessing situations and collaborating with others in the interest of sustainable development.
6.	Cooperation	*Working together on sustainability-related issues.* Identify sustainability-related issues and collaboratively seek solutions. Constructively negotiate and manage disagreements and conflicts of interest concerning sustainable development.
7.	Participation	*Shaping social processes.* Analyze societal processes, identify the involved groups of actors, recognize their interests, and question power dynamics. Recognize individual and collective opportunities for action in society for sustainable development and participate in political and civil society processes.
8.	Responsibility	*Experiencing yourself as part of the world.* Perceive oneself, the social and natural environment holistically and in a global context. Experience oneself as part of this environment and approach it with respect and responsibility. Recognize both positive and negative emotions in this process and manage them constructively.
9.	Values	*Reflecting on your own and other people's values.* Be aware of personal and collective ways of thinking, values and norms, attitudes and actions, as well as their origins, and assess them in light of sustainable development. Discuss, understand, and relate sustainable development as a guiding principle of societal development and its underlying values to other societal guiding principles. Reflect on both personal and others' values, particularly concepts of justice, and use them as a basis for action.
10.	Act	*Taking responsibility and utilizing scope for action.* Recognize, evaluate, and utilize personal and collective opportunities for action in support of sustainable development.

Additionally, we searched for ESD dimensions and topics in the six curricula of the selected occupations. To connetct the efforts of SD in compulsory school and VET, we decided to combine the seven interdisciplinary topics of sustainable development from the national compulsory school curriculum (D-EDK, 2016b) and the nine topics and corresponding dimensions of sustainable development from the sustainability analysis conducted by the SERI (SERI, 2020). Table 3 shows the SERI and D-EDK perceptions of SD and also provides information about our synthesis from the two sources. While SERI lists three dimensions and distributes 10 topics across the dimensions, D-EDK does not refer to dimensions, at all. However, seven topics that partly overlap with SERI (2020). Our synthesis tries to avoid redundancies in the description and naming of topics and dimensions: "Economy" in "Economy and consumption" was removed, to ensure there are no redundancies with the topic "Economic efficiency and value creation"; "Innovation and education" is more appropriately categorized under the dimension of "Society" rather than "Economy", because education is fundamentally a societal process, even though it contributes to economic outcomes; "Health" was integrated into "health and well-being"; "Gender and equality" and "Equal opportunity" were merged into "Equal opportunities and equality", meaning that gender disappeared, because we think that it can well be included in "Equal opportunities and equality"; We chose "Biodiversity, natural resources and materials" over "Natural environment and resources", because the two topics are redundant and the further highlights the habitat of plant/ animal species. The integrated version of SD includes three SD dimensions and 13 topics.

Tab. 3. ESD Dimensions and Topics
Source: Own depiction.

Topics (including corresponding Dimension) of Sustainable Development (SERI, 2020)		**Topics of Sustainable Development (D-EDK, 2016b)**		**Integration of Topics and Dimension used for this Study**	
Dimension	**Topic**	**Dimension**	**Topic**	**New Dimension**	**New Topic**
Economy	Economic efficiency and value creation	*Note: No dimensions mentioned*		Economy	Economic efficiency and value creation
Economy			Economy and consumption	Economy	Consumption
Economy	Innovation and education			Society	Innovation and education
Economy	Mobility and logistics			Economy	Mobility and logistics
Society	Working conditions			Society	Working conditions
Society	Health and well-being		Health	Society	Health and well-being
Society	Equal opportunity		Gender and equality	Society	Equal opportunities and equality
Ecology	Biodiversity, natural resources and materials		Natural environment and resources	Ecology	Biodiversity, natural resources and materials[4]
Ecology	Climate and energy			Ecology	Climate and energy
Ecology	Environmental pollution and waste			Ecology	Environmental pollution and waste
			Politics, democracy and human rights	Society	Politics, democracy and human rights
			Global development and peace	Society	Global development and peace
			Cultural identities and intercultural understanding	Society	Cultural identities and intercultural understanding

The six curricula of the occupations were taken to a document analysis using a structured qualitative content analysis (Kuckartz, 2016) in a deductive approach. The initial coding categories were based on the ESD competence categories specified by éducation21 (2018, see Table 2) and the integrated SD dimensions and topics (see Table 3).
The competence category descriptions, together with the SD dimensions and topics, were coded in a high-inferential categoriacal coding procedure. High-inferential coding refers to the level of inference drawn from a text to assign a code. In our case interpretation was limited to stay as close to the competence, dimension or topic as possible, but the codes had to be perceived in a larger context within the whole curriculum. This means that the curriculum was read through and then a decision was made if a code was given or not. After a category was identified, the applicable code was assigned to the curriculum (not to the exact text paragraph). It is possible to assign a specific wording or statement to multipe competences, dimensions, and topics. Within this high-inference methodology, three coders were instructed on SD competence categories, dimensions and topics to optimize intersubjectivity (see Steinke, 2000) by building a common sense of the categories and dimensions. Then, independent coding of was performed (26 categories (3 dimensions of ESD and 13 topics of SD + 10 SD competences) and conducted in MAXQDA with all coders each coding two curricula. All coders were academic staff at a university of teacher education with a tertiary-level degree. Further, they were all part of the project team. Due to the high-inference approach inter-coder agreement or reliability was not computed, because from a constructivist point of view the identification of a code is a function of the curricular text basis and a coding of SD, its competences, dimensions and topics, and can not be attributed to a single word or line in the text. Thus, we did not see inter-coder agreement/ reliability as a meaningful indicator.
The identified SD competences received a ranking value between three (highest rank) and one (lowest rank); zero (does not appear in column) and the rankings was summed up over all occupations.
The frequency rankings of SD dimensions were inspected and condensed to an average ranking across the occupations (median). We also used z-standardized scores to compare under-/ over-representations of SD dimensions based on the arithmetic mean average of the frequencies. A z-score refers to zero as a represeantative of an overall average. Each frequency from Figure 1 was substracted by the general $average_g$ across all dimensions and the result divided by the standard $deviation_g$ of the general average. This z-transformation allows to compare the frequencies of the dimensions with reference to the general average frequency and indicates a relevance of SD in the curriculum. As a rule of thumb one can say that a z-value exceeding ± 2 standard deviations can be considered statistically significant at a 5% level. We did not perform additional inferential statistics.

4 Findings

The curricula of six basic VET programs were systematically analyzed to identify SD dimensions, topics and competences. The findings show that all examined occupations refer to SD dimensions, topics and competences. However, there are major differences in the formulation and the focus of the individual curricula.

Table 4 below shows the distribution of the three most common SD competences within the respective occupations. The four SD competences "Responsibility, four appearances", "Act, four appearances" as well as "Anticipation, three appearances" and "Systems, three appearances" occur most frequently across all occupations.
When the frequency of codes was identical, the rank was assigned based on the overall frequency of the competence across all occupations (see number in brackets in the occupation columns in Table 4). For example, in Geomaticits, "Perspectives" was most frequently rated (five times), "Cooperation" second most (four times), but three competences ("Anticipation", "Responsibility", and "Creativity" all had a frequency of three codes. Across all occupations "Anticipation" was coded 25 times, "Responsibility" 20 times, and "Creativity" four times, therefore "Anticipation" was ranked on place three, "Responsibility" on place four etc.

The most common SD competences are also formulated differently in terms of content and length in the selected curricula. In the occupations Physics Laboratory Technician and Road Builder, the SD competences are formulated in a detailed manner. In the curricula of Physics Laboratory Technician, the competence of "Responsibility" is formulated the following way: *Physics laboratory technicians are aware of the hazardous areas in their work. They recognize these and independently ensure occupational safety and health protection with suitable measures."* This way of formulation is similar to the wording in the curriculum of Road Builder: *"The road builder always checks whether his or her approach to carrying out work meets the requirements in terms of quality, environmental protection and sustainability and makes the necessary adjustments if required."* In contrast to that "Responsibility" is formulated in the curriculum of Chemical and Pharmaceutical Process Technologist like a keyword (*ecological behavior").*

Tab. 4. Most frequent SD competences including counts in the analyzed VET curricula.
Source: Own depiction.

Occupations / Rank (Score)	Building Services Technician	Electronics Technician	Geomaticist	Physics Laboratory Technician	Road Builder	Chemical and Pharmaceutical Process Technologist
1. (3)	Systems (7)	Anticipation (17)	Perspectives (5)	Act (4)	Responsibility (4)	Responsibility (7)
2. (2)	Responsibility (4)	Act (16)	Cooperation (4)	Responsibility (4)	Systems (3)	Systems (3)
3. (1)	Act (3)	Cooperation (6)	Anticipation (3)	Knowledge (4)	Act (1)	Anticipation (3)

The Table 4 shows that seven out of ten SD competences were present among the three most frequently coded competences. A more detailed view on the competence distribution is given in Table 5. The table lists the competences and their frequency with reference to Table 4. Additionally, for the frequency per column in Table 4 a ranking value between three (highest rank) and one (lowest rank); zero (does not appear in column) was assigned and summed up. Finally, the average ranking, if listed, was computed. For example, the competence "anticipation" did not appear in the Building Services Technician column and therefore received a zero, it appears in the Electronics Technician column at first place, so it received a value of three. In the Geomaticist column it receives a score of one, etc. The resulting sum of rankings represents an indicator of the overall relevance of the competence. A median score was computed for the average ranking if the competence was listed.

In Table 5, one can see that "Responsibility" and "Act" appear four times, but "Responsibility" is more often and more consistently ranked and at a higher value than "Act". On the lower end, "Knowledge" appeared only once with a relative low frequency in Physics Laboratory Technicians. Interestingly, "Responsibility" does not appear in the list of the most frequent competences in Electronics Technicians and Geomaticists, but is very frequent in the other occupations. "Responsibility" is highly relevant in the curricula of Physics Laboratory Technician, Road Builder, Chemical and Pharmaceutical Process Technologist, and Building Services Technician. The competences "Perspectives" and "Cooperation" seem relevant in no other occupation than Geomaticist.

Tab. 5. Distribution of most frequently coded competences between occupations.
Source: Own depiction

SD Competence	Frequency across occupations	Rankings (in the order of Table 3)	Sum	Median ranking if listed (Sum/ Frequency)
Responsibility	4	2+0+0+2+3+3	10	3
Act	4	1+2+0+3+1+0	7	2
Anticipation	3	0+3+1+0+0+1	5	2
Systems	3	3+0+0+0+1+1	5	2
Cooperation	2	0+1+2+0+0+0	3	2
Perspectives	1	0+0+3+0+0+0	3	3
Knowledge	1	0+0+0+1+0+0	1	1

Across all curricula/ occupations "Ecology" is the most frequent dimension (230 counts), followed by "Socienty" (127 counts), and "Economy" (105 counts). Furthermore, the findings show that the SD topics identified in the curricula can primarily be assigned to the dimension "Ecology" in most of the evaluated curricula (Figure 1, Building Services Technician, Electronics Technician, Physics Laboratory Technician and Chemical and Pharmaceutical Process Technologist). Only in the curricula for the occupations of Geomaticist and Road Builder are most SD topics allocated in the dimension of "Society". The second most frequently found dimension is "Economy" in the occupations of Building Services Technician, Electronics Technician, Geomaticist and Physics Laboratory Technician. It is also noticeable that only in the Road Builders' curriculum no SD topics could be assigned to the "Economy" dimension. The topics of "Climate and energy" ("Ecology"), "Health and well-being" ("Society") and "Economic efficiency and value creation" ("Economy") were identified most frequently across all occupations.

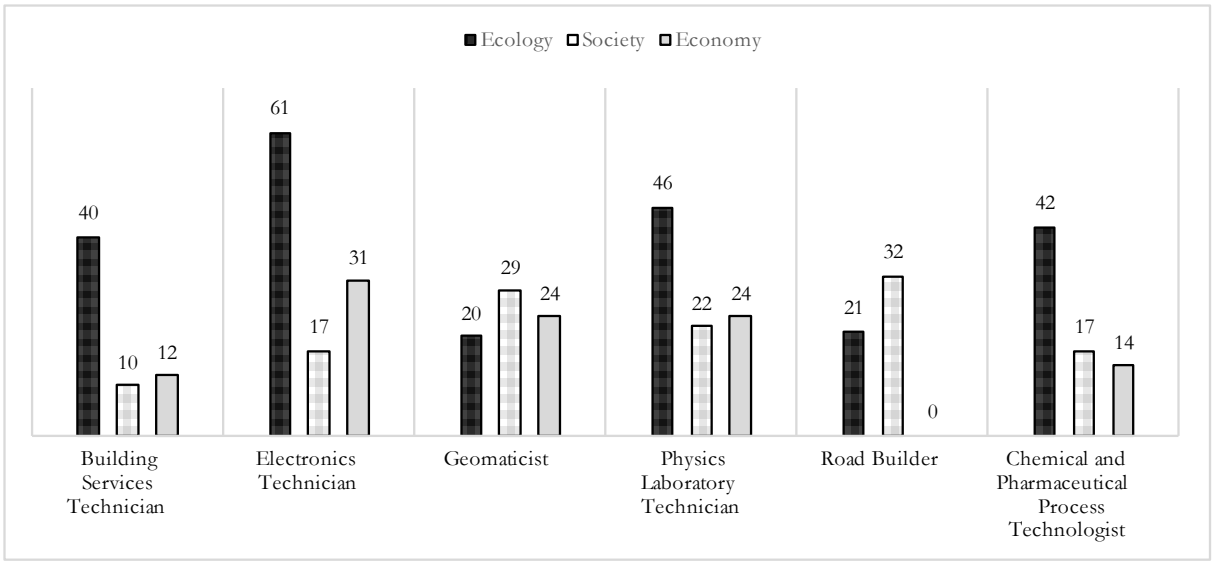

Fig. 1. Frequency of SD dimension by occupation.
Source: Own depiction.

An overview of the SD dimensions in the curricula is given in Figure 2. For better comparison z-values for each dimension were computed based on the average frequency of the dimensions across all occupations, i. e. all frequencies from Figure 1 were summed up and divided by 18 (= six professions x three dimensions). The grand mean of frequencies is AVG_g= 25.67 (SD_g= 14.68). Each frequency from Figure 1 was substracted by grand mean and the result divided by the grand mean's standard deviation. This allows to compare the frequencies of the dimensions with reference to the general average frequency and indicates a relevance of SD in the curriculum. In Figure 2, one can see that the dimension "Ecology" is far above average in Electronics Technicians as compared to the other occupations. The "Economy" dimension in Road Builders is far below average. The Geomaticists share an average amount of SD dimensions. Similar results were found when we based the z-scores on the averages by dimension.

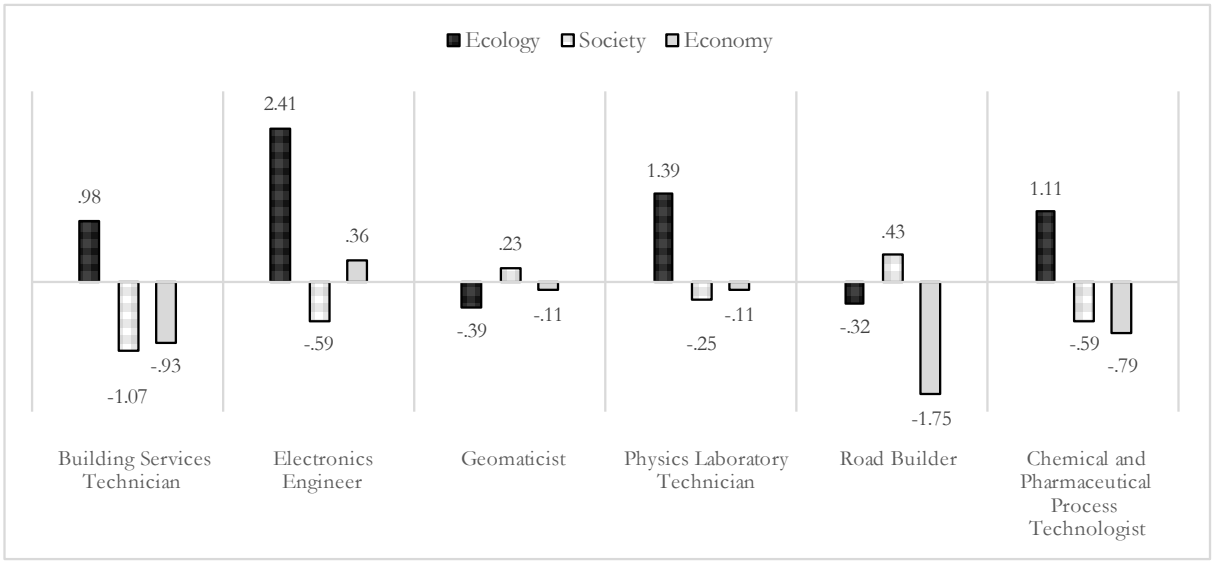

Fig. 2. z-standardized frequencies of SD dimensions by occupation (grand mean centered).
Source: Own depiction.

5 Discussion and Conclusions

This section summarizes the findings and discusses the limitations of the study. It also provides suggestions for future research questions. In our study, the following three research questions were addressed: (1) Which SD competences are anchored in the selected VET curricula? (2) Which SD dimensions are anchored in the selected VET curricula? (3) How are the SD competences and SD dimensions reflected in the selected VET curricula?

The analysis of the selected VET curricula shows that all the occupations examined have references to SD topics, dimensions and competences. Although all occupations are related to a house building context in a direct or indirect way and and are all – generally speaking – intense in resource consumption and of considerable environmental, social, and economic relevance, the number and occurrence of SD competences as well as dimensions and topics are very heterogeneous. The most common SD competences are "Responsibility", "Act" as well as "Anticipation" and "Systems". Striking differences were found in the distribution of the three most common SD competences within the selected curricula. This reflects the individual ESD/ SD characteristics of the occupations and curriculum authors.

We found "Responsibility" and "Act" are the most frequently occurring SD competences. Therefore, "Responsibility" seems the most important SD competence across the curricula examined. However, with reference to the individual occupations, the importance of "Responsibility" is not shared by all occupations; for example, "Responsibility" is not among the three most frequent competences in Electronics Technician education and Geomaticist education. Interestingly, "Cooperation", "Knowledge", and "Perspectives" hardly appear in the top competences.

With reference to the topics within the dimensions, we found different priorizations of topics across the analyzed occupations. In the curricula of Building Services Technician, Electronics Technician, Geomaticist and Physics Laboratory Technician the second most often detected dimension for SD competences is "Economy". This is in line with ealier research (see Lozano & Barreiro-Gen, 2019) and can be explained by the strong relationship of VET and economy. In contrast to this, the curricula for Geomaticist and Road Builder, highlight SD topics in the dimension of "Society". Across all analyzed curricula, the topics of "climate and energy" ("Ecology"), "health and well-being" ("Society") and "economic efficiency and value creation" ("Economy") were identified. "Economy"-related topics are the least represented. Looking at these results and Lozano & Barreiro-Gen (2019), it seems to be of high relevance where and how to study ESD/ SD. Lozano & Barreiro-Gen (2019) investigated general higher education via self-report, while our study is based on a document analysis.

Our results indicate that "Ecology" represents the dominant dimension in SD (see Fekih Zguir et al., 2021). But a more precise picture needs to be drawn: Geomaticists and Road Builders priorize "Society" over the other dimensions.

In a wider interpretation, our study consolidates the finding that SD is most commonly understood as a environmental/ ecological issue (Lozano & Barreiro-Gen, 2019; Fekih Zguir et al., 2021). The societal orientation of Geomaticists and Road Builders may hint towards a more differentiated picture: We assume that these occupations directly and visibly address interests of a society as a whole and share direct contact with people, and therefore have a stronger societal focus. Whereas the other occupations in our analysis rather work with a content-specific focus and are not directly visible for society (e. g. doing analyses in a laboratory). The z-standardized frequencies of SD dimensions by occupation show, that Electronics Technicians have a strong focus on "Ecology", whereas Road Builders show a lack in the "Ecology" dimension.

Overall, SD dimensions are by no means equally addressed in the curricula. The question of focus or equal distribution, to our knowledge, has not been addressed in ESD research, yet. It was also found that SD competences are formulated very differently in terms of content and length in the selected curricula. In the vocational curricula of Physics Laboratory Technician and Road Builder the SD competences were formulated rather long whereas in the formulation of SD competences in other curricula is relatively short, in some cases even key-point like.

In this regard, the differences between the various SD competences, dimensions, and topics can probably be attributed to the fact that the curricula for the occupations studied were composed by different professional organizations. Some organizations may differ from others in their perception of relevant SD competences, dimensions, and topics, to the extent that they see a need to implement SD in their curriculum, others may not share the SD content that we used for the coding of the curricula. For our analyses we used one widespread and common-sense notion of ESD (SD respectively), and the results need to be interpreted against this theoretical background. We acknowledge that it is a Switzerland-specific point of view.

In terms of SD curriculum implementation, some occupations (and the professions/ professional associations in their back) may be advanced in terms of SD integration in their curricula, because they need to adhere to official terms and regulations. Therefore, our coding system would reveal a high score. Yet, the score only represents the existence

competences, dimensions, and topics of SD in a curriculum. The coding, and this study, cannot draw conclusions on how ESD is implented in VET instruction (c.f. Holst et al., 2024).

From the document analysis we also cannot infer what notion or definition of ESD/ SD, if at all, has driven the curriculum development. The involvement of a central body for ESD, e.g. a national competence center like the éducation21 foundation in Switzerland that comunicates a shared idea of ESD in VET, is probably required in order to ensure that SD competences are uniformly included in the various curricula. Furthermore, when using SD competences, the general question arises as to whether these differ from the generally defined 21st century skills (cf. WEF, 2023). Should "Perspectives" and "Cooperation", for example, be interpreted differently in the context of SD or ESD? In addition, it is surprising that "Perspectives", as the most important 21st century skill of 2023 (WEF, 2023), is rare in the analyzed curricula. As the SD competences are transversal, i. e. applicable to different situations and contexts, the question also arises as to what exactly it means in the context of the individual professions or occupational fields. For example, is "Responsibility" the same for Road Builders as it is for Electronics Technicians?

The great heterogeneity of SD competences, dimensions, and topics spread across the whole curriculum and the variation between curricula makes it difficult to train teachers to teach for ESD. From a practical point of view it becomes even more difficult if one wants to add ESD to the teaching. Therefore, in our opinion, ESD should not be seen as an add-on (see Holst et al., 2024), it has to be integrated using the existing topics and reframing them in an itegrative educational approach. In a wider scope, ESD pedagogical research and praxis needs to find ways to connect competences, dimensions and topics with occupation-specific content in order to achieve a constructive and effective education for sustainable development.

Our study is particulary limited in its representativeness due to the small number of analyzed VET curricula (six out of 245). Therefore, the findings are not universally valid and apply only to the occupations evaluated. It would be interesting to extend this analysis to additional VET curricula. In this way, a more comprehensive picture of the integration of SD competences in Swiss VET curricula could possibly be drawn. Furthermore, it would be valuable to examine the links between SD dimensions and SD competences across different occupations. Considering that Swiss VET takes place at multiple learning locations, it would certainly be worth to also examine the integration of ESD in companies and the inter-company courses, in more detail.

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