education sciences

MDPI

Article

Vocational Schools' Underrecognized Role in PBL for Sustainability: Evidence from the German Dual VET System

Julia Hufnagl * and Silvia Annen

Faculty of Social Sciences, Economics and Business Administration, University of Bamberg, Feldkirchenstraße 21, 96052 Bamberg, Germany; silvia.annen@uni-bamberg.de
* Correspondence: julia.hufnagl@uni-bamberg.de

Abstract

Project-Based Learning (PBL) is a promising approach for sustainability education. This study adds to the current state of research by investigating PBL for sustainability in the German dual vocational system. The objective of this study was to determine (1) which role, in teaching sustainability, apprentices and pre-service teachers attribute to vocational schools and teachers and (2) what factors lead to the success of PBL for sustainability. The research design employs a triangulation approach that combines qualitative data from interviews and focus groups. The findings indicate that a shortage of resources, such as time and personnel, poses considerable challenges to PBL for sustainability in vocational schools. PBL for sustainability is considered an ancillary component that is desirable but does not align with the vocational school mandate of rapid learning success. Pre-service teachers acknowledge the significance of networks and learning location cooperation for PBL for sustainability, while apprentices prioritize the practical implementation of projects. The study results further demonstrate a strong connection between sustainability and personal relationships and interactions at school. Research and practice can take our findings as an opportunity to make greater use of the respective strengths of both learning locations in working together toward a sustainable future.

Keywords: sustainability education; Project-Based Learning (PBL); pre-service teachers; Vocational Education and Training (VET); learning location cooperation

1. Introduction

Internationally, there is ongoing discourse surrounding the transition to sustainable futures, with a growing body of research in this field (e.g., Huber & Schneider, 2022). Sustainable Development Goal 4.7 emphasizes the importance of preparing individuals to tackle sustainability challenges through education (United Nations, 2015). However, school learning does not yet correspond to the requirements of sustainability (e.g., Scheunpflug et al., 2023). This also applies to Vocational Education and Training (VET), which has seen increased relevance in sustainability transformation (e.g., Ramsarup et al., 2024).

In this paper, we conceptualize sustainability as a multifaceted concept encompassing both intra- and intergenerational justice, thereby incorporating ecological, social, and economic dimensions. Project-Based Learning (PBL) enables learning for sustainability in VET, delivering the greatest gains in sustainability-skill development compared to other approaches (Birdman et al., 2022). Dual VET apprentices learn to view issues from multiple perspectives by grounding their learning in authentic, real-world contexts through PBL.

Academic Editor: Stephan Gerhard Huber

Received: 15 December 2025
Revised: 25 January 2026
Accepted: 10 February 2026
Published: 14 February 2026

Despite the extensive literature on PBL for sustainability-oriented learning (cf. Megayanti et al., 2020), research on PBL for sustainability in dual VET is scarce.

In the German dual system[1], the workplace and vocational school are both crucial institutions for consideration of sustainability. The dual system is an interesting subject for research, as real-world connections and collaborations play a much stronger role than in the university or school system. In the workplace, PBL uses real-world sustainability projects as learning occasions, whereas at school, projects are staged in a more artificial setting. Vocational school, in turn, can address topics that the company does not currently prioritize, given that school is not contingent upon economic gain. While the German literature already provides a detailed definition of what constitutes a sustainable learning environment in companies (e.g., Feichtenbeiner et al., 2022; Lambini et al., 2021), there is a lack of clarity regarding the role of vocational schools in sustainability education. At the same time, the sustainability-skill requirements for vocational training staff are much better defined than those for vocational school teachers (e.g., Beer et al., 2024; Lambini et al., 2021). This article therefore answers the following questions: Which role in teaching sustainability do apprentices and pre-service teachers (i.e., students enrolled in a teacher education program) attribute to vocational schools and teachers? Which factors enable successful PBL for sustainability in the German dual VET system, as perceived by apprentices and pre-service teachers?

We examine and answer these questions using the financial services and information technology (IT) sectors as examples, since a sector-specific approach to sustainability education has emerged as state of the art in the German VET discourse (cf., e.g., Beer et al., 2024; Strotmann et al., 2024). These sectors are critical for sustainability in the German economy, as their products and services have cross-sectoral effects on the location of investments and the organization of workflows (e.g., Bengtsson & Ågerfalk, 2011; Dec & Masiukiewicz, 2021). The financial services industry's established emphasis on dual VET for securing skilled labor, contrasted with the IT industry's recent and unconventional embrace of vocational qualifications, underscores the unique and divergent nature of VET in these sectors, making them particularly interesting for study. The industries also differ in that the IT sector operates with a project-based work structure, whereas the financial services industry relies predominantly on standardized, process-driven workflows.

2. Project-Based Learning for Sustainability in VET

This section reviews current research on PBL in sustainability education and VET, identifies the research gap, establishes the theoretical foundation for the study, and presents the context of the study (i.e., the German dual VET system).

2.1. State of Research on PBL in Sustainability Education and in the VET Context

PBL, a student-centered instructional method, enables apprentices to learn how to consider sustainability in their daily work. Consequently, PBL is a widely endorsed pedagogy for sustainability education (Birdman et al., 2022) and a context-specific learning model, which involves learners' active engagement in authentic, real-world challenges (Kokotsaki et al., 2016; Lee et al., 2014). These challenges necessitate social interactions and knowledge exchange. For example, apprentices at vocational schools could collaborate to design, prototype, and test a cloud-based application that meets carbon-footprint targets. They could use authentic data, industry-standard tools, and receive iterative feedback from a partner company. The teacher would play an essential role as a facilitator, linking classroom theory (e.g., sustainability metrics) to the project milestones.

Learning by doing facilitates learners' ability to untangle the complexity of sustainability (Nation, 2008). To achieve the cloud-based application of our example, it is necessary to carefully consider performance, scalability, and reliability in addition to environmental (e.g., sustainable coding) and social (e.g., accessibility standards) aspects. PBL in vocational schools faces various obstacles including inappropriate assessment, time constraints, poor performance measurement, teachers' skill gaps, weak real-world connections, and lack of awareness regarding teachers' specific roles in PBL, with teachers' roles, industry collaborations and contextual factors shaping the effectiveness of PBL for sustainability (Gessler & Sebe-Opfermann, 2018; Lee et al., 2014; Liu, 2019; Lyu et al., 2025; Megayanti et al., 2020). In particular, the identification of a suitable partner with an authentic, real-world problem that can be accommodated within an academic schedule is challenging.

There are notable similarities between sustainability education and PBL, particularly in their emphasis on the practical relevance of societal practices, social learning, autonomy, and interdisciplinarity (e.g., Gudjons, 2008; Kokotsaki et al., 2016; Weijzen et al., 2024). Through PBL in higher education and VET, students do not only develop key skills for sustainability (Birdman et al., 2022; Lozano et al., 2017, 2019; Megayanti et al., 2020). Birdman et al. (2022) have even demonstrated that learners develop these skills to a greater extent than through any other learning activity. This skill growth occurs especially in relation to the complexity of real-world challenges, collaborative processes, solution-oriented stakeholder engagement, and transfer of knowledge into practice. Studies have identified a substantial positive shift in attitudes towards sustainability through PBL among university and VET students (Derkach et al., 2023; Perrault & Albert, 2018). Research has further demonstrated that PBL has a positive impact on the behavioral changes exhibited by student teachers in regard to environmental protection (Kılınç, 2010). PBL therefore enables changes in behavior and attitudes, two areas that are heavily debated in sustainability education (Scheunpflug et al., 2016).

A synthesis of extant research reveals that the discourse discusses PBL as a promising approach for sustainability education due to the positive findings on skill development, attitude development, and behavioral change. However, most studies on PBL for sustainability refer to vocational education at higher education institutions, not in dual VET (e.g., Lyu et al., 2025). Real-world connection, collaboration, and student autonomy are central characteristics of PBL, while time management and authenticity are some of its greatest challenges.

2.2. Desideratum: Roles and Success Factors in Teaching Sustainability in German VET

This study adds to the current state of research by investigating PBL for sustainability in the German dual system. Within this system, which we regard as a hierarchical model based on Bronfenbrenner's (1981) ecological systems theory, vocational schools and companies function as distinct learning environments. These entities should complement each other and cooperate in accordance with regulatory principles (BIBB, 2023). Despite cooperation being central to dual VET in theory, practice shows weak company–school ties (Gessler, 2017).

Notwithstanding the considerable body of literature that exists on PBL, studies are mostly not conducted in the context of dual VET (see above). We can only partially apply the existing results to dual VET, which offers strong potential for real-world connections through company–school cooperation, thereby solving one of the major challenges in PBL (Lee et al., 2014). To our knowledge, there are currently no empirical findings on success factors to facilitate PBL for sustainability in dual VET. Additionally, there is a paucity of research addressing the roles of vocational schools and their teachers in teaching sustainability. The prevailing focus has been on the role of educational staff and the

conditions necessary for success in the workplace as a learning environment in VET (see above). This focus is due to companies' dominant role in dual training and extensive third-party funding programs focused on companies. This study therefore (1) explores the role of teachers and vocational schools in teaching sustainability and (2) examines institutional and pedagogical factors that enable successful PBL for sustainability in the German dual VET system. The study is predicated on the premise that the implementation of sustainability in VET is a task for educational practice, as assigned by policy recommendations (e.g., United Nations, 2015).

3. Data and Methods

The qualitative, exploratory research design employs a triangulation approach that combines different data sources to address the two research questions. The following subsections describe the sampling and data collection (Section 3.1) and the data analysis approach (Section 3.2).

3.1. Sampling and Data Collection

We collected qualitative data from apprentices and pre-service teachers. Considering apprentices' perspectives is fundamental because they are the primary beneficiaries of vocational educational settings. This also avoids the risk that educators might overestimate the quality and quantity of PBL opportunities while uniquely assessing which school-based activities feel authentic, useful, and transferable to real-world sustainability challenges due to their immediate application needs.

The understanding of pre-service teachers' views on teaching sustainability is essential, as they permit a focus on the potential impact on the future in our study and show what is needed in teacher education. Their beliefs and approaches directly influence how they incorporate sustainability into the curriculum. Pre-service teachers' conceptualizations of the teaching role are less influenced by institutional inertia than those of current teachers. They exhibit a greater degree of receptivity to innovative approaches, such as PBL and sustainability-focused pedagogy. Their subjective understanding of the role of teachers in implementing PBL for sustainability is therefore linked to how such learning will be implemented in vocational schools in the future.

The potential of triangulating data from those groups lies in the systematic combination of diverse perspectives and consideration of various aspects (Flick, 2018). While interviews with apprentices capture the perspectives of individuals in depth, focus groups with pre-service teachers obtain many different perspectives on PBL for sustainability. By combining both, we can gain further-reaching insights than by applying one data collection technique (Flick, 2018).

We interviewed 15 apprentices from 15 companies in a partially standardized guided interview. The selection criteria included the company's affiliation with the IT or financial services industry and prior experience with PBL and sustainability as part of their dual training (e.g., in the form of implementing a resource conservation project within the company or a project on selling sustainable financial products at a vocational school). To reach a diverse group of apprentices and avoid potential sampling biases, the study was framed as an exploration of learning in companies and schools through projects, with sustainability presented as one important dimension of this broader context. The sample consisted of eight participants from the IT sector and seven from the financial services sector (two females and 13 males), including four in their first year, five in their second year, and six in their third year of training. Participants hailed from a variety of vocational schools and states, covered a range of occupations in both sectors, and were around 20 years old. We first asked the apprentices about the importance of sustainability for them and in

their apprenticeship, followed by questions on their autonomy in addressing sustainability at vocational schools, their perceived opportunities for co-determination to sustainability, and their experience with PBL for sustainability at vocational schools.

To gain insight into pre-service teachers' perspectives, we conducted two focus-group interviews with a total of 15 students from the same German university who took part in two different university courses that dealt with sustainability in the professionalization of teachers. Both courses employed project-based methods of sustainability education (e.g., design of prototypes for sustainability-oriented teaching). The students studied various education-related degree programs. The first focus group consisted of six students (five females and one male). They were around 22 years old. The second group consisted of nine master's students (three females and six males) who were around 25 years old. Although the focus groups took place in a university setting, no staff members who were superior to the students and who assessed their academic performance were present to prevent any biased answers. A trained moderator led each focus group, accompanied by a trained observer. This study analyzed only the transcripts, while observation protocols helped clarify any unclear context.

Participation in the interviews and focus groups was voluntary and anonymous. We transcribed the audio recordings from the interviews and focus groups verbatim and smoothed them out linguistically (Mayring, 2014).

3.2. Data Analysis

We collectively analyzed the data from interviews and focus groups with apprentices and pre-service teachers in a triangulation approach. This integration of two data sources enables the recognition of subjectivity in its multifaceted and contradictory forms (Flick, 2018). We formed categories using the MAXQDA 24 software following Mayring's (2014) qualitative content analysis. In creating categories, we draw on systematic literature reviews on PBL in schools and VET by Kokotsaki et al. (2016) and Megayanti et al. (2020), on the programmatic characteristics of PBL by Gudjons (2008), and on the study of PBL in vocational schools by Gessler and Sebe-Opfermann (2018). With regard to sustainability education, we draw on the contributions by Holst et al. (2023, 2025), Stern et al. (2018), Vare et al. (2019), Wagner et al. (2025), and Weijzen et al. (2024). We thus combine theoretical foundations from VET research, research on sustainability education, and research on PBL. In cases where these categories did not cover the material, we additionally formed inductive categories. We examined a comparison of the two sectors, but we found no differences in cases.

We defined coding rules for the preliminary category system before four people coded the data. Afterwards, peers in teams of two posed probing questions, challenged assumptions, identified potential biases, and offered alternative interpretations. Following this process of peer debriefing, questionable passages were discussed within the group of four coders. The results were presented to the authors, who refined the category system in a final round of coding through dialogue. This communicative validation process involved the authors engaging in critical discussion and working toward consensus on the final category system. We present and discuss the key findings in the subsequent chapter. For a comprehensive overview of the category system's primary categories, please refer to Table 1. We have numbered the interviews consecutively for anonymization and refer to these numbers below. The authors have translated all quotations from German.

Table 1. Roles and success factors in PBL for sustainability.

	Apprentices	Pre-Service Teachers
School/Teacher Role	• Complementary role • Venue for receiving knowledge • Topic repetition • Technical expertise development • Practical relevance • Rapid learning success	• Role model • Self-acceptance • Learning companion • Project advocacy
Success Factors	• Real-world connection • Learning location cooperation • Interactivity • Strong relationship • Balance of autonomy and guidance • Open communication culture • Respectful behavior	• Networks • Individualization • Interdisciplinarity • Strong relationship • Balance of autonomy and guidance • Open communication culture • Motivation • Resources

4. Results: Roles and Success Factors in Sustainability Education

The following subsections address the two research questions concerning the role of vocational schools and VET teachers in teaching sustainability (Section 4.1) and the institutional and pedagogical factors enabling successful PBL for sustainability in the German dual VET system (Section 4.2).

4.1. The Role of Vocational Schools and VET Teachers in Teaching Sustainability

To address research question one, the study firstly considers the perspectives of apprentices on the role of vocational schools and secondly considers the perspectives of pre-service teachers on the VET teachers' role.

4.1.1. Apprentices' Perspectives on Vocational Schools' Role in Teaching Sustainability

Vocational schools are perceived to function in a *complementary* manner to in-company training. The apprentices say that it mainly *repeats topics* from in-company training: "We learn in the company and then review the same topics at vocational school. At such times, we often already know ourselves which answer is correct. [. . .] So sometimes there are overlaps, and it's not always positive." (interview [int.] 1, position [pos.] 318). Vocational schools are distinguished by their emphasis on the *development of technical expertise for sustainability* amongst apprentices: "It [vocational school] is more technical, you learn [. . .] the technical terms and so on" (int. 2, pos. 496). A further function is to ensure the *practical relevance* of apprenticeships by addressing the practical aspect of sustainability. For example, an apprentice describes a situation in which a request for a practical example facilitated their understanding:

> "We simply asked: 'Hey, why don't you give us a practical example,' and then we've also explained, 'then we can visualize it better. We have a reference to reality.' And then that was also implemented and then it simplified things." (int. 5, pos. 484)

Vocational schools are perceived primarily as *venues for receiving knowledge*, as this quotation shows: "School is a place for learning. And the teacher teaches you something, so to speak, and that's why you're the student and don't tell the teacher what to do" (int. 12, pos. 72). The quotation emphasizes the limited agency of students in vocational schools, portraying these institutions as predominantly unidirectional in their educational approach.

The role of the school is also to achieve *rapid learning success* with sustainability. In interviews 2, 4, 5, 6, 8, and 12, the lack of time was identified as a defining factor in the role of vocational schools in teaching sustainability. Sustainability in general is addressed "when there is time" (int. 12, pos. 23), and related projects are not seen as part of the curriculum, as this example shows: "Then [when doing a project on sustainability], you fall behind with the lessons again and have to cancel some of them," (int. 4, pos. 23). PBL is associated with a high time investment because students think there is a ready-made solution that can be presented more quickly than conducting a project, as clearly illustrated by this quotation:

> "Yes, you can probably make the lessons more active and let the students work through the material themselves, but it always depends on how much time you have. Because it's faster when the teacher chews it over for you and you just have to learn it. Instead of working it out for yourself, because if you find something wrong, it's a bit pointless, yes." (int. 12, pos 78)

For PBL for sustainability, vocational schools would have to fundamentally revise their existing teaching and learning concepts, as this quotation shows: "From my experience of the apprenticeship so far, the very linearly planned teaching concept would have to be completely restructured and switched to clear working through small groups" (int. 9, pos. 365).

In summary, the function of vocational schools in teaching sustainability is mainly to strive for apprentices' passive assimilation of pre-existing knowledge with limited opportunities for interactive learning. PBL for sustainability is anticipated to require substantial time investment. Vocational schools primarily replicate in-company training content and serve as a complement to companies.

4.1.2. Pre-Service Teachers' Perspectives on Teachers' Role in Teaching Sustainability

Teachers should act as a *role model* and thereby be intrinsically motivated to engage in sustainable practices, while simultaneously inspiring others to act similarly without compulsion, as this quotation shows: "You really have to start early and should also be intrinsically motivated so that they do something for the environment, for example. And that it's not perceived as coercion." (focus group [fg] 1, pos. 493, participant [p.] 3). However, it is also essential that teachers embody a certain degree of *self-acceptance* by demonstrating that it is acceptable to not always act in a consistently sustainable manner, as this statement underscores:

> "I also think it's important to convey to myself that there is no such thing as black and white. Either I am totally sustainable or not. Instead, it's okay if you can't reconcile certain things with yourself or [. . .] don't want to. That's totally okay." (fg 1, pos. 1009, p. 5)

This is particularly relevant because the role model function can lead to conflicts, as this quotation shows:

> "Can I advocate this [to go by plane] if I am actually in favor of something like decarbonization, vegan, vegetarian food, if I want to teach my students later that we need something like solar plants and wind turbines? Am I allowed to do that? Or am I not allowed to? These are completely normal questions that each and every one of us has. I think it's perhaps also a matter of finding a balance for yourself, because I think I personally find it difficult to just do it perfectly on all points.". (fg 1, pos. 959, p. 4)

A self-accepting attitude gives teachers the chance to catch up on missing technical knowledge independently, as this example problematizes: "I don't have the technical

expertise in sustainability, but I think we hopefully learned how to do the right research and how to find your way into the topic during our studies" (fg 2, pos. 591, p. 4).

Teachers should furthermore regard themselves as a *learning companion* for apprentices, which is defined "as someone who stands aside in the respective learning process, [...] and tries to help" (fg 1, pos. 61, p. 4), possibly "as a kind of moderator" (fg 2, pos. 514, p. 6), who "knows their own limits" (fg 1, pos. 765, p. 3). Shared responsibility with the students is implied by this, as this quotation illustrates: "You don't always have to decide everything on your own. [...] You can also very, very often simply involve the kids" (fg 1, pos. 336, p. 3).

Finally, pre-service teachers perceive their role to be one of *advocating for projects* in external settings, as this example shows: "It is necessary to show assertiveness, also towards the school management and companies. [...] It is particularly important to be [...] convinced of the project" (fg 2, pos. 503, p. 3).

To summarize, the role of teachers is twofold: first, to serve as a role model in the field of sustainability education, and second, to demonstrate self-acceptance regarding their own behavior. They function as a learning companion, advocating for projects externally. Now that the roles have been differentiated more precisely, the following section deals with factors for successful PBL for sustainability.

4.2. Factors for Successful Project-Based Learning for Sustainability in German Dual VET

To address research question two, the study firstly considers the perspectives of apprentices and secondly considers the perspectives of pre-service teachers on success factors.

4.2.1. Apprentices' Perspectives on Success Factors for Project-Based Learning for Sustainability

PBL for sustainability is successful from apprentices' perspectives, if *real-world connection* is given, as this quotation shows: "So not just fictional scenarios that are worked on in class, but perhaps truly relevant topics or real problems that need to be solved." (int. 15, pos. 399). Particular emphasis is placed on the desire for projects to actually be implemented. In Interview No. 10, *cooperation between learning locations* is suggested as a possible way to ensure a real-world connection:

> "So what I would really love to see, for example, would be companies writing to schools and saying, yes, we would like to have something like this as a project. And then the students could work on projects in their classes, in groups, or something like that, with complete freedom and the support of their teachers, and then submit them to the companies. And then the company could choose a project, for example. That would be really cool for all the students, too, because they would have actually done something that is implemented in the real world." (int. 10, pos. 239)

Interactivity further supports the feeling to contribute to actual, tangible outcomes: "the feeling of being able to make a difference arises when lessons are interactive" (int. 7, pos. 229). Interactivity also has a motivational function. One apprentice draws the following conclusion from an experience with PBL: "Interactivity also made the whole thing more fun and you were somehow a bit more motivated and wanted to listen or do the tasks, to deal with the topic in depth." (int. 8, pos. 826)

Furthermore, a *strong student–teacher relationship* is important. In the absence of such a relationship, apprentices may feel unable to contribute to the educational setting, as this quotation illustrates: "The relationship is not personal, so I don't have the feeling that I can have a say or contribute anything." (int. 2, pos. 483). This relationship can be enhanced by PBL for sustainability, as one apprentice reflects from an experience: "The relationship

between teachers and students improved, and you got the feeling that you belonged to the community." (int. 3, pos. 13)

For PBL for sustainability to be successful, apprentices view a *balance between autonomy and guidance* as important. Autonomy granted to apprentices, such as the "option to work freely" (int. 7, pos. 250), is preferred: "I think it's better, of course, if you deal with the issue yourself instead of just being told about it" (int. 15, pos. 443). Nevertheless, some guidance is necessary, as described: "It is very motivating for me to have clearly defined the various requirements in advance, as I then have a fixed roadmap for where I am going or at least can already see a rough path." (int. 9, pos. 305). Giving guidance also involves clarifying "how much time this will take." (int. 12, pos. 96).

PBL for sustainability can be successful if learning environments are characterized by an *open and constructive culture of communication*. The material sets out a series of principles that define this culture of communication, including being open (int. 6), defining clear responsibilities (int. 6), finding compromises (int. 8), establishing an open feedback culture (int. 13) and communicating on equal terms (int. 15). Another cultural aspect is the expectation of *respectful behavior* to meet sustainability standards: "Above all, you also have to say that sustainability is not just the kind of practical behavior of living sustainably, but I think it also involves a lot of social aspects, so simply treating each other with respect" (int. 8, pos. 116). A culture of respect is required between teachers and learners and within the learners' group when working collaboratively.

To summarize, a combination of real-world connections, a balanced approach to autonomy and guidance, and an open and constructive culture of communication are key factors that enhance motivation for PBL for sustainability from apprentices' perspectives. Real-world connection is contingent on cooperation between learning locations, interactivity, and a strong student–teacher relationship.

4.2.2. Pre-Service Teachers' Perspectives on Success Factors for Project-Based Learning for Sustainability

From pre-service teachers' perspectives, *networks* are important for PBL for sustainability, as this quotation shows: "A lot has to be clarified beforehand and especially among colleagues: 'Hey, I would do a project week, but I would definitely need people to go along.'" (fg 1, pos. 687, p. 5). These networks include internal connections at school and learning location cooperation. For pre-service teachers, it is considered particularly important to meet learners *individually*, taking into account their interests and current level of learning: "To pick up pupils at their respective locations, i.e., to accompany them individually and appropriately" (fg 1, pos. 758, p. 4). *Interdisciplinarity* is a way to ensure individuality, as the following quotation illustrates: "to break away from discipline-specific approaches and perhaps simply to start thinking independently again as an individual or private person" (fg 2, pos. 126, p. 1). Networks and interdisciplinarity help to address sustainability as a complex, multifaceted topic from different perspectives.

An appropriate *balance between autonomy and guidance* is also considered an important success factor, as the following quotation shows: "That is perhaps also our task, that we somehow give impulses, but that it is still so interactive that [the apprentices] can contribute independently" (fg 1, pos. 69, p. 3). In interdisciplinary settings in particular, a specific task is helpful as a point of reference.

Pre-service teachers feel responsible for building *strong student–teacher relationships*: "I think you just have to make sure that [. . .] you don't just look at the project, but also at the student" (fg 2, pos. 238, p. 4). An *open and constructive culture of communication* is also required for PBL for sustainability, as this quotation shows: "Also openness, that you're not so completely set in your ways and deny the youths all their ideas straight away."

(fg 1, pos. 749, p. 1). Since sustainability carries the risk of generational conflict, open and constructive communication is seen as one way to overcome problems in PBL.

Pre-service teachers attribute the success factor of *motivation* both to themselves and to the apprentices, as illustrated by the following quotations: "Yes, and we also need motivated students, which is often where we fall short" (fg 2, pos. 228, p. 6); "So you [as a teacher] really have to [. . .] be intrinsically motivated to do something for the environment." (fg 1, pos. 493, p. 3). Achieving motivation among learners is even described as the "main goal" (fg 1, pos. 224, p. 2) of PBL for sustainability. Another aspect is the availability of various *resources*, such as time, money, and personnel (fg 2, pos. 221, p. 3, p. 4, p. 5). Resource management is referred to as "the most important thing" in focus group two (pos. 223, p. 3).

Table 1 provides a concise overview of the overall results. Several categories are consistent across the apprentices' and pre-service teachers' perspectives, including a balance between autonomy and guidance, a strong student–teacher relationship, and an open and constructive culture of communication. The responsibility for establishing relationships and a respectful communication culture is primarily attributed to teachers. The perspective of pre-service teachers complements the perspective of apprentices by drawing connections between interdisciplinarity, relationship building, and balancing autonomy and guidance. While pre-service teachers' statements refer to motivation (of learners and teachers) and resource management, apprentices place stronger emphasis on interactivity and the vocational school's complementary role to in-company training, which is to deliver knowledge, repeat topics, develop technical expertise, establish practical relevance and ensure rapid learning success.

Overall, three recurring aspects in the categories prove to be particularly influential for PBL for sustainability in dual VET: Firstly, the emphasis on rapid learning success, the prioritization of resources, and the depiction of vocational school as repetitive and devoid of interactivity underscore the prevailing *scarcity of resources* as one predominant factor. Secondly, the prioritization of practical relevance, real-world connections, interschool networks, cooperations, and interdisciplinarity indicates that *learning location cooperation* is a crucial factor. Thirdly, the learning companion role, the emphasis on strong relationships, and the definition of how to balance autonomy and guidance, as well as the motivational and cultural aspects, demonstrate that *relationship building* should be prioritized. The following discussion will address these three key findings in the context of the prevailing discourse and their ramifications for research and practice.

5. Discussion: Resource Management, Cooperation and Relationship Building at Vocational Schools

The findings revealed that a *lack of resources* poses significant challenges to PBL for sustainability. Apprentices express a common concern that PBL for sustainability requires considerable time. They perceive vocational schools primarily as environments for passive knowledge reception while simultaneously acknowledging the benefits of interactivity. Other studies have identified a demand for innovative teaching methods in VET (e.g., Ostuni, 2025). In addition to time constraints, the interviewees also identify financial resources and staffing as further challenges. Lack of time and personnel are challenges known in the discourses on sustainability education (e.g., Holst et al., 2025; Wagner et al., 2025), PBL in VET (e.g., Gessler & Sebe-Opfermann, 2018), and learning location collaboration in VET (e.g., Schwede et al., 2025). It is also well known that sustainability is frequently regarded as a supplementary element of educational settings (e.g., Holst et al., 2023). Considering these findings, it is unsurprising that our participants predominantly regard PBL for sustainability as a resource expender that is desirable but does not align with the voca-

tional school mandate of rapid learning success. These insights underscore the necessity of equipping vocational schools with adequate resources while overcoming the tendency to view sustainability-oriented teaching approaches as a time-consuming add-on instead of a part of the regular curriculum. Given the significant impact of school leadership on resource management and educational reforms (cf. Huber & Pruitt, 2024), further research is necessary to examine the role of school principals in promoting PBL for sustainability. Such research may build on the increasingly extensive discourse on sustainability in school leadership (see Huber & Schneider, 2022, for a review of the literature). Incorporating additional stakeholders, such as current vocational school teachers, would help ensure a comprehensive evaluation.

PBL for sustainability and *learning location cooperation* go hand in hand, as the results show. Pre-service teachers consider internal and external networks important, while apprentices consider external partnerships that connect them to the real world valuable. In our study, we see vocational schools reduced to technical aspects. The practical part of the dual training serves as the baseline, which is then built upon in school. This description of a complementary function of schools indicates that the decades-old assumption that on-the-job training took place in companies and that theoretical training and follow-up work took place in schools (Sloane, 2022) remains prevalent, with the addition that practical relevance is strongly expected at vocational schools. Schools rarely exploit the potential to take up real learning opportunities from the training companies. This is especially problematic and unfortunate in dual VET. While higher education typically relies on the establishment of real-world connections through artificial means, dual VET is characterized by practical learning situations that offer a more authentic and hands-on learning experience. Interfaces are often where sustainability skills develop, which is why cooperation across fields and education levels is important (Holm et al., 2017). Accordingly, collaborating with companies in PBL enhances the development of sustainability skills (Lyu et al., 2025). VET offers particular potential for interdisciplinarity and transdisciplinarity—two important principles in sustainability education (e.g., Vare et al., 2019; Weijzen et al., 2024). In fact, learning location cooperation embodies transdisciplinarity by integrating diverse knowledge, fostering stakeholder collaboration, focusing on real-world problem-solving, and creating holistic educational experiences that emphasize connections across various fields. Our study highlights real-world connection as a key driver of successful PBL for sustainability, and the literature likewise notes that incorporating concrete workplace sustainability issues makes the topic more relevant for learners (e.g., Coll et al., 2003; Cörvers et al., 2016; Weijzen et al., 2024). In the German dual system, company trainers primarily bear responsibility for learning location cooperation (BIBB, 2023), while teachers are expected to facilitate collaborations in sustainability education (Vare et al., 2019). The data indicates that pre-service teachers recognize the necessity of cooperation. However, cooperation opportunities and the different focuses of learning locations are rarely acknowledged. One advantage of vocational schools in comparison to companies is that they are less tied to the logic of utilization in learning sustainability. Research and practice can leverage our findings to strengthen cooperation between the two learning locations. The collaboration potential between them has long been underutilized (Gessler, 2017), and sustainability-focused teaching underscores the importance of cooperation. There is potential for cooperation not only between learning locations, but also among teaching staff at schools, as our study and other international studies demonstrate (e.g., Ostuni, 2025). Further research should incorporate a diverse array of stakeholders, including company training and school staff, to assess cooperation potential in more detail.

Both actor groups place significant emphasis on the importance of *relationships*. Specifically, teachers are expected to adopt a learning companion role, adeptly balancing autonomy

and guidance. Meanwhile, schools are charged with fostering agency through motivational and cultural aspects. While PBL creates positive relationships between apprentices and teachers, this positive relationship also serves as a success factor for PBL for sustainability. In addition, the results reveal a strong relationship between the student–teacher relationship and students' involvement at school. Apprentices have highlighted that sustainability goes beyond the practical application of sustainable living to include relational aspects like interacting with peers and supervisors. The importance of autonomy, respect, and accessibility in sustainability education has been well established (e.g., Vare et al., 2019). Many other studies highlight balancing direct instruction with independent inquiry and student autonomy as key PBL success factors (see Kokotsaki et al., 2016, for a review of the literature). This study now brings these findings together and shows that relationships and culture play a greater role in PBL for sustainability than previously assumed. This shows that, as Bronfenbrenner (1981) suggests, specific environmental factors shape learning situations. Major cultural trends affect vocational schools, such as those toward a positive failure culture or toward a sustainable lifestyle. Interestingly, although participants mention the role model function of teachers—whose importance for sustainability outcomes is well known from previous research (e.g., Stern et al., 2018)—this function remains less relevant in relation to relationship aspects and is weakened by the fact that pre-service teachers do not aspire to have a perfectly sustainable lifestyle. Instead, they appreciate that PBL allows them to share responsibility with apprentices.

Student involvement can support learning for sustainability. However, the schools' approach fails to address the apprentices on a personal level, thereby preventing them from developing a sense of involvement. Students are instead afraid of making mistakes. The dearth of personal relationships may engender a sense of disempowerment, whereby students feel they are unable to contribute to their education. This issue is problematic because the extant literature considers participation to be essential for sustainability (e.g., Læssøe, 2010). It is also known that social support and access strongly determine action, while knowledge has a negligible effect (Albarracín et al., 2024). Establishing relationships that encourage autonomy and a sense of purpose is therefore particularly important when it comes to sustainable action. Suggested solutions to promote ownership of learning arise directly from the data: It is the responsibility of teachers to act as learning companions, being a point of contact at critical points, thereby finding an optimal balance between autonomy and guidance, a balance that is reciprocal and interdependent. However, research also shows that apprentices reject progressive roles and apparently prefer traditional teaching and role concepts at school (Keller & Raemy, 2025). Supporting learners in their self-directed learning is therefore not always easy for teachers, and the current role of negotiation is not only up to teachers, but also to apprentices. Vocational schools should reposition themselves within the VET system and go beyond being venues for receiving knowledge. Instead, they should act as collaborative environments where students have a voice in decision-making and shaping their educational experiences. Our study shows that a systematic implementation of PBL for sustainability in vocational schools fosters positive teacher–student relationships, thereby facilitating autonomy and engagement among students. These factors can ultimately yield sustainable actions. It is however important to note that PBL does not always include a high degree of autonomy. PBL is defined more by the duration of the project than by the degree of autonomy (e.g., Megayanti et al., 2020). Further studies are needed to develop more detailed didactic recommendations based on our success factors. Involving current teachers, who may be influenced by institutional inertia and exhibit a lesser degree of receptivity to innovative approaches, could be helpful to ensure their acceptance of such approaches.

This study contains several potential sampling biases that should be acknowledged when interpreting the findings. Participants who chose to engage were more likely to be interested in PBL and sustainability, motivated to share their perspectives, or have stronger opinions about the topic than those who declined. This means the sample may overrepresent individuals with a strong interest or opinion on the topic, potentially skewing the findings toward more positive or engaged perspectives on sustainability education and PBL. Participants of the focus groups were limited to those who actively chose to enroll in sustainability-focused courses, rather than representing the broader population of pre-service teachers. These students are likely to have more positive attitudes toward sustainability education and greater exposure to sustainability than pre-service teachers who did not take these specific courses. The findings may not generalize to pre-service teachers who received minimal or no sustainability training in their teacher education programs. Future research could address this limitation by implementing diverse access routes, such as recruiting pre-service teachers from both sustainability-focused and general teacher education courses. Active, tailored outreach efforts (e.g., customized digital approaches) have the potential to ensure representation of apprentices across a range of sustainability and PBL exposure levels. The study focused on apprentices from the IT and financial services sectors, which may not represent other sectors with different sustainability challenges, practices, and educational approaches. A more holistic picture could be created by considering other sectors and professions in further studies. An investigation into the effectiveness of PBL for sustainability—that is, the actual effects on learning outcomes, professional practice, or corporate sustainability performance—would require different empirical designs and represent a desideratum.

6. Conclusions

PBL has been identified as a promising method for sustainability education in VET, demonstrating higher gains in sustainability-skill development in comparison to alternative approaches. Despite the extensive literature on PBL for sustainability, research specifically focusing on dual VET—particularly regarding the roles of vocational schools and teachers and success factors—remains scarce. The dual VET system is a critical yet underexplored context for sustainability education research. It uniquely enables real-world connections through collaboration between workplace and school settings, allowing authentic and transdisciplinary sustainability education through projects.

The insight that real-world connections and learning location collaboration enable authentic PBL for sustainability is highly transferable to countries with strong VET systems (such as Switzerland, Austria, France, and the Netherlands) since they share similar structural elements where workplace learning and school-based instruction coexist. However, the specific role of vocational schools as complementary to workplace training may vary depending on national VET structures. In systems where vocational schools have more autonomy, the school's role might be more transformative rather than complementary. The finding that relationships and culture play a greater role in PBL for sustainability than previously assumed is universally applicable across educational contexts, as relational dynamics are fundamental to learning regardless of national boundaries. The resource constraints identified (particularly time and personnel shortages) are likely to be common challenges in sustainability education across most VET systems, making this finding highly transferable. We see funding potential on the part of companies here, as they have an interest in promoting sustainability in schools.

The most significant adaptation needed for transferability would be recognizing that in countries without a dual system, vocational schools may need to actively create the real-world connections that the German dual system inherently provides. In these contexts,

the school's role would need to be more proactive in establishing workplace partnerships to achieve the same authentic learning experiences. In addition to the institutionalization of employer partnerships, our findings suggest that schools should strongly incorporate authentic, work-based learning into their curricula.

Ultimately, the study demonstrates that when vocational schools intentionally leverage their system's inherent real-world connections and collaborative potential through PBL, they can transform from passive knowledge venues into active sustainability catalysts. This transformative potential is applicable to any VET system that can establish meaningful workplace–school connections. By centering apprentices' and pre-service teachers' perspectives, we reveal that intentional learning location collaboration unlocks PBL's potential to foster sustainability engagement and action within (German) dual VET. PBL for sustainability has the potential to empower apprentices to become sustainability agents who can navigate complex challenges with relational awareness, considering technical competence from multiple perspectives.

Author Contributions: Conceptualization, J.H.; methodology, J.H. and S.A.; software, J.H.; validation, J.H. and S.A.; formal analysis, J.H.; investigation, J.H.; resources, J.H.; data curation, J.H.; writing—original draft preparation, J.H.; writing—review and editing, J.H. and S.A.; visualization, J.H. and S.A.; supervision, S.A.; project administration, J.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: In Germany, approval from the ethics committee is not necessary for studies such as the one we have conducted. A research project involving participants and affected persons, where no risks or harm to the participants are expected and which does not violate basic ethical principles, does not require ethics approval. The questions asked in the fieldwork do not pose any particular risk or burden to these individuals compared to their everyday lives. All participants gave their informed consent for inclusion before participating in the study.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy reasons and in accordance with the data protection laws in Germany.

Acknowledgments: We would like to extend our sincere gratitude to Annette Scheunpflug for her invaluable support and advice throughout this study. We would also like to acknowledge the greater research team in conducting the overall research project, namely Stefanie Badmann, Christian Gärtner, Christina Schell, and Lisa Scheuring. The publication of this article was supported by the Open Access publication fund of the University of Bamberg.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

IT	Information technology
PBL	Project-Based Learning
VET	Vocational Education and Training

Note

[1] The German dual VET system combines paid, on-the-job training in a company with part-time classroom instruction at a vocational school. Apprentices thus acquire practical skills while simultaneously completing a formal curriculum that leads to a recognized qualification.

References

Albarracín, D., Fayaz-Farkhad, B., & Samayoa, J. A. G. (2024). Determinants of behaviour and their efficacy as targets of behavioural change interventions. *Nature Reviews Psychology*, *3*(6), 377–392. [CrossRef]

Beer, M., Frommberger, D., & Steinkamp, H. (2024). Sustainable management and training—Approaches to qualifying trainees and in-company vocational training staff in the dual system. In R. Hermann, H. Kress, & J. Olesen (Eds.), *Sustainability in Vocational Education and Training—National and international experiences* (pp. 203–214). Verlag Barbara Budrich.

Bengtsson, F., & Ågerfalk, P. J. (2011). Information technology as a change actant in sustainability innovation: Insights from Uppsala. *The Journal of Strategic Information Systems*, *20*(1), 96–112. [CrossRef]

BIBB. (2023). *Empfehlung des hauptausschusses des bundesinstituts für berufsbildung vom 20. Juni 2023 zum rahmenplan der ausbilder-eignungsverordnung*. BIBB.

Birdman, J., Wiek, A., & Lang, D. J. (2022). Developing key competencies in sustainability through Project-Based Learning in graduate sustainability programs. *International Journal of Sustainability in Higher Education*, *23*(5), 1139–1157. [CrossRef]

Bronfenbrenner, U. (1981). *The ecology of human development*. Harvard University Press. [CrossRef]

Coll, R. K., Taylor, N., & Nathan, S. (2003). Using work-based learning to develop education for sustainability: A proposal. *Journal of Vocational Education & Training*, *55*(2), 169–182. [CrossRef]

Cörvers, R., Wiek, A., de Kraker, J., Lang, D. J., & Martens, P. (2016). Problem-based and Project-Based Learning for sustainable development. In H. Heinrichs, P. Martens, G. Michelsen, & A. Wiek (Eds.), *Sustainability science* (pp. 349–358). Springer. [CrossRef]

Dec, P., & Masiukiewicz, P. (2021). Socially responsible financial products as a contribution of financial institutions to sustainable development. *Sustainability*, *13*(6), 3067. [CrossRef]

Derkach, T. M., Bilianska, M. M., & Yaroshenko, O. G. (2023). Project-Based Learning as an approach to enhance ecological component in professional education. *Educational Technology Quarterly*, *2023*(4), 481–497. [CrossRef]

Feichtenbeiner, R., Weber, H., Hantsch, R., & Berger, N. (2022). *Establishing sustainable learning venues: A guideline for training companies on the road to becoming more sustainable. Vocational Education and Training in practice*. Barbara Budrich.

Flick, U. (2018). *Doing triangulation and mixed methods. The sage qualitative research kit*. Sage. Available online: https://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=3287558 (accessed on 24 October 2025).

Gessler, M. (2017). The lack of collaboration between companies and schools in the german dual apprenticeship system: Historical background and recent data. *International Journal for Research in Vocational Education and Training*, *4*(2), 164–195. [CrossRef]

Gessler, M., & Sebe-Opfermann, A. (2018). Project-based learning in German Vocational Education and Training: A structured approach to developing self-determined, cooperative problem-solving competence. *Boletim Técnico do Senac*, *44*(3), 374–441.

Gudjons, H. (2008). *Handlungsorientiert lehren und lernen. Erziehen und unterrichten in der schule*. Julius Klinkhardt.

Holm, T., Vennervirta, P., Pöykkö, T., Hämeenoja, E., & Teirasvuo, N. (2017). Identification of skills needed for central areas of green and low-carbon economy, for the needs of labor market, in Finland. *European Journal of Sustainable Development Research*, *1*(1), 5. [CrossRef]

Holst, J., Brock, A., Grund, J., Schlieszus, A.-K., & Singer-Brodowski, M. (2025). Whole-school sustainability at the core of quality education: Wished for by principals but requiring collective and structural action. *Journal of Cleaner Production*, *519*, 145897. [CrossRef]

Holst, J., Singer-Brodowski, M., Brock, A., & De Haan, G. (2023). Monitoring SDG 4.7: Assessing education for sustainable development in policies, curricula, training of educators and student assessment (input-indicator). *Sustainable Development*, *32*(4), 3908–3923. [CrossRef]

Huber, S. G., & Pruitt, J. (2024). Transforming education leadership through multiple approaches to develop and support school leadership. *Education Sciences*, *14*(9), 953. [CrossRef]

Huber, S. G., & Schneider, N. (2022). Developing school leadership: Trends, concepts, approaches and impact. *eJournal of Education*, *22*(1), 1–30.

Keller, A., & Raemy, P. (2025). Emphasising self-directed learning in VET-schools: Teachers' convictions and role negotiations. *International Journal for Research in Vocational Education and Training*, *12*(1), 1–19. [CrossRef]

Kılınç, A. (2010). Can Project-Based Learning close the gap? Turkish student teachers and proenvironmental behaviours. *International Journal of Environmental & Science Education*, *5*(4), 495–509.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-Based Learning: A review of the literature. *Improving Schools*, *19*(3), 267–277. [CrossRef]

Lambini, C. K., Goeschl, A., Wäsch, M., & Wittau, M. (2021). Achieving the sustainable development goals through company staff vocational training—The case of the federal institute for Vocational Education and Training (BIBB) INEBB project. *Education Sciences*, *11*(4), 179. [CrossRef]

Læssøe, J. (2010). Education for sustainable development, participation and socio-cultural change. *Environmental Education Research*, *16*(1), 39–57. [CrossRef]

Lee, J. S., Blackwell, S., Drake, J., & Moran, K. A. (2014). Taking a leap of faith: Redefining teaching and learning in higher education through Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning*, *8*(2), 2. [CrossRef]

Liu, H. (2019). Barriers of Project-Based Learning in teaching and learning of Chinese technical and Vocational Education and Training (TVET): A review. *TVET@Asia*, *12*, 1–14.

Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2019). Teaching sustainability in European higher education institutions: Assessing the connections between competences and pedagogical approaches. *Sustainability*, *11*(6), 1602. [CrossRef]

Lozano, R., Merrill, M., Sammalisto, K., Ceulemans, K., & Lozano, F. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. *Sustainability*, *9*(10), 1889. [CrossRef]

Lyu, J.-Y., Lin, W.-B., & Wang, P.-S. (2025). Integrating green finance into vocational education. *American Journal of STEM Education*, *15*, 23–44. [CrossRef]

Mayring, P. (2014). *Qualitative content analysis: Theoretical foundation, basic procedures and software solution*. SSOAR. Available online: https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173 (accessed on 24 October 2025).

Megayanti, T., Busono, T., & Maknun, J. (2020). Project-Based Learning efficacy in vocational education: Literature review. *IOP Conference Series: Materials Science and Engineering*, *830*(4), 42075. [CrossRef]

Nation, M. L. (2008). Project-Based Learning for sustainable development. *Journal of Geography*, *107*(3), 102–111. [CrossRef]

Ostuni, C. (2025). *Empowering VET teachers with the skills to tackle the challenges of sustainable development and drive innovation*. VETNET. [CrossRef]

Perrault, E. K., & Albert, C. A. (2018). Utilizing Project-Based Learning to increase sustainability attitudes among students. *Applied Environmental Education & Communication*, *17*(2), 96–105. [CrossRef]

Ramsarup, P., McGrath, S., & Lotz-Sisitka, H. (2024). A landscape view of emerging sustainability responses within VET. *Journal of Vocational Education & Training*, *76*(2), 259–280. [CrossRef]

Scheunpflug, A., Krogull, S., & Franz, J. (2016). Understanding learning in world society: Qualitative reconstructive research in global learning and learning for sustainability. *International Journal of Development Education and Global Learning*, *7*(3), 6–23. Available online: https://eric.ed.gov/?id=EJ1167818 (accessed on 24 October 2025). [CrossRef]

Scheunpflug, A., Osterrieder, M., Banze, A.-C., & Abele-Brehm, A. (2023). Global values in school curricula. In D. Bourn, & M. Tarozzi (Eds.), *Pedagogy of hope for global social justice* (pp. 59–76). Bloomsbury Publishing Plc. [CrossRef]

Schwede, J., Heisler, D., & Harteis, C. (2025). Integrating practice-based learning into formal education: Stakeholder perspectives on the challenges of learning location cooperation (LLC) in Germany's dual VET system. *Social Sciences*, *14*(3), 117. [CrossRef]

Sloane, P. F. E. (2022). Rereading kerschensteiner today: Doing VET in German vocational schools—A search for traces. *Journal of Philosophy of Education*, *56*(3), 408–424. [CrossRef]

Stern, M. J., Frensley, B. T., Powell, R. B., & Ardoin, N. M. (2018). What difference do role models make? Investigating outcomes at a residential environmental education center. *Environmental Education Research*, *24*(6), 818–830. [CrossRef]

Strotmann, C., Kastrup, J., Casper, M., Kuhlmeier, W., Nölle-Krug, M., & Kähler, A.-F. (2024). A model for structuring and describing sustainability-related competencies for trainees in the food crafts and food industry. In R. Hermann, H. Kress, & J. Olesen (Eds.), *Sustainability in Vocational Education and Training—National and international experiences* (pp. 129–146). Verlag Barbara Budrich.

United Nations. (2015). *Transforming our world: The 2030 Agenda for sustainable development*. United Nations.

Vare, P., Arro, G., de Hamer, A., Del Gobbo, G., de Vries, G., Farioli, F., Kadji-Beltran, C., Kangur, M., Mayer, M., Millican, R., Nijdam, C., Réti, M., & Zachariou, A. (2019). Devising a competence-based training program for educators of sustainable development: Lessons learned. *Sustainability*, *11*(7), 1890. [CrossRef]

Wagner, S., Keller, M. V., Schlögl-Flierl, K., & Daumiller, M. (2025). "Was denn noch?" wie lehrkräfte den auftrag zur umsetzung von bildung für nachhaltige entwicklung wahrnehmen. *GAIA—Ecological Perspectives for Science and Society*, *34*(3), 151–160. [CrossRef]

Weijzen, S. M., Onck, C., Wals, A. E., Tassone, V. C., & Kuijer-Siebelink, W. (2024). Vocational education for a sustainable future: Unveiling the collaborative learning narratives to make space for learning. *Journal of Vocational Education & Training*, *76*(2), 331–353. [CrossRef]