How to Foster the Awareness for Sustainable Development in Vocational Training with the Help of Audits

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***Abstract* — The paper reviews an approach within vocational training that makes use of the audit principles to create awareness and responsibility for sustainable development within corporate structures. First, company-adaptable courses are carried out to underpin the chances for business development regarding sustainability. Subsequently, the instructors introduce the apprentices to a methodology of dealing independently with company-specific topics such as waste of raw materials. Here, the audit principles support the apprentices in making reasoned statements on the progress with the help of e.g., key performance indicators for sustainable development. Based on these insights and the knowledge gained, they carry out improvement actions and projects in terms of e.g., service-learning-processes. In the long run, apprentices become aware of 1) methods to improve processes and 2) the value of sustainability as well as 3) their very own ability to change their work environment. The "*NAUZUBI*" project has been conducted in the context of a third party funded pilot project of the Federal Institute for Vocational Education and Training commissioned by the German Federal Ministry of Education and Research. Thereby, it is an element of the action program on Education for Sustainable Development (ESD) and linked to the UNESCO Global Action Program on ESD.**

Keywords — Engineering Education; Sustainability Audits; Quality Management; Key Performance Indicators; Service-Learning-Processes

I. INTRODUCTION

According to publications of the UNESCO Global Action program on Education for Sustainable Development (ESD) a *paradigm shift* towards the focus on sustainable education is to be predicted in the professional world [1], [2]. However, the changing nature of nowadays work already requires employees that have "skills to be effective in a global environment" [3]. Knowledge for *sustainable development* at all corporate levels, which in turn requires the acceptance of cultural diversity and future generation, is a necessity to foster "global awareness" and thus promote *peace engineering* [4], [5].

Regarding the last decade of well-documented endeavors towards integrating sustainability topics within the German system of vocational education and training, a persistently high level of commitment (e.g., external funding) is evident [6], [7]. Here, the pilot project "*NAUZUBI*" complements and focuses on specific aspects of sustainability within technical vocational education and training (TVET) by making use of industrially established quality management methodologies. Auditing enables integrating the topic of sustainable development into company-based training structures. Accompanied by the University of Siegen, the Darmstadt University of Technology, and the Technical University of Munich, five associated companies, three vocational schools, the German Trade Union Confederation and the Chamber of Industry and Commerce in North Rhine-Westphalia, young apprentices independently conceive, plan and realize sustainability audits within different industrial areas. Prior to supervising the apprentices throughout the process, the trainers attend a teach-the-trainer workshop which introduces methods on how to instruct the apprentices about sustainable development and the audit methodology.

The taken approach is (by-design) didactical-reasoned and easily adaptable to other areas of industry. It promotes the essential values of peace engineering, i.e., sustainability and capacity of reflection and thereby it contributes to answer the question "How to learn about Peace Engineering?" [8].

II. USING THE AUDIT PRINCIPLES AS A VEHICLE FOR PROMOTING AWARENESS FOR SUSTAINABLE DEVELOPMENT

A. The German Dual System in Vocational Training

Vocational education and training (VET) in Germany is based on a cooperation between two learning venues. One learning venue of the apprenticeship training is school-based and often realized in vocational-specific inter-company training centers. Here, regional committees are in charge and include employer and employee representatives convened by the relevant federal states. The other venue is the place of training within the company providing vocational training for young apprentices. Both learning venues build the so-called German *Dual System*. Recently, e.g., the United States Department of Labor has shown a keen interest of transferring structural parts of the general concept of the German "*Ausbildung*" into the United States vocational education concepts [10], [11], [12].

Here, the ministries of education and cultural affairs in the federal states cooperate in a standing conference (*KMK*) in order to ensure nationwide comparability of the examinations, which typically integrate theory and practice. Also, the Federal Institute for Vocational Education and Training (BIBB) shall

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be responsible for research and serves as an adviser for the federal government as well as other vocational training providers. The BIBB is commissioned by the Federal Ministry of Education and Research (BMBF). It has a steering role for all training occupations and is in charge of general VET policy issues [13].

The BIBB takes care of 18 pilot projects within the BMBF program complex "Vocational Education and Training for Sustainable Development 2015-2019". It can be split into three clusters. The focus of six projects of funding line I is on the "*Development of training and qualification concepts for sustainability in commercial occupations*" and six projects in funding line II relate to the "*Establishment of a sustainable learning venue in vocational education and training institutions*". Funding line III focuses on "*Development of domain-specific sustainability competencies in food sector occupations in the craft trades and in industry"*. The aim of funding line II is the organizational and personnel development of trainees and professionals in vocational education and training. The way of implementing sustainability in training and working practice is to be experienced and influenced within the respective work environment. The aim is the development of indicators that define a sustainable learning venue [14]. One of these six pilot projects, that can be found in funding line II of the BIBB, is called "*NAUZUBI*", which is the German acronym for: *"Sustainability Audits with young apprentices"*.

B. Sustainable Development in the German VET-System

The term Sustainable Development originates from forestry and describes a permanent provision of resources, in the context of a contemporary understanding of an intra- and intergenerational equity [15]. The connotation of the German term includes the claim of a holistic and well thought out concept. Consequently, sustainability is a comprehensive social process and is seen as a cross-section task, e.g., ethical principles of a company or an institution show a clear link to economic activities. "Ecological", "economical" and "social" aspects build the tree dimensions which are considered as pillars of sustainable development [16]. The concept of sustainability appears in different contexts and different degrees of maturity. Thereby, it is an integral part of scientific discourses and involved in economic, social and political processes [17], [18]. In the context of sustainable development, an important definition was provided by the UN-WCED as part of the global discussion on environmental protection and global challenges, such as climate change [19]. Platforms like these provide an important starting point and increase the awareness of an appropriate way of addressing topics in the context of sustainability regarding its complexity, scope and long-term development. The (German) Government and international programs reflect these aspects of sustainable development [20], [21].

In the German-speaking world, sustainability is often used acronymically and refers to its use of North American concepts which primarily focus on single specific aspects of sustainable development, e.g., Corporate Social Responsibility (CSR). It is considered as a strategic tool of management achieving CSR through concrete measures [22]. In turn, the impact of these measures corresponds with the criteria of sustainable development. In the United States, the CSR discussion has necessarily taken place much sooner further back in the past due to its economic history. In the European region, material rationality has found its place early as the "individual basis of the CSR" beyond the principle of the *respectable businessman* as fundamental instrument of European business ethics [23]. This means that the current aspirations regarding sustainable development within the European Union are based on values and moral concepts which cannot be traced back to American economic history [25]. At the European level, this is also a reason why the interest in voluntary but binding regulations on sustainability within the economy has increased in the course of globalization and reoccurring multinational companies. Meanwhile in the United States, substantial aspects (CSR) have been discussed extensively since the middle of the last century. Ultimately, sustainability must be contextualized and defined referring to prevailing ideas within cooperating economic areas, participating organizations and actors. This applies in particular since the individual dimensions of sustainability have changed significantly in the past decade [27]. Therefore, it is advisable to agree on an organizational and project-specific comprehension of sustainability, based on different definitions as the first step within such an interdisciplinary consortium.

Extensive pedagogical research shows that the major issues of sustainable education to be addressed are the development of responsibility on an individual and social basis as well as creating global awareness concerning moral and normative aspects of sustainable development [29]. Here, sustainable development has been represented as a complex construct with poly-dimensional components, which is oriented towards processes and communication and is of cross-functional character [31]. Furthermore, heuristic structures are more likely to be found than linear structures. They are essential in basic education. Not only is it important for vocational education and training but is also linked to the functional system [ibid.]. The represented basic concepts in occupational, economic and pedagogical areas of research indicate that the subject matter is notably present in form of domain-specific problems, e.g., [33], [34], [35], while it also appears in the context of treating and supporting youth from minoritized communities [36], [37]. Research in this area is of in-depth and empirical nature. Moreover, evaluation and implementation study results and related approaches are presented in scientific publications. The BIBB pilot projects, which were conceived during funding periods until 2010 (condensed overview in [7], [38] as well as [39]) and publications of the German Institute for Sustainable TVET, i.e., [40], are to be mentioned in particular. The topic or methodical implementation of sustainable development (or both) are frequently subject to research reports and scientific papers, e.g., [41], [43], [44], and [45].

As shown in several publications, sustainable development as an important prerequisite for a peaceful society has arrived as a major topic in vocational education and training, e.g., [7], [18], [39], [44], [46], and [47]. A couple of key issues remain unresolved. Examples include curricular research addressing the question of the methodology of implementing sustainable development as an integral part of the curricular concepts. Impact research tries to answer the question of what effect is

suitable and intended to be implemented in vocational learning. The cccupational research discusses whether further education and training for educational staff need to be optimized to increase the attractiveness of the sustainability topic in VET. In this respect, differentiated BMBF-funded approaches on various aspects of sustainable vocational development can be recognized in Germany [48], [49], [50]. A number of pilot projects intend to integrate and further develop best practice respecting the current state of research. Regarding the pilot projects target group, diverse information and concepts as well as sound findings are available on this matter and reoccur in particular in the approaches of [48]. Additionally, study results on industrial-technical trainees by [44] and [51] are also important in the context of specific concepts found within the "*NAUZUBI*" pilot project.

C. The respective Concept of Competence

According to the German Sustainability Codex (DNK), the overall view of sustainable development in German VET is essential as (1) technical work plays an increasingly important role in professional activity in our society. (2) Immediate effects are observed, due to its operational flexibility and (3) the high level of cognitive and reflective features in contrast to unskilled or semi-skilled work (which might be more common in other countries). As the main focus of issues concerning sustainable development is on ecological and economic aspects, sustainable development requires an awareness of responsibility towards protecting the environment, economic viability, and a peace-oriented society which is able to act according to decisions that are based on information and sensible as well as reasonable, e.g., [8], [17], [29], and [52].

Therefore, contact with raw materials, supplies, systems, devices, equipment, products, etc. is indispensable for technical work in the occupational practice. The reason for this is the experiential and reflective character of technical work. If any issues evolve while carrying out technical work, trainees and technical workers may immediately detect weaknesses in context with sustainability, such as "waste" issues. The technical workers have a high level of reflection and their expertise make independent planning, taking decision and actions possible. The cognitive and affective basic prerequisites of technical workers ensure to comprehend and relate to sustainability aspects and occurring problems, directly from the operational area. This initiates a self-responsible approach to sustainability and influences the implementation method in the overall company context. Production and service areas show flat hierarchies, and the established quality management systems (e.g., PDCA, Kaizen, TQM, Lean and Six Sigma or general "shopfloor" topics) combine technical work with a high level of reference and decision-making. It is during the operational process when most sustainability issues occur. Subsequently, these issues are forwarded by effective cyclical processes to the decision board of the respective organization. Technical workers integrate themselves by making informative or conceptual contributions which can be made at any stage of the operational process. Acquiring necessary competencies for sustainable thinking and acting is enabled through technical work which is a highly effective development context.

The system of technical VET in Germany with its integrative educational prospect of in-company and school-based training can be valued as fully capable of its capacity for integrating aspects of sustainable development. This is based on the fact, that the current understanding of the underlying concept of competence in the German VET-System contains aspects of abilities as well as motivational aspects of competence regarding sustainable development. Here, a holistic approach seems legitimate, due to the fact that willingness can be fostered at the same time as performing occupational activities or pursuing a work process [38].

Therefore, the following six key premises to efficiently implement audits as sustainability-specific learning scenarios emerged from the current state of research and the discussions with the associated practice partners:

- Sustainable Development requires integrated concepts of thinking and action (e.g., active learning)
- Sustainable thinking is not linear. The present and desired state of the awareness of sustainable development must first be understood, internalized, processed discursively and evaluated.
- Acting sustainable must become experienced reality. Ultimately, (the company's) reality must change.
- Plausible reference and contact persons (experts) must be involved to reach the scope of a reality.
- The selected context should represent the professional reality in the best possible way, e.g., social integration.
- The direct involvement of vocational schools is necessary to ensure the expansion and relativization of the direct company contexts.

III. Current State of Implementation

A. The Concept of an Sustainability Audit Process

The international quality management system standards ISO 9000 [53] and ISO 19011 [54], the approach as outlined in [55] and the different phases of the sustainability audit as described by [56], [57] and [58] form the basis for the sustainability audits of this pilot project. Here, an accentuated complex of cognitive and affective discussion is required to change sustainable thinking and acting into operational reality. Self-regulated and reflective action are to follow from the nature and concept of the sustainability audit resolving sustainability issues. For this, the following premises are to be present:

(1) The concept of Sustainable Development must be understood and internalized by the apprentices.

(2) The developed level of awareness about the range of sustainability aspects must be high enough to differentiate in which audit phase it is anticipated.

(3) The importance of the topic must be internalized as high priority to implement it into operational processes and work.

(4) The implementation of auditing, the process and the basic idea must be understood by the apprentices. They must be able to implement the (supervised) auditing concepts appropriately.

A corporate culture that welcomes and accepts a sustainability audit with great interest and genuine commitment and implements it to promote its apprentices forms the basis. The implementation of respective training units requires trainers and teachers who have internalized the topic of sustainability and are qualified enough to introduce and supervise a sustainability audit accordingly. To achieve the competencies for this, training courses and further education are offered. As cooperating vocational schools provide the basis for specific learning environments, sustainability must be integrated into subject-specific education. Diverse and complex knowledge can only be achieved with enough development space. The apprentices have to realize the overall context and the whole picture. Subsequently, factual, ethical and moral aspects can be gathered and discussed with the teachers and instructors. Qualified teachers, who have completely internalized the topic of sustainability and are able to introduce it to the apprentices, facilitate adapting learning processes to the sustainability audit and provide appropriate training and supervision. Thus, this concept ensures cooperative units that consist of the business and vocational school protagonists and take place in a respective learning environment. It is a process which comprises content, approaches and measures, which are steadily coordinated and compared with each other. The sustainability audit represents a process that is structured as a coherent development and implementation concept. It consists of the following components:

(1) Learning about sustainable development in subject-specific education using exchange of information, analysis, reflection and hypothetical action.

(2) Preparing the sustainability audits in the participating companies by instructors and apprentices; developing a sustainability audit concept and informing participants.

(3) Implementing the sustainability audit and subsequently self-evaluating within the company with trainers and apprentices.

(4) Reflecting and relativizing the sustainability audit of the respective company at the vocational school by teachers and trainees.

Thereby, the pilot project "*NAUZUBI*" pursues the following goals:

- Developing and implementing sustainability audits by and with the apprentices in the respective companies
- Establishing companies as sustainable learning venues

B. Current State of Implementation

Both objectives require the subject of sustainability to become firmly embedded into corporate organizational structures by establishing educational training structures over the long term. These structures enable accessing the sustainability topic and ensure effective learning. The entire pilot project has been subdivided into specific structures. These project structures define essential objectives and subordinate objectives. The pilot project was initiated and began with the start of the first working sessions of the consortium. In these sessions, the overall strategy and the work tasks were determined and specified for the two "reference area groups". Additionally, organizational elements were introduced for the internal exchange and public visibility of the pilot project. One of the first steps was to inquire about the company-specific goals, guiding key values and major needs of all six involved participating partners, and also to analyze the existing training and internal organizational structures. Guidelines define concepts tailored to the specifics of companies and vocational school partners. These guidelines were developed based on the discussions about four core aspect categories: (1) values, (2) structures, (3) measures and (4) parameters and indicators. The required comparability and integrability was ensured by these categories internally and externally accessible documents have been carefully reviewed. The focus was on sustainability and organizational structure. The analyzed and evaluated findings formed the basis for defining company-specific concepts for the further course of the project. The training concepts for participating practice partners and three vocational schools were defined, too. In 2017, first sustainability workshops were conducted for the involved apprentices. Their response was positive. The further education concept included supplementary workshops in different groups. For instance, audit concepts were designed in cooperation with the educational staff of the companies. Furthermore, sustainability and quality management were subject to in-depth discussions in train-the-trainer workshops. Another part of the workshop was developing new approaches concerning cooperative tandems in learning environments and implementing the project topics in school.

The process of implementation did not begin before the developed didactic-methodical concepts were analyzed and evaluated in order to consider optimizing or modifying them. In the further course, the development of the overall concepts was enhanced. This resulted in first concepts integrating learning place cooperative teaching-learning situations for a long-term qualification of apprentices in schools and companies. The results of these analyses and discussions formed the objective of integrating the ideas of the NAUZUBI project into the operational structures of companies. In this context, companies function as learning organizations. The issue of waste is embedded in the sustainability audit, resulting in company-specific implementation perspectives. The apprentices are introduced to the entire subject area "sustainability audit" in a realistic and practical way with the help of existing audit concepts and a selection of key figures related to "waste". For instance, based on key figures, they may implement the audits on waste in the mechanics learning workshops or monitor raw materials and supplies consumed accordingly to the sustainability aspects. Addressing the aspects of operational implementations are subject to the discussions and descriptions in class. Here, companies and university partners cooperate closely. For the immediate use of the achieved real context, real-world learning situations were created through workshops in the training departments in the context of auditing. These learning situations are intended for areas of energy consumption in compressed air generation, as

well as paper, cloth or freshwater consumption. Relevant arrangements, agreements, preparations and conceptions regarding this topic are concluded. The implementation of the audits is planned for quarters three and four of the year 2018. Cooperating universities, companies and schools form the consortium, which is responsible for the implementation of NAUZUBI. Vocational schools were contacted to identify suitable partners in the project. These schools were already known to the universities from existing cooperations. They were considered as highly innovative and motivated and thereby selected to participate the joint project. Subsequently, the vocational schools selected companies with an appropriate cooperation structure profile and which were at least particularly interested in sustainability topics. Over time, schools, companies, trainers and teachers formed corresponding units. At present, company-specific concepts are in an implementation process supervised by these dyads. For one specific audit of the four main pillars of the German Sustainability Codex (DNK), the apprentices of each company are encouraged to develop a framework concept. The concepts include components that are training-strategic, and which involve process management of training. In addition, these concepts also focus on environmental, resource and climate issues as well as relevant social aspects (emphasis on labor law, equal opportunities and professional qualifications). The aim of NAUZUBI is creating an awareness of sustainability in companies, for the present and the future. The apprentices from the participating companies play a key role within the project. They are introduced to a project of sustainability in the apprenticing company and supervised by instructors and vocational school teachers.

"Sustainability Audit" is the referenced name of the pilot project in the further course [36], [37]. The core concept is reflected in this title. Auditing concepts, which are training-related, have been present for some years now (e.g., [37], [38]). According to [38], an audit for sustainability can be divided into several phases. These comprise the phase of planning (inventories, current status), the phase of implementation (sustainability management systems), the phase of controlling and the phase of evaluation. The sustainability audit includes a cycle that is subdivided into several processes. a) Collecting specific relevant (operational) aspects of sustainability, b) evaluating and focusing on these aspects, c) internal work on the detected areas that need to be improved, d) defining measures to find solutions, e) reviewing these measures and assessing of possible risks and consequences and finally f) giving feedback to the persons involved. The current standard of the German Sustainability Code of the Council for Sustainable Development is the basis for the sustainability audit. A total of 20 different individual criteria are integrated within four areas, which determine the content of the audit. However, not all criteria have to be implemented. The criteria are to be adaptable, differentiated and specified to training situations in the respective company. Ideally, this leads to a coherent overall concept for HR departments in all four main areas of the DNK.

IV. Conclusion

In view of the above, auditing the sustainability of companies is one way of promoting apprentices to become aware of their opportunity to make use of, reflect and shape their very own future work environment right from the beginning. The pilot project "*NAUZUBI*" has shown that including existing and relatively complex organizational structures into the conceptual design can ensure realizing very successful and company-specific solutions by the young apprentices. The persons involved engage to foster a holistic awareness about their work, the interfaces to other divisions and important contact persons by conceiving, designing, implementing and conducting sustainability audits. Furthermore, and beyond the focus on vocational training, the associated companies are offered the opportunity to move towards developing "*sustainable learning venues*".

In the context of the German framework curriculum for dual vocational training for tool and industry mechanics, the current state of knowledge and embeddedness into the actual training process has been rated as insufficient according to an extensive analysis of the curriculum and several interviews. Subsequently, the concept of sustainability audits was defined by using iterative loops. In addition to the company-specific discussions at the level of human resources and middle management, teach-the-trainer workshops were offered to the participants of the respective schools and companies. Subsequently, findings and impressions of the audit preparations have been discussed and reflected in the overall consortium. Here, introductory workshops regarding sustainable development in general, as well as the topic audit methods as a means of implementation, proved to be necessary although two of the (engineering) companies involved must deal with audits in daily business.

The topic of "*waste*" is (still) identified as a major focus in companies, even though different maturity levels and directions became apparent in the course of the project. Based on these findings, operational concepts and approaches have been developed to address issues concerning waste in line with the prevailing (company-specific) requirements and means. In that respect, the benefits for industry are the following:

- Transferability: The developed procedure is seen as a cross-department or cross-company framework, extendable by e.g., service-learning-processes.
- Autonomy: Company-specific development areas can remain open and unrestricted.
- Approachability: It shows the direct link between "sustainability" and "auditing".

Thereby, apprentices are being confronted on purpose with sustainability in the operational context and immediate impressions and experiences of the practical implementation result. Here, the notion of education is to achieve a culture of peace through refocusing technical and vocational education and training programs on sustainable community development.

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