PROJECT-BASED LEARNING IN GERMAN VOCATIONAL EDUCATION AND TRAINING: A STRUCTURED APPROACH TO DEVELOPING SELF-DETERMINED, COOPERATIVE PROBLEM-SOLVING COMPETENCE

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Abstract

The implementation of project-based learning in Vocational Education and Training schools in German started in 2005 and the endeavor has crossed borders to application in other European countries too. This research shows empirical results of how students and teachers perceive this approach and settles statements about the intention of project-based learning. The article shows contextual conditions, problem statement, state of the art, and theoretical framework. Moreover, points out the project-based learning as a combination of cooperative team learning and self-determined learning embedded in two wider approaches: the cognitive apprenticeship model, and the project management methodology.

Keywords: Vocational education and training. VET. Project-based learning. PBL.

1. Introduction

This first section based on Gessler (2017) due to describe contextual conditions, such as the basic structure of the dual apprenticeship system in Germany, the objective of vocational education and training (VET), the reforms that created the supporting conditions for implementing project-based learning in VET, and finally, the problem statement.

1.1 The dual apprenticeship system in Germany

In Germany, the dual VET system operates in parallel in both real-world work environments (where students normally spend 3–4 days a week) and vocational schools (normally 1–2 days a week). There

are statutory regulation documents for goals, content, and timetable structures for VET in both learning environments: companies are governed by training regulations, the vocational schools by framework curricula. Table 1 provides an overview of the structure of the dual system of vocational education and training in Germany.

Table 1 - Jurisdictions in the dual VET system

	The dual system of vocational education and training for approximately 330 recognised vocations		
Learning location	Company		School
Regulations	Training regulations		Framework curriculum
Focus	Vocational training		Vocational education
Jurisdiction	Federal government		State government (comparable with states in Brazil)
Statutory basis	Industry	Craft	Individual federal states' education acts
	Vocational Training Act	Crafts Code	
New and further development of regulations	Federal Institute for Vocational Education and Training (BIBB)		Standing Conference of the Ministers of Education and Cultural Affairs of the Länder (KMK)
Appointed experts	Industry and craft representatives		Teachers and school representatives
Solution of separated jurisdiction	Joint agreement since 1972 between the federal government and the KMK/ state governments on coordinating training regulations and framework curricula		

Source: Gessler (2017, p. 697).

During the 1980s, school-based education within the German dual VET system saw heavy criticism, with industry representatives asserting that school-based education was disconnected from reality and did not prepare students to tackle the challenges of working life in companies. In other words, schools were not oriented toward the customer.

1.2 Competence to act

On 14 and 15 March 1991, the Standing Conference of the KMK passed a framework agreement for VET schools: vocational schools should develop skills by combining technical competence with self and social competence (KMK KULTUSMINISTERKONFERENZ, 1991; see also RAUNER, 1988). They also should provide basic and specialised vocational education that builds upon previously acquired general education, with the aim of enabling persons to meet challenges in the workplace as well as participate in shaping their work environments and society through social and environmental responsibility.

The triad of competences mentioned above — technical, self, and social competence — has a long tradition in Germany (ROTH, 1971), and predates the areas of learning concept as a central tenet of VET. Within the areas of learning concept, the triad of competences is reframed as an overall "competence to act"; part of VET's aim is to impart vocational competence to act and extend general education (KMK KULTUSMINISTERKONFERENZ, 2011). The three dimensions of competence to act are defined as follows (BADER; MÜLLER, 2002):

- **Technical competence:** The ability and readiness to handle tasks independently (planning, implementation, and monitoring in particular) and correctly, and to assess outcomes. This competence also involves extra functional skills such as logical, analytical, abstract, and integrated reasoning as well as the ability to recognise interconnected systems and processes.
- **Self-competence:** The ability and readiness to clarify, reflect on, and assess for one's self the developmental opportunities, requirements, and restrictions of work, family, and public life; to develop one's own talents, and to conceive and pursue one's own life plans. This also entails, among other things, developing well-thought-out moral values and a self-determined commitment to specific values.
- **Social competence:** The ability and readiness to comprehend social relationships and interests, affection, and tension, as well as to communicate with other people rationally and responsibly. This competence also involves the development of social responsibility and solidarity.

On one hand, these dimensions are dependent and interconnected, and cannot be developed independently of one another. On the other hand, these dimensions provide reference points and can be considered separately in order to evaluate whether all three dimensions are sufficiently represented.

The above-listed dimensions are accentuated with three transverse types of competence—communicative competence, methodological competence and learning competence —, which are not independent dimensions, but emphases within the technical, self-, and social competences. The three transverse competences are defined as follows (BADER; MÜLLER, 2002):

- **Communicative competence:** the ability and readiness to share issues and feelings with other persons via verbal (spoken or written) languages, and through nonverbal means (e.g., gesticulation and facial expression). This competence also encompasses the ability to perceive, understand and express one's own and others' intentions and needs, and is important in understanding and shaping communicative situations.
- **Methodological competence:** the ability and readiness to determine plans and targets when handling vocational tasks and problems (e.g., outlining steps in a process). Persons with this competence independently select, apply and develop

thinking methods, procedures and solution strategies. Methodical work includes independent design and assessment, which require initiative and creativity.

- **Learning competence:** the ability and readiness to comprehend, evaluate, and integrate into thought processes information regarding specific issues and relationships, independently as well as alongside others. In terms of professional work, learning competence develops through the mental processing of technical illustrations (e.g., sketches, wiring diagrams, professional articles), as well as in the comprehension and interpretation of social relationships and actions found in media (newspaper reports, magazine articles, films, etc.). Importantly, learning competence also involves the ability and readiness to develop, and use in further development, learning techniques and strategies within and going beyond one's vocational area.

This comprehensive concept of competence forms the basis for the dual VET system's turn toward work-centered models, as well as for the following teaching and learning reform research.

1.3 Reforming teaching and learning

In response to aforementioned critiques from industry representatives regarding the inadequacy of VET school environments, the areas of learning concept (German: *Lernfeld-Konzept*) was introduced in 1996 as a structural principle for framework curricula in VET Schools (not in general education). The reform had wide-ranging consequences not only for course and lesson design, but also for organisational conditions of schools, cooperation between schools and companies, and required qualifications for teachers. The traditional dichotomy — where school-based learning is all about theory and work-based learning is all about practical experience — is deemphasised in this approach through the reorientation of school-based content to match practical requirements for vocational and professional work.

Methodical work includes independent design and assessment, which require initiative and creativity

The reform did away with the concept of 'subjects' in vocational school environments and replaced it with that of 'areas of learning'. Vocational areas of learning are complex teaching-learning arrangements that require vocational actions, promote reflection, and facilitate the accrual of applicable know-how, acting as didactic equivalents of professional vocational activity. They are made up of complex tasks that are handled pedagogically using action-oriented learning situations that couch subjects of study in concrete terms. A team of teachers develops learning situations in educational conferences. The arrangements are work-oriented but didactically realised in the classroom and are accompanied by didactic reflection relevant to the vocation as well as individual and social life (GESSLER; HOWE, 2015).

1.4 Problem statement

After the reform, the first stage of curriculum development concentrated on adapting existing curriculum content to the areas of learning paradigm, transforming textbook lessons into learning situations. The federal state government supported this Germany-wide effort through project funding. This first stage lasted approximately until 2005. The second stage, after 2005, concentrated more on the development of new content and areas of learning in view of the overall goal: to foster the development of competence to act. In 2005, the education minister of the state of Bremen (the smallest state in Germany) initiated this second stage with a major reform: a certain amount of teaching and learning time in VET was compulsorily reserved for project-based learning. The reform started in a VET school in Bremen called "*Fachoberschule*". Upon the beginning of the school year in fall 2005, all teachers in Bremen in this school type were obliged to set up project-based learning environments.

2. State of the art

This section briefly elaborates the state of the art with reference to the time span at the beginning of the German's plan for the implementation of project-based learning in 2005.

Gudjons (1986) formulates ten programmatic characteristics of project-based learning: (1) life-world orientation, (2) orientation towards the interests of the participants, (3) self-organization and self-responsibility, (4) societal practice relevance, (5) purposeful project planning, (6) product orientation, (7) inclusion of many senses, (8) social learning, (9) interdisciplinarity, and (10) reference to the course. How these principles can be implemented on a daily basis and structured in classroom teaching was not answered. Similarly, further reports proclaimed general principles without formulating related didactical guidelines and concrete practical instructions for teachers and students (e.g., BASTIAN et al., 1997; HÄNSEL, 1999). The idea of project-based learning exists already since the 16th century and was first applied in architectural schools in Europe (KNOLL, 1993). Nevertheless, the concrete implementation in classroom teaching was for still unclear.

The few empirical studies paint a rather critical picture of project-based learning. Zimmer (1987) documents a variety of "forms of resistance" by teachers against project-based education; these range from a rejection of collective forms of work to a lack of insight into the need for well-planned procedures. Günther (1996) comes to a rather critical judgment of project-based learning on the basis of almost 300 interviews with students in numerous schools: only one in three students, he reports, identifies as a "project-oriented" type. Another third of students considered themselves "project-distant", and the remaining third was undecided. Schümer (1996) concludes that the conditions of institutions (e.g. timetables, performance evaluations, and the subject-teacher principle) discourage the use of project-

based learning. These findings suggest that attitudes and behaviours differ among teachers, and that teachers who practice project-based education tend to be more cooperative and satisfied with their jobs. Studies by Pätzold et al. (2003) and Seifried (2006) have shown that project-based learning in VET is marginal in Germany, with less than 5% of teaching hours invested in project-based learning. Teachers gave various reasons for not employing project teaching in their lessons. In particular, they indicated a lack of project didactics and teaching materials, and noted that framework conditions (e.g., time limits on lessons) would make the use of a project-based model difficult, if not impossible. Petri (1991) found similar results. Although teachers (here: in Austria) appreciate the advantages of project-based teaching given its promotion of autonomy, social learning, motivation, and the broadening of perspective, they "capitulate" to the difficulties: high expenditure of time, problems planning jointly with students, obstacles to cooperation, difficulties arising from disagreements with institutional policy or procedures, lack of understanding of the college.

Teachers who practice project-based education tend to be more cooperative and satisfied with their jobs

In conclusion, schools, teachers, and students were in 2005 not prepared for the implementation of project-based learning (PBL) in VET schools, nor made sufficiently aware of how to set up projects, how to teach with projects, or how to learn in a project environment.

3. The project-based learning approach

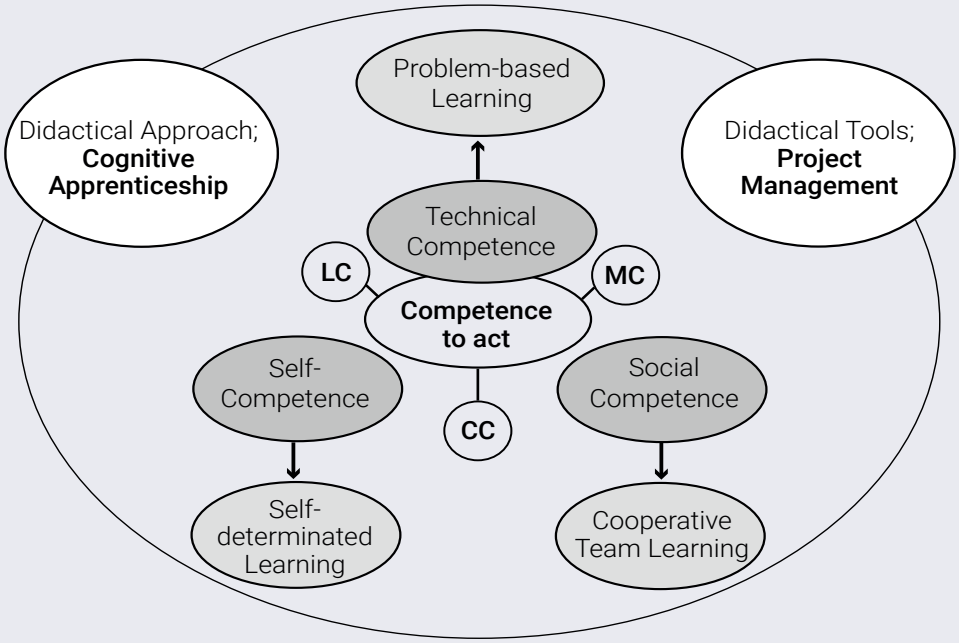
In light of the vacuum caused by lack of school and teacher readiness and of clear didactical approaches, as well as by wide pedagogical expectations (e.g., self-responsibility and social learning), the state institute for schools of Bremen commissioned one of the authors, Michael Gessler, to support the implementation of compulsory project-based learning in selected VET schools in Bremen.

The assignment was given five months before the summer school holidays, with the goal that after the break, teachers should be capable of offering project-based learning. The group[1] spent three months developing a didactical approach to teaching, as well as creating learning materials for teachers and students, followed by two months of teacher training[2]. After the summer school break, the group invited all involved school classes, students, and teachers to the University of Bremen for one week for the initial phase of project-based learning implementation. There were four reasons for holding the first project-based learning experiences at the University: first, this allowed offering support immediately in case of problems. Second, the novel surroundings helped students and teachers break through routines and habits carried over from the traditional school environment. Third, the presence of all involved students and teachers facilitated social control as well as social engagement. Fourth, locating the trials on-premises made it convenient to observe practices and collect data.

3.1 Learning approaches

The foundations of the model are the aforementioned three competences comprising competence to act (technical, self-, and social) and the three cross-dimensional competences (communicative, methodological, and learning). These dimensions are correlated with three learning and motivation approaches, which are problem-based learning, cooperative team learning, and self-determined learning. They are framed and integrated through the didactical approach of "cognitive apprenticeship" on one hand and the tools of "project management" on the other hand (Figure 1).

Figure 1 - Theoretical framework



CC = communicative competence; MC = methodological competence; LC = learning competence

Source: Own depiction.

This section will describe these learning approaches, and in the next section, the framing.

3.1.1 Problem-based learning

Problem-based learning goes back to the McMaster model outlined by Barrows (1986), originally developed for medical education. In addition to motivating the learner, problem-based learning should lead to the development of applicable knowledge while promoting self-control, problem-solving, and social skills.

The implementation of different emphases, especially in Anglo-Saxon countries, is based on basic principles: The core idea of problem-based approaches is — as the name implies — that complex and realistic, not well-defined, problems are the starting point of learning. The assumption here is that high realism and authenticity in lessons trigger active-constructive and self-directed learning processes lead to applicable knowledge (LAVE; WENGER, 1991).

High realism and authenticity in lessons trigger active-constructive and self-directed learning processes lead to applicable knowledge

Based on the view that active knowledge building presupposes a well-ordered knowledge base whose structure requires guidance and support, instructional elements are also provided in these approaches. The central principle is the self-responsibility of learners in terms of, among other things, their knowledge gaps and their levels of commitment. The dominant organizational form is small-group learning, in which the self-directed and discursive phases alternate according to the experiences and needs of learners. Learning groups are guided and supported by a tutor in order to develop necessary competences, such as problem-solving or cooperation. In an ideal problem-based learning environment, students work on several problems at once in coordination (BARROWS, 1986; REINMANN; MANDL, 2006; SAVERY, 2006; ZUMBACH, 2003).

Commonplace workplace problems are central components of problem-based learning, but as Dörner et al. (1983, p. 302) describe, a problem signifies that "the means to reach a goal are unknown or the known means can be combined in new ways, but also that there are no clear ideas about the intended goal". Problems are characterised by complexity. Dörner (1976, 1986, 1992) classifies complexity in problems using the dimensions 'dynamics', 'interconnectedness', and 'lack of transparency'. Dynamics is the extent to which a problem and its parts are not statically related to each other but moving together or against each other, so that factors like origin and development must be taken into account (DÖRNER et al., 1983). Interconnectedness means the extent to which the presumed variables of the system influence each other and defy measurement in isolation. Lack of transparency indicates that most assumed real-world variables are only partially known in problem-solving processes. An intervention in a complex system leads to side effects that are only foreseeable in a very long time.

According to Pólya (1964), problem-solving processes can be subdivided into four phases: (1) understanding the problem, (2) developing a plan, (3) executing the plan, and (4) reviewing. In each of these phases, different heurisms (i.e., heuristic aids, strategies, and principles) are applicable. Pólya (1981) characterizes heurisms as learnable guides that may help during the problem-solving process, such as questions to consider when approaching a given type of problem. He divides the problem-solving process into four phases, assigning several questions to each:

Understanding the problem

- What is given?

- What is unknown?
- What is the condition?

Developing a plan

- Is this a known problem?
- Are there known related problems?
- Are there known helpful strategies?
- Can the problem be reworded?

Executing the plan

- Can the steps be controlled?
- Is the correctness of each step clearly identifiable?
- Is proof of the correctness of the step possible?

Reviewing

- Is the result controllable?
- Is the result also achievable by other means?
- Is the result also applicable to other problems?

Heurisms seek to facilitate problem-solving by offering a framework for reasoned approaches to (PÓLYA, 1964).

3.1.2 Cooperative team learning

Tuckman and Jensen (1977) developed a phase model for the development of basic group structures that has remained current, in which groups whose members have no prior familiarity with each other undergo the following development phases: 'forming', 'storming', 'norming', 'performing', and 'adjourning'. This phase model illustrates an ideal developmental logic for groups, outlines a plausible process of group formation and evolution, and conclusively explains observed changes over time in groups.

The first phase, forming, is characterized by participants' uncertainty because they do not know each other, what to expect, or what is expected of them. Overall, positive socio-emotional behaviour predominates, with interactions polite but distant. In the course of this phase, group members get to know each other.

The next phase, storming, focuses on the development of the group structure. Leadership, influence, and role structures emerge; this process can be accompanied by disagreements and conflicts, so negative socio-emotional behaviour is more frequent during this phase.

As role structures evolve in the norming phase, group members develop a shared understanding of the group's goals and a system of norms that serves to guide the group's interactions. The interaction framework is increasingly characterized by close relationships among group members, which is reflected overall in predominantly positive socio-emotional and task-related behaviours.

In the performing phase, interaction patterns are task-oriented and aimed at achieving established group goals, while the final stage, adjourning, is defined, depending on the group's track record and results, by a sense of achievement or disappointment (TUCKMAN; JENSEN, 1977).

In the norming phase and even in the run-up to it, groups — partly tacitly and partly consciously — develop expectations of individual group members regarding typical tasks and situations. These are reflected in a more or less coherent system of rules of conduct, which in this context are referred to as group norms. Group norms usually evolve in the early stages of a group but may evolve over time, perhaps because of adaptation to a changed environment or new group composition. Depending on their degree of maturity, they also reflect a general understanding among the group of members' individual goals, tasks, and roles. In a favourable case, group norms also entail knowledge of each member's expertise and special skills; a similar understanding of what the group should do, and who should do what, is a good condition for communication, coordination and cooperation (MOHAMMED; DUMVILLE, 2001; NIJSTAD; VAN KNIPPENBERG, 2007).

These characteristics of cooperative team learning have to be considered in the didactical approach. Finally, Johnson and Johnson (1994) define five key elements of effective cooperative learning: (1) individual accountability, (2) positive interdependence, (3) face-to-face interaction, (4) collaborative skills, and (5) processing and reflecting. In the didactical approach of the project, these factors were strongly considered; if the goal is to engender the three competences in VET, then success can only be reached if all objectives are reached. For example, if the team solved a technical problem, but the team process was ineffectual and one or more individuals feel insecure rather than empowered, the whole approach has failed.

3.1.3 Self-determined learning

Motivation is often just subdivided into intrinsic and extrinsic motivation. In contrast, Deci and Ryan (1993) distinguish multiple forms of motivation based on intent. Intentional and therefore motivated actions are directed either toward achieving an immediately satisfying, interesting, or exciting experience or toward a longer-term goal. Behaviours that do not pursue a recognizable goal are called "amotivated".

Motivational energy can be classed three ways in terms of the needs that drive it: (1) motivational energy driven by physiological needs, (2) that driven by emotional needs, and (3) that driven by psychological needs. For Deci and Ryan (1993), in particular, there are three key psychological needs that they call "basic human needs," as they are proven, indispensable, and innate prerequisites for human well-being: (1) the need for self-determination and autonomy, (2) that for experience of competence and effectiveness, and (3) that for social involvement.

- **Self-determination and autonomy:** The need to experience one's self as the starting point of one's actions and decisions. Krapp and Ryan (2002) define autonomy not as "independence" or "unlimited freedom", but rather, as a fit between tasks required in the current situation and the perception of a person (importance of the task, willingness).
- **Experience of competence and effectiveness:** The need to be able to make a difference and be able to meet chosen and set requirements (i.e., be competent); and the need to experience that one is not at the mercy of one's environment, but can control events through actions (i.e., be effective).
- **Social involvement:** The need to feel connected to other people in a social environment, to be effective in this environment, and to experience one's self in a personal and autonomous way (DECI; RYAN, 1993). People want to be accepted and recognized by persons who are important to them (KRAPP; RYAN, 2002).

When motivated actions are the result of a free choice and correspond to the wishes and goals of the individual self, they are self-determined or autonomous. However, if they are forced and incongruent with individual wants and needs, they are considered controlled. Self-determined and controlled behaviour thus define the endpoints of a continuum that determines the quality or orientation of a motivated action. This continuum is subdivided into five types of motivated action. Four types are extrinsically oriented, with goals a result of external factors: (1) external, (2) introjected, (3) identified, and (4) integrated; while (5) intrinsic implies no external impetus for goals — in other words, the execution of the action constitutes the goal (DECI; RYAN, 1993). Deci and Flaste suggest that individuals pursue goals and realize actions because it is in their nature to take on tasks and actively satisfy their innate needs. They are who, because they are forced to, but because of their nature to (DECI; FLASTE, 1995).

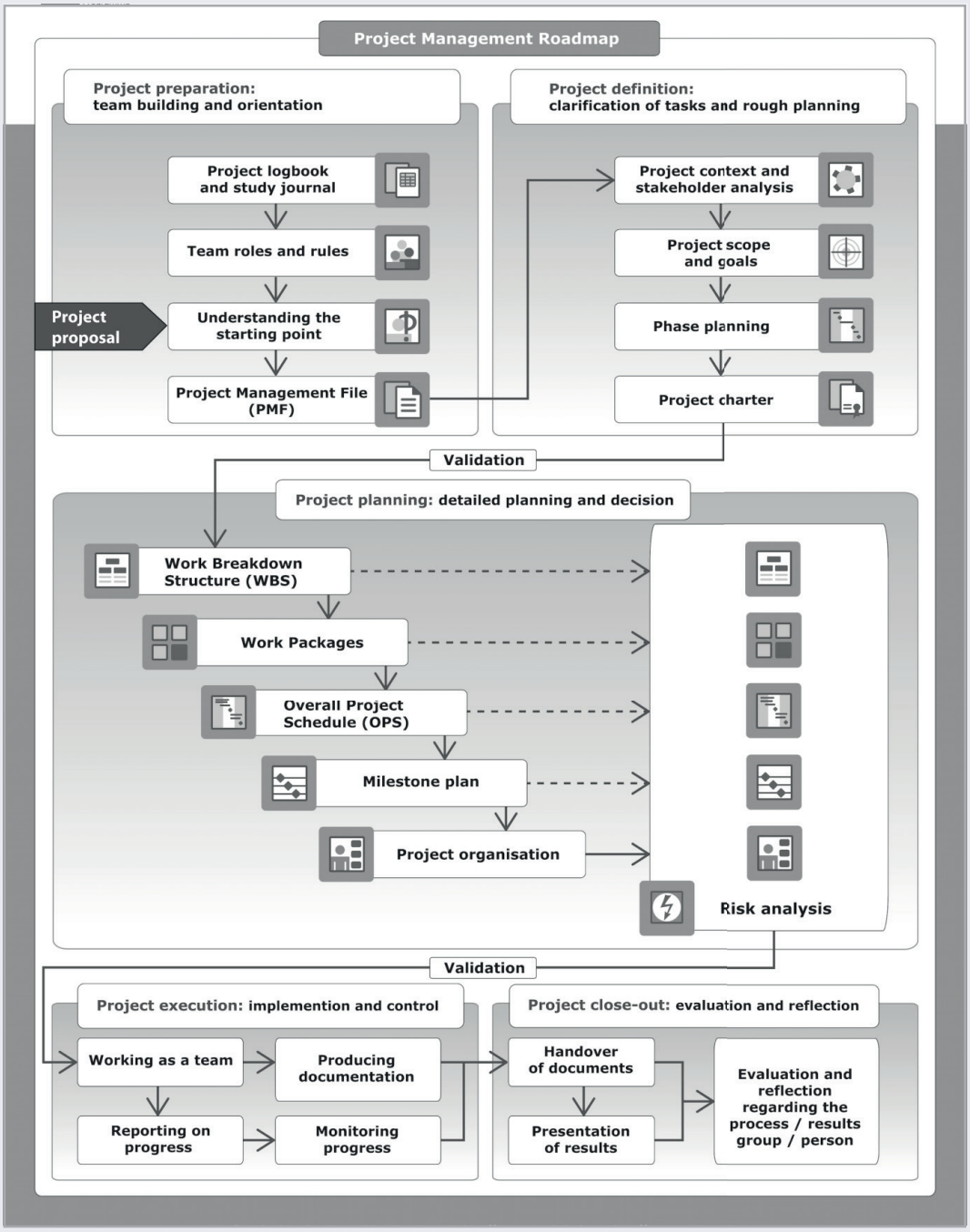
3.2 Framing and integration

This section will now describe approaches to framing and integration: project management on the one hand and cognitive apprenticeship on the other hand.

3.2.1 The project management approach

This research used project management (GESSLER, 2009, 2016) as a resource in two ways: by structuring project-based learning based on project management methodology, and conversely by basing project management methodology on the experience of doing projects. This approach was immediately accepted, and indeed strongly supported, at VET schools. Figure 2 shows the road map (educational guide for project-based teaching and learning).

Figure 2 - Road map



Source: Gessler & Uhlig-Schoenian (2005, 2017).

The guides developed to support project-based teaching and learning (GESSLER & UHLIG-SCHOENIAN, 2017; UHLIG-SCHOENIAN; GESSLER, 2016) mutated step by step into a dogma, at least in the sense that the users (teacher trainers, teachers, and students) believe that this procedure is the only truth. However, the purpose of project-based learning is about solving problems. If variations in tools or process (Figure 2) are necessary to achieve results, they should be encouraged. Each step in the road map includes 'micro-steps', described in the next section.

3.2.2 The cognitive apprenticeship approach

The research identified seven methods, which have been dubbed as 'micro-steps', for the design of project-based learning environments according to the principles of cognitive apprenticeship.

1. **Modelling of excellence:** As the first micro-step, a teaching expert introduces a project management method to solve a concrete problem. For this purpose, the expert externalizes and explains invisible and implicit processes, like heuristic and control strategies. The goal is to build a mental model for students that includes the facts, processes, and steps necessary to solve the problem.
2. **Coaching:** During the next step, learners themselves apply the methodology outlined by the expert in small groups. While doing this, they are monitored and coached by the expert, who offers assistance, suggestions, and responses, and draws the learner's attention to aspects of the problem or ways of proceeding which have not yet been perceived.
3. **Scaffolding:** As knowledge increases, the relationship between learner and expert becomes more cooperative, with learners handling as much work within a project as is appropriate to their knowledge. In case of difficulties, the expert offers individual assistance.
4. **Fading:** The expert gradually reduces his or her assistance until learners are able to solve a given problem completely independently.
5. **Articulation/presentation:** Learners are encouraged to structure and articulate their knowledge by a variety of means, such as question-and-answer games or role-swaps between expert and learner. This kind of articulation offers the opportunity for learners to speak about their acquired knowledge in cooperative activities. In this research, groups gave presentations on solutions to each problem, with time allowed for discussion and comparison of various solutions.
6. **Reflection:** Learners are urged to compare their own problem-solving processes to those of colleagues or experts. Video or audio recording is useful for purposes of reflection, as it allows for review and comparison of problem-solving processes after the fact.
7. **Exploration:** The expert supports learners by encouraging interest in a problem, defining the problem field, and proposing problems with different levels of

difficulty. As in the case of 'scaffolding', assistance in discovery is reduced in response to increasingly independent explorative behaviour, until learners are independently able to define, determine, and systematically solve problems.

Before the first step — understanding the starting point — can be achieved, three prearrangements are necessary (see figure 2): first, a system of project logbooks and study journals should be introduced; study journals stimulate reflection and the development of metacognitive knowledge, and project logbooks are useful in assessing accomplished work and assisting teachers in evaluation of the process. Second, the establishment of team roles and rules must be stimulated in a prescribed way; when they are not, roles develop in unintended, uncontrolled, and often dysfunctional ways. Third, the initial problem to be solved in a given project should be presented in detail at the onset of the project. Problems should be explained to a degree based on students' prior experience in the field, and parameters such as environmental conditions, causes, and technical tools may be outlined; alternatively, in the interest of difficulty, this presentation could detail only the project goal.

To guide the as-yet inexperienced and somewhat uncertain teachers through the process, the project developed a step-by-step guide which was updated in the following years, most recently in 2016.

3.3 Crossing the borders

With funding from the German Association for Project Management, the project transferred and implemented its approach all over Germany in different VET programmes. Also, defined a core curriculum for areas of learning. In 2007 started to implement the approach also in pre-vocational education (GESSLER; KÜHN, 2014) and developed for this purpose a comic (UHLIG-SCHOENIAN; GESSLER, 2007, 2016). With funding from the European Commission, adapted the approach in numerous European countries, including Poland, the Czech Republic, Hungary, Turkey, France, Italy, Spain and Portugal. Recently, have been working on extensions to strengthen the development of entrepreneurial competence (GESSLER; SEBE-OPFERMANN, 2014).

4. Results

Since the first implementation improved the materials and teacher training and built up a group of representatives in the schools and trainers for the teacher trainings. However, this section documents early post-implementation results from two perspectives: students and teachers. The data collection of the perception of the students took place in autumn 2009 at the beginning of the school year in the observed classes at the same time (SEBE-OPFERMANN, 2013). The data collection of the perception of the teachers took place between 2008 and 2010, before the teacher training (t_1) and after the finalisation of the project-based learning unit in the school (t_2).

4.1 Perception of students

This section describes the results for the central dimensions of the model: the perceptions of students on their self-determined learning, social team learning, and problem-solving.

4.1.1 Self-determined learning

The mean values indicate that participants perceived healthy levels of autonomy, competence experience, and social involvement

For this investigation, 142 students from six classes attended the study, forming 33 learning teams. The researchers evaluated complete data sets for 103 participants, amounting to a response rate of 73%. The average age in the sample at the time of the study was 20.4 years (SD = 2.6).

Based on the self-determination theory of motivation of Deci and Ryan (1993), the study used an already existing scale (1 = very low to 4 = very high) to tabulate motivation types among participants (PRENZEL, 1994; PRENZEL, 1996; PRENZEL et al. 1996). Among learners, the motivation types amotivation (x = 1.55, SD = 0.49) and extrinsic motivation (x = 1.83, SD = 0.57) showed values well below the theoretical mean (scale: 1 = very low to 4 = very high). On the other hand, the motivation types introjected, identified, and intrinsic all showed values above the theoretical mean of the scale (x = 3.01–3.46). The low standard deviation (SD = 0.52–0.63) indicates that the vast majority of respondents reported similar motivations to each other. The overall motivation scale shows a high level on average (x = 3.24, SD = 0.43) and suggests a high rating of participants' own motivation. Reliability of the scale can be described as acceptable, with C_{α} = 0.70.

According to the self-determination theory of motivation (DECI; RYAN, 1993), perceived features of learning environments such as support for autonomy, competent action, and social involvement in learning are conducive to the development of self-determined motivations. These three motivational conditions were also measured using the Prenzel survey tool. Participants were asked the extent to which their learning environment offers options, freedom, and support for independent action; the extent to which they receive recognition for or feedback on their performance; and the extent to which interaction during class is collegial and supportive. These three survey aspects have been combined into aggregates. The mean values indicate that participants perceived healthy levels of autonomy, competence experience, and social involvement (x = 2.99-3.44). The standard deviation makes it clear that these features were perceived very similarly on average. The reliabilities of the aggregates (C_{α} = 0.74-0.85) have sufficient-to-mediocre dimensions. The values of the overall scale for motivational conditions, which are composed of the three aggregates mentioned above, illustrate that learners experienced motivational conditions in the classroom (x = 3.18). The standard deviation (SD = 0.48) of the total scale indicates that these conditions were largely felt to be similar. The scale has an acceptable reliability (C_{α} = 0.75).

4.1.2 Cooperative team learning

The individual cooperative action was assessed based on a self-developed scale (scale: 1 = very low to 4 = very high) reflecting the perception of one's own participation in cooperative actions in general (one item) and in various aspects of one's involvement (three items). The item statistics indicate that learners overwhelmingly rated both their participation (x = 3.6) and their involvement (x = 3.42-3.57) highly. The standard deviation (s = 0.60-0.76) illustrates that these estimates are relatively similar among learners. The resulting total scale has a mean value of x = 3.51 (SD = 0.51) and an acceptable reliability (C_α = 0.76).

The question of cooperation in groups was raised in the form of another self-developed scale (scale: 1 = very low to 4 = very high), with cooperation operationalized on the basis of four items: (1) the general quality of cooperation in the group (one item), (2) the perceived level of cooperative support from the group (one item), (3) the degree to which group tasks in the group were responsibly performed (one item), and (4) the extent to which a goal was commonly and sustainably pursued (one item). The statistics make clear that all cooperation-related items were predominantly rated favourably (x = 3.23-3.63). The standard deviation (SD = 0.61-0.85) shows that estimates differed only slightly. The scale indicates that cooperation in the group was healthy (x = 3.47, SD = 0.63). The scale has a good reliability (C_α = 0.85).

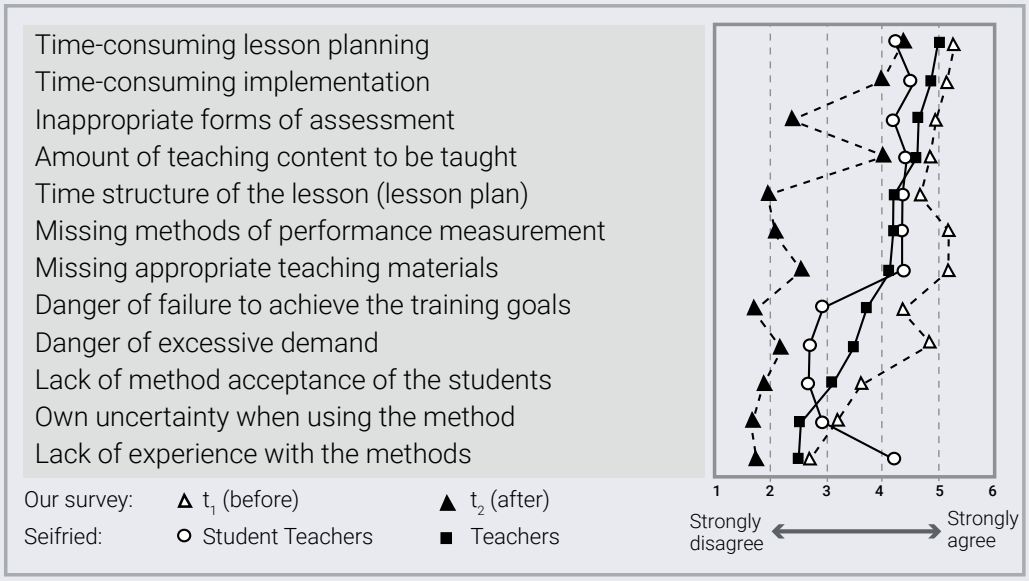
4.1.3 Problem-solving learning

Structure of problems plays an important role in cooperation in projects. The self-developed scale (scale: 1 = very low to 4 = very high) for problem-solving learning reflects the subjectively perceived need to work together to solve a problem (one item), the perceived importance of role-dependent sub-tasks in relation to the overall outcome (one item), and the perceived opportunity for each group member to participate in problem-solving (one item). The resulting overall scale for problem structure shows moderately high values (x = 3.3, SD = 0.59) above the theoretical average (x_{theo} = 2.5) and a good reliability (C_α = 0.86).

4.2 Perception of teachers

On average, four months elapsed between the two data collecting points (t_1: N = 286, t_2: N = 248). The survey items used were the same as in a study conducted by Seifried (2006). Seifried did not conduct surveys at two different time points; rather, he gave the survey to different cohorts: student teachers (N=214; still at the university) and teachers (N=222; already in practice). The Figure 3 shows the resulting data from both surveys.

Figure 3 - Effect of practice on teacher perceptions



Source: Own Depiction.

In this survey, barriers to implementing project-based learning were perceived differently before the teacher training (t_1) and after the implementation in the classroom (t_2). Planning and implementation was still perceived as time-consuming and the amount of teaching content as problematic, but other barriers became obsolete (e.g., inappropriate forms of assessment, time structure, lack of performance measurement methods). All differences are statistically significant ($p < .05$).

Seifried's data showed the cohorts, student teachers and teachers, as perceiving many aspects similarly; just one aspect was very different rated: the lack of experience with the methods. Overall, the respondents were before more critical and pessimistic as the Seifried cohort, placing greater weight on barriers. After experiencing project-based learning, the cohort has been less critical. Therefore, it is possible to assume that the teacher data of the Seifried cohort are biased: The teachers had in fact little experience with the methods, even though they did not communicate this lack of experience.

5. Final considerations

Project-based learning is, on one hand, a valuable approach to enriching classroom teaching; on the other hand, many obstacles stand in the way of its success. The project-based model is advantageous in its promotion of problem-solving, social, and self-determination competences. All these competences are in demand in the labour market, and it is therefore right and correct to intensify engagement in implementing project-based learning in VET schools.

Despite this, implementation will not be without difficulties: a didactical approach to teacher training, along with supporting materials, is necessary. In addition, extra time, space and specialised resources must be allocated; teachers require training in advance and peer support during implementation (this study suggests teams of two teachers for the initial trials); and assessments have to be changed according to the project-based learning method and the competence developed (social competence should also be recognized).

Multiple-choice tests or simple exams based on only the reproduction of knowledge are insufficient in project-based learning. Exams should focus on understanding, experience, and the demonstration of competence within the process as well in relation to the developed product or service. The focus of project-based education should not be to replace other forms of learning but to increase the variety of teaching and learning methods available and to integrate project-based methods with traditional teaching.

Notes

[1] Gessler & Uhlig-Schoenian (2005, 2017). The development group was a mixed group with representatives from VET schools, one representative from the state institute for schools (Jürgen Uhlig-Schoenian), and one representatives from the University of Bremen (Michael Gessler).

[2] The teacher training was conducted by the authors, the representative from the state institute for schools, and one independent trainer.

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