Research Article

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Design Thinking for German Vocational Schools? Discovering of an Innovative Approach by Testing in Teacher Education

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Abstract: Design Thinking is an innovative approach that solves concrete problems and develops new products. Its constant spreading in industry, business, and non-profit organizations raises the question to which extent this approach may be of importance for German vocational schools. There is an increasing debate among scientists about design thinking in educational contexts, in which different authors regard it as useful for curriculum and school development as well as for coping with everyday school life. To assess the importance of design thinking for German vocational schools, pre-service teachers have tackled vocational school issues with design thinking. The paper concludes that design thinking is indeed of interest to vocational schools and that further work is recommended.

Keywords: Action Research, Design Thinking, Innovation, School Development, Teacher Education, Vocational Education and Training

1 German vocational school and the interest in design thinking

Vocational education and training (VET) has a high priority in the Germany, which is historically justified. The crafts guilds, which were established in the Middle Ages, had established a VET tradition which they perpetuated over centuries (Tremblay, & Le Bot, 2000). The master craftsmen of the companies registered in the guilds were authorised to instruct young people in their profession

while working in the company and thus to pass on the knowledge and skills of the profession. With the beginning of industrialisation, however, craft companies started to construct complex technical objects, for instance the steam engine, designed by academics. The excess work associated with training young people in addition to more demanding skills required, became overtaxing for craft companies. In order to cope with the excessive demand associated therewith, the German state endeavoured to (re-)claim the abstract training for the craft company, thus creating a training partnership that has lasted to this day and which is known as dual VET. Outside of Germany, this type of education can only be found in this form in Austria and Switzerland.

To the present day, in dual VET it is still the master craftsman who determines who can complete a training course in her or his company. Once they have found a trainee, they commit themselves with a training contract to train him for 3 to 3.5 years while working in their company and to release the trainee 1 to 2 days a week to attend a vocational school. There, the trainee acquires competences which the master craftsmen cannot teach them. However, the state did not become involved in this partnership without self-interest. The democracy wanted to expand general school education in order to better prepare young people for the liberal democratic system that they should actively participate in shaping as responsible citizens. In other words, vocational schools in Germany provide both demanding practical and theoretical vocational training for currently 326 training programs (EQF levels 3-4; Statista, 2018) as well as general education that encompasses lessons subjects such as German, politics, economics, sport, health promotion and religion. In addition to dual VET, vocational schools offer further training programs such as preparatory training before dual VET (EQF Level 1-2), full-time school-based VET (EQF Level 3-4) in the sectors in which a dual training partnership has not been able to establish itself, the possibility of obtaining training qualifications up to the

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high school level (EQF Level 3-4) and master craftsman or technician training following the completion of initial VET (Level 6).

Inevitably, not every vocational school can offer all 326 training programs and new potential training programs. They operate particularly in conurbations. Nevertheless, 5,000 pupils in 35 industrial-technical, social and economic programs, spread over several grades, are not uncommon in vocational schools in the countryside. This enables a high diversity of educational offer as well as specialisation both for students and teachers. So, the dual VET system requires a high level of coordination between companies and schools alongside real work and business processes, both with regard to practical and theoretical VET and to the educational mandate. This dual VET system requires that, for example, German or political instruction must be linked to learning situations based on real work and business processes, which demands a high level of creativity from the teachers. In order to achieve this, multidisciplinary teams of teachers are required to develop learning situations that are responsive to the regional needs of the companies – for instance through cooperation between learning venues – to make appropriate learning possible. These multidisciplinary (teachers of the various vocational disciplines and general education subjects) and multiprofessional cooperations (teachers with training companies and pupils) have not yet been focused on vocational teacher education.

How is design thinking conceptualised in this paper? Design thinking is an innovation approach that solves specific problems and develops new products (Brown, 2009; Plattner, Meinel, & Weinberg, 2009). Often, design thinking is used for digitization projects, but it does not focus solely on technical but also on organizational and social aspects. Basically, design thinkers assume that our life and work is becoming increasingly complex and therefore cannot be modelled only by one single type of expertise. Only when different expertises are brought together purposefully and systematically, solutions for a problem – so-called challenges – can be elaborated considering the complex needs of people, the financial constraints of a project as well as the technical possibilities (Plattner et al., 2009). To master the challenges, design thinking relies on the following three building blocks (ibid.):

a) Cooperation in multidisciplinary teams: The aim is to understand challenge from as many perspectives as possible through a multidisciplinary composition of teams. For example, the discussion with economic and social educators in the topic of “Designing a vocational school learning space for a smart factory” provides a significantly broader understanding of the subject, than

when “technicians” work on it alone and focus only on technical aspects. This more complex understanding in turn affects the creative design process, because more diverse aspects are taken into account when ideas are being developed in multidisciplinary teams than in single-discipline teams. Challenges often do not have a purely disciplinary character, but are so-called “wicked problems” that cannot be solved by a single discipline. Design thinking does solve disciplinary challenges better. It focuses only on those challenges that contain complexities beyond a single discipline.

b) An open as well as variable space for teams, which supports the creative work in a special way: Design thinking is oriented towards creativity research, which states, for example, that a statically seated posture can only provide limited support for creative work. Only when movement in space is possible, i.e. everyone can adopt a comfortable posture for the respective situation (e.g., standing or squatting) and express their ideas freely, for instance by writing on a wall, is the mind stimulated for new ideas. The room should offer both the opportunity for retreat and support of group processes, so that both the individual work phases and the team phases can be managed well.

c) Working along a six-part iterative design process: For the creative collaboration, the six steps 1. understand challenge, 2. observe facts, 3. develop synthesis, 4. generate ideas, 5. create prototypes and 6. test prototypes are elementary to let the multidisciplinary teams work systematically towards a solution. These six steps reveal the proximity to an artistic approach. Information is collected for the design, ideas are generated, drafts are created and presented to the supplier of the challenge (e.g., school leader) in order to generate information from the dialogue for the further development of ideas. However, working in multidisciplinary teams requires more steps in order to systematically bring together different expertises. For this purpose, the individual steps are supported by different methods that demand an intense discourse within the team. Particularly in the first four steps, an average of four different methods are being deployed. When generating ideas, these are, for example, classical creative techniques such as brainstorming or the 6-3-5 method. This ensures that all team members work together on the challenge and cannot avoid the process. The iterative approach – i.e. the possibility to jump back or forward in the design process – is supposed to ensure that findings collected in one process step can subsequently be incorporated into the design process. For a more detailed description of the design thinking approach, please refer to the cited literature (Plattner et al., 2009).

For the German-speaking countries, this innovative approach has already found widespread use in industrial companies (e.g., BASF, Bayer and Siemens) and IT companies (e.g., SAP and Deutsche Telekom) and also non-profit organizations now use design thinking (Schmiedgen, Rhinow, Köppen, & Meinel, 2015). In the context of education, first uses are evident. For example, the search for “design thinking” in the education research search engine (www.fachportal-paedagogik.de) provides 249 publications (as of 19.03.2019, adjusted for double entries), ten of which are German, the others English. While only single-digit numbers of publications per year have been recorded between 2004 and 2010, the numbers have been rising from 23 in 2013 to more than 53 in 2018, which indicates an increasing interest in this topic. Most of the publications are practice reports on the training of design thinkers in predominantly academic domains. Beyond that, however, it is also possible to identify contributions that fundamentally deal with the use of design thinking in educational contexts, for instance:

- Already in 2011, Allert and Richter discussed that design thinking as a collaborative way of thinking and acting (p. 7) can be beneficial for the development of educational innovations with digital media.
- Burrell, Cavanagh, Young, and Carter (2015) present case studies that show how teamwork can be used to develop new curricula, highlighting the potential of design thinking in this context.
- Noel and Liub (2017) show how design thinking at elementary school can be used to promote empathy and team-building skills.
- Höllen (2017) explains that design thinking could be used successfully to design meetings in large-city adult education centers.
- Danah and Richardson (2017) focus on the school environment and encourage teachers to consider design thinking to tackle everyday school life: “To solve stubborn, everyday problems of practice in schools, they should approach those problems strategically and systematically”. (2017, p. 60)
- Gallagher and Thordarson (2018) present a book that teaches school administrators how to use design thinking for school development.

The aforementioned publications show that design thinking is used in educational contexts for different purposes, but no publications have been identified for vocational schools. Expanding the focus and research upon design thinking with regard to VET in the technical disciplines, the following results can be cited: With regard to the concept of smart factory (German: Industrie

4.0), Hartmann (2016, p. 44) and Heinrich (2016, p. 119) point out that the technical innovations will further increase the relevance of creativity techniques as well as the competence for multidisciplinary cooperation for industrial specialist work. These are elementary components of design thinking. In 2003, Schlausch and Schütte also showed in a case study that skilled workers were involved in multidisciplinary teams when developing new production machines, which also follows the design thinking approach.

The observations as well as the publications presented, draw the conclusion that design thinking can be relevant for vocational schools in different contexts: About school development, as a method to promote competence for multidisciplinary and creative work in future industrial work, or also to strengthen teacher cooperation. In conclusion, design thinking can be considered relevant in different contexts of vocational schooling – may it be as a method to promote competence for multidisciplinary and creative work in future fields of work or even to strengthen teacher cooperation. On the other hand, the publications reviewed originate from the Anglo-Saxon area, where the school system is different. Consequently, it cannot be assumed that design thinking can also be successfully applied in German vocational schools, so that a discussion of this approach is advisable before recommendations regarding design thinking are made for vocational schools.

At the Münster School of Vocational Education (MSVE) at Münster University of Applied Sciences, this raised the author’s question as to how a study can be conducted to examine the relevance of design thinking for vocational schools. Since the findings presented on the use of design thinking in educational contexts were promising, it seemed to be ethically justifiable (Altrichter, Feldman, Posch, & Somekh, 2008, p. 152), to conduct the study within the framework of a course in vocational teacher training: Pre-service teachers work on challenges from VET and the overall experience gained in this context is used to evaluate the innovation approach. Building on these considerations, the focus was on the following two research questions:

1. How can teachers be educated for design thinking, so that they can successfully work on design challenges in educational contexts?
2. Is design thinking a useful approach for school development in German vocational schools?

The two research questions above approach design thinking at different levels of action for vocational schools. Answering the first question is a prerequisite for having

qualified vocational teachers, which can work with design thinking challenges in order to gain experience with the innovation approach for answering the second question.

2 Research design

To answer the research questions, the approach of action research was adopted, which allowed to plan a didactic measure in a practical and emancipatory way, to carry it out, to verify its acceptance by the participants and to further develop it with them (Bortz, & Döring, 2006, p. 341-342). Through this approach, it is possible to transfer design thinking into a practical context, so that practitioner researchers are able to cope with “challenges and problems of practice” and carry through innovations “in a reflective way” (Altrichter et al., 2008, p. 6). Accordingly, a course in vocational teacher training – in which the students work on challenges – was planned along the framework conditions at the MSVE, carried out under real conditions, documented and interpreted by the students, the teachers and the users based on the results obtained from the challenges. Action strategies were then derived and thus the course was further developed in accordance with the cycle of action and reflection (Altrichter et al., 2008, p. 8), resulting in answers to the research questions. As a measure, a one-semester master’s seminar from the module “Vocational Education Studies I” was developed and carried out at the MSVE in the scope of two hours per week (three or four credit points). In this seminar, the students worked in multidisciplinary teams on design thinking challenges from vocational schools.

In order to record the experiences gained in the seminar, several methods were used to gather information from several perspectives. For this reason, the perceptions of teachers, students and third parties were recorded using different survey methods (Altrichter et al., 2008, p. 144):

- The impressions of the university teachers that emerged during the seminar were written down in a diary for each seminar session. Teachers were advised to pay particular attention to the extent to which the three components of design thinking can be implemented in the seminar (multidisciplinary teams, open and variable room concepts and the six design steps) as well as whether the time schedule was practicable and how they themselves evaluated the students’ learning performance. Special attention was paid to negative aspects of cooperative learning, because this is a very elementary aspect of the multidisciplinary cooperation of the students. To this end, Neber names a total of four effects, three of which were particularly

reflected in the diary by the teachers (2001, p. 362-363). These are the free rider effect (weaker learners leave the work to more efficient group members), the sucker effect (more efficient learners feel exploited and reduce their willingness to make an effort) and the ganging-up effect (teams settle with solutions that are associated with less effort).

- The students completed a questionnaire for course evaluation (40 items, standard questionnaire for course evaluation at Münster University of Applied Sciences) and at the end of the seminar, in the absence of the lecturer, they gave feedback on key questions jointly formulating answers as a group and writing them down on wall newspapers. Design proposals for the optimisation of didactic measures were requested, as was the contribution that design thinking can make to vocational schools. The results were then viewed together with the teachers, questions of understanding clarified and the findings were documented.
- In addition, the students had to present their challenge or solution approaches to third parties. These were MSVE university teachers in the first run, teachers from vocational schools in the second and a mixed group of MSVE faculty members and teachers in the third. Their estimations concerning the students’ approaches – i.e. the content transfer – had been then recorded, regarding the potential usability of Design Thinking for vocational schools.

These explanations show that the efforts are to be understood as exploration. The two research questions are not intended to generate any fundamental knowledge about design thinking, but rather to provide an assessment via an open procedure as to whether design thinking can be used in vocational schools and what it can be instrumentalized for afterwards.

3 Execution of the seminar in the master’s program

To design the seminar, the author drew on the literature on design thinking and attended a three-day training course at the Hasso Plattner Institute in Potsdam (Germany). Experiences from design thinking projects outside vocational teacher training were also available and could be followed up (Krüger, 2016, p. 55). To answer the research questions, the author thus plays both the role of the researcher and the lecturer, which is characteristic

for action research (Altrichter et al., 2008, p. 5). In the first of three runs to date (winter term 2017/18, summer term 2018 and winter term 2018/19), a further lecturer was also involved in the seminar, who presented training and experience in design thinking and brought this into both the seminar design and implementation.

The first step was to ensure that the teams were multidisciplinary – an important component of design thinking (Plattner et al., 2009). The intention of this innovative approach is to obtain a multidisciplinary picture of a challenge through various professions in order to generate complex ideas that a single profession would not come up with. In this respect, the teacher training course at the MSVE offers good prerequisites because the students come from the seven professional fields: Civil Engineering, Electrical Engineering, Nutrition and Home Economics, Health Sciences and Nursing, Information Technology, Mechanical Engineering and Media Design/Design Technology and attend the same seminars. Students who have the same combination of subjects are rarely represented in a seminar with the general education subject of their choice. In addition, the students often already completed a vocational education, for instance as a nurse or electrician. Despite the diversity of the students described in relation to their studies and their professional careers, it must also be noted that they are homogeneous in one respect: All students have the goal of becoming teachers at a vocational school and complete the same educational-scientific modules (except for vocational subject didactics).

Another building block of design thinking is the provision of an open and variable space for the teams, which supports creative work in a special way. As a teacher training facility, however, the MSVE has many “moderation walls”, some of which can be moved flexibly in the room and others are fixed to the wall. Wall newspapers, moderation cards, pens, scissors and glue are also available. For prototyping, the author provided from private stock Lego bricks, as well as costumes and props for role-playing games. By putting away the seminar tables and dividing the rooms with presentation walls, similar conditions could then be created as in rooms specifically outfitted for design thinking. In addition, as many rooms as possible were made available in all three runs to enable undisturbed group work. Also, in the second run with a new design thinking room at the University of Applied Sciences Münster, two sessions gave the participants the opportunity to gain experience in implementing the open and variable room concept for design thinking in a better way (Plattner et al., 2009).

For the seminar it must be shown that the available two hours per week were bundled into five block events and distributed evenly over the course of the semester. Thus, it was possible to impart theoretical knowledge on the students in the blocks and then to give them room to apply this knowledge to their challenges. Even though there were always instructional phases, carried out by the teacher, project-oriented learning based on the students’ own challenges dominated. In order to carry out the challenges, it was also necessary for the students to act independently between these blocks, for example when they carried out the observation phase and interviewed teachers at vocational schools. The students were also encouraged to attend all seminar dates and to notify of the exit of fellow students during teamwork immediately.

The students could decide whether or not they wanted to be graded in the course. Participating actively sufficed to receive credit points. To be graded, however, students took an individual oral exam with two examiners for half an hour. It should be noted that approximately 4 out of 5 students decided to take an oral exam at the end of the course. In total, the seminar was held three times:

1. In the first run in winter term 2017/18, five teams (a total of 23 students) were commissioned to design an innovative learning space for vocational schools, whereby the focus for each group was different (linking digital and real learning spaces; design of a stress-reducing classroom; inclusion-oriented classroom design; design of a classroom conducive to learning; design of a classroom for action-oriented teaching). The challenges they focussed upon were fictitious in nature. Students were presented with suggestions for topics that they could take up and modify.
2. In the second run in summer term 2018, three teams (15 students) completed the seminar. Because the experience from the first run was that the supervision of the teams is particularly demanding in the first half of the seminar, a limitation on the number of students and team size was advisable for the maintenance of a good supervision quality. While the topics in the first run were fictitious, in the second run real challenges from three different vocational schools in the Münster region were collected and processed. These topics were: “The development of a concept to promote the media didactic competence of teachers”, “The stress-reducing teachers’ lounge” as well as “The design of an innovative learning room for media designers, which combines virtual and real learning actions”. All three topics were presented by the designated individuals from the vocational schools in a short

video contribution, the results were viewed by them and evaluated in terms of their content transfer to the respective vocational school.

3. In the winter term 2018/19, too many students wanted to participate in the course, so that four teams were admitted with a total of 19 students and four bachelor students had to be excluded. Due to the unplanned fourth group, it was necessary that one topic had to be dealt with by two groups. In order to limit the overlaps by working on the topic, the respective focus was set differently, which proved to be viable. The topics were: “How to motivate high school graduates (1st team) or engineers (2nd team) to become a teacher for vocational school in technical professions?”, “The stress-reducing teacher lounge” and “Designing a learning space for the MSVE that is healthy, motivating, learner-centred, project-oriented and scientific but also optimal for digital learning”. The two topics (one of which was addressed by two teams) from the vocational schools were dealt with and one topic from the MSVE. All results were presented to representatives from the educational institutions.

4 Reflection: Presentation and evaluation of results

To answer the first question, “How can teachers be trained for design thinking, so that they can successfully work on design challenges in educational contexts?”, a first look is taken at the three building blocks of multidisciplinary teams, open and variable space and iterative design process, and the extent to which the inherent demands could be met in teacher training. Subsequently, the seminar concept will be tested based on the experiences made and the acceptance of the seminar by the students will be discussed. Finally, the transfer content of the results of the challenges will be discussed, especially by answering the second question “Is design thinking a useful approach for school development in German vocational schools?”

4.1 The three building blocks of design thinking

a) The first task for the teams was to achieve a composition that was as multidisciplinary as possible. It should be noted here that, in the first run, the personal disciplines of Nutrition/Home Economics and Health Sciences/

Nursing were overrepresented, which meant that two teams could not be well mixed and consisted only of these two disciplines. Although attention was paid to a variety of general-education subjects, it turned out that a stronger mix would have been desirable, which was particularly noted by the students. Compared to the other teams, there were no significant qualitative differences in the results, but the group dynamics were visibly lower, which was reflected in a less intense discussion process. Here the claim of “multidisciplinary teams” is dependent on the professional specialisations interested in the seminar. In case of a high demand for the seminar an unequal distribution of the vocational fields could be met by a quota regulation. In addition, it was discussed with the students that they are very homogeneous with regard to the educational goal of becoming a VET teacher and that the multidisciplinary claim could therefore only be fulfilled to a limited extent. In this regard, they predominantly expressed the opinion that, although the common denominator was noticeable, the cooperation was dominated by the different technical expertise. This was evident, for example, when the technical disciplines wanted to approach a question in a very structured way, the media designers opted for a very free-spirited discussion and the students from personal disciplines were very user oriented. The prerequisite of multidisciplinary was therefore met with minor restrictions.

b) Regarding the open and variable room concept, the seminars were carried out well within its spatial conditions – as can be seen in Figure 1. In the second run, the students had the opportunity to test a special and new design thinking room at the Münster University of Applied Sciences on two dates. They decided to use the rooms at the MSVE and did not attribute any added value to the special design thinking room. The university teacher’s observation deviated from this assessment, as more dynamism could be detected during the teamwork.

c) The students worked intensively along the six-unit iterative design process based on their challenge. During the first three of the six design steps (information, observation and synthesis) formulated by Plattner et al. (2009), the teams needed a lot of help. Intensive support was necessary so that the students did not feel overwhelmed by their challenges and the design thinking approach. In these three phases, the students also saw a strong contrast between the quality criteria of scientific work and of design thinking. While the scientific work strives for very reliable findings and requires in-depth analytical considerations, design thinking takes a broad, multidisciplinary view of the challenge and wants to achieve (intermediate) results as quickly as possible. For

Figure 1: Design Thinking for German Vocational Schools?

this purpose, it is accepted that design steps are repeatedly taken, so that the design process is deliberately iterative. A discussion with these contrasts must be addressed in the seminar in the context of the processing status of a challenge with the students in order to avoid the design thinking approach being devalued based on the quality criteria of scientific work. The following three design steps (developing ideas, creating prototypes and testing prototypes) were easier for the students because the teams developed a common point of view within the framework of the synthesis, which simplified the subsequent discussions.

With regard to the three building blocks of design thinking, it can be concluded that the seminar was able to take sufficient account of these, but that – as explained – minor shortcomings (e.g., that the students are not multidisciplinary with regard to their training as teachers) had to be accepted, as well as didactic interventions (e.g., the discussion that design thinking is fundamentally different from the quality criteria of scientific work).

4.2 Examination of the seminar concept

Surprisingly, the initial concept of the seminar could be maintained without major corrections. This applied to both the content and timing of the seminar. Consequently, only minor changes were made to both aspects. As already highlighted, the teamwork was also characterized by an intensive cooperation, only one student dropped out of the seminar due to the change to another study course. Even though the time schedule was initially assessed as practicable, more time would be desirable for the seminar to take place. There are two reasons for this: First, the challenges have been completed in relation to the six design steps, but the last design step involves testing the prototype, gathering information about its user acceptance. This collected information is normally fed back into the design process to further optimize the prototype or, if necessary, discard it and then approach the user with a new idea. This iterative process of design thinking cannot be realized with the available time budget of two hours per week, because the challenge is only completed after completing the last design step. In the future it is

intended to explain and run through the design process in seminar once, explaining in theory and practicing all design steps. On this basis, the students would then be able to continue working independently, allowing for the learning objective of mastering design thinking to be assessed as achieved. Second, more time would be needed to deal with the design thinking process in terms of how it can be integrated into professional teaching. Especially in the second and third run, the students showed a high level of creativity in this respect. If their ideas could be further differentiated and, if necessary, compared with existing findings from literature, the transfer to vocational schools would be taken more into account. With a total of three to four hours per week, these two requirements could be met.

Typical problems of cooperative learning such as free rider, sucker and status-dependent effects (Neber, 2001) could not be observed. In the first and second run, however, there was one team each in which the ganging-up effect (*ibid.*, p. 363) became visible, which means that the teams settled on solutions that required less effort. This effect was countered in the third run by requiring the teams to obtain a written “OK” from the lecturer for each next design step using a form. This was previously done orally and was therefore sometimes handled too freely. It seems that this solution is viable because no ganging-up effect could be observed in the third run.

As far as learning performance is concerned, the students put a lot of effort into dealing with the challenges. This applies to the teamwork, but also to the theoretical understanding of design thinking and the challenge. In the exams, the students were able to reflect the design thinking approach well and combine them with their own experiences. The theoretical interaction with the challenges was also remarkable. In the first design step, “understanding”, all the teams carried out research and meticulously compiled the results. In the first run, which dealt with the innovative design of learning spaces at vocational schools, the results of all five teams presented a very comprehensive picture of aspects of how a learning space should be designed from a theoretical point of view. The students demonstrated a high level of theoretical knowledge, which was not focused on in the seminar concept because the challenges were in principle freely selectable. Regarding this, Fischer (2015) points out in a workshop report that he considers design thinking to be very suitable for a solid theoretical examination of a scientific topic because he himself has had correspondingly good experiences. This shows a university didactic potential, which had been validated by the author’s own observations.

4.3 Acceptance of the seminar by the students

The seminar was overbooked in winter term 2017/18, in summer term 2018 and in winter term 2018/19, so that all places were easily filled. It received consistently good recommendations from the students. Right from the start, students expressed great interest in methods that promise innovation. Getting to know and practicing creativity techniques was also repeatedly emphasized as a targeted learning goal. On the other hand, the students had little experience with the concept of design thinking beforehand.

The 40 items in the course evaluation were rated positively between 1 and 2 (on a scale from 1 to 6, with 1 corresponding to “agree” and 6 to “disagree”, $N = 57$ within three runs). Only the question of coordination with other courses and the question of whether the course was well prepared for the final thesis were each awarded 3. These two areas for improvement cannot be dismissed, and consideration must be given to how they can be addressed in the future. The students suggest one to two hours per week as preparation time and two hours per week as follow-up time. This corresponds with the statements in the seminar: “You have to get involved, but it’s a lot of fun”. With regard to the question “I work predominantly alone”, the students gave the rating from 5 to 6, which again proves the strong cooperation within the teams. The statement in the open-ended questions: “We have never worked so efficiently in a team before” also supports this. In terms of content, creativity techniques are very often highlighted as added value, but also the change of perspective demanded by design thinking: “Change of perspective is a fundamental virtue that a teacher should definitely learn!” (answer to an open-ended question). Gallagher and Thordarson (2018) particularly emphasize the latter as a very important aspect when they formulate the approach of school management in traditional leadership models as “leader (teacher) centred” (2018, p. 8) and in design thinking as “user (student) centred” (*ibid.*). This means that a very important learning objective can be achieved in the seminar.

Unfortunately, the students did not offer much criticism due to their enjoyment, which makes the limitations of action research visible, because the euphoric basic mood forces a group dynamic that silences critical voices to a large extent. For this reason, critical voices were captured and evaluated very meticulously. These often include small aspects, such as the order of the team contributions in the final event, which were then changed in the second run. On the other hand, individual opinions

such as “I had to download programs and was dependent on the laptop” (answer to an open-ended question), did not result in changes in the subsequent runs, because the teachers expected a certain degree of independence from the students.

In principle, it can be stated that the seminar concept presented is sustainable and enjoys a high level of acceptance. The students work conscientiously on their challenges in multidisciplinary teams based on the design process and thus also acquire a thorough understanding of theoretical insights. The learning outcomes and evaluations also show that the students are learning to deal with design thinking in a comprehensive manner. In this way it can be shown for the answer to the first question that this is a sustainable approach to how (prospective) students can learn design thinking. However, the questions as to what the students will later take up in their professional life as teachers and to what extent they can then prepare their students for creative and multidisciplinary technical work remain unanswered. From the point of view of vocational teacher training, it remains open whether this seminar concept can help achieve a solid method transfer into vocational teaching. This question must be answered by further studies.

4.4 Content transfer of the results from the challenges into vocational schools

The publications presented in the first chapter signalled a high benefit of design thinking, which Gallagher and Thordarson (2018) explain from the point of view of school management and Danah and Richardson (2017) for coping with everyday school life. Whether this benefit can also unfold in vocational schools is examined from three perspectives below. The transfer of the design thinking approach from the perspective of the students and the transfer of the results from the challenges will be discussed. Finally, it is explained how third parties evaluate the transfer of the results.

Transfer of the design thinking approach from the students' point of view: With regard to the transfer of the design thinking approach to vocational schools, the students particularly see the following fields of application: School development, teacher cooperation (especially with regard to the cooperative development of learning situations) as well as the way of thinking in order to systematically change perspectives for questions related to people. In the first run, the students were divided into two distinct groups on the question of transfer. While one half was very euphoric and expressed statements such as

“The method is very useful for the later profession in the teaching staff, as well as a method in class” (answer in an open question), the other half had critical opinions: “I don't really see any sense in this course for a teacher – we will never need the topic in our future profession” (answer in an open question). In the second and third run, the students then worked on real challenges of vocational schools. This led to a much better assessment of the transfer, because in the context of the real school it became apparent to them that practical questions could really be clarified. Despite this, there were also some cautious voices that remarked that it would be difficult to introduce design thinking among the teaching staff alone. Only when several colleagues were familiar with this approach one could hope that they would form a multidisciplinary team to work on challenges. Consequently, it can be assumed that the dissemination of the design thinking approach to vocational schools cannot be achieved solely through vocational teacher training. Further training of active teachers and school management seems to be indispensable.

Transfer of results from the students' point of view: In the first run, the students were satisfied with their results. They assessed their quality as high. It was stated that the local conditions were not known and that an assessment was therefore difficult. This limitation is easy to understand because the fictitious challenges did not provide any real framework conditions in which the study participants could check their results. It became clear that real challenges from vocational schools had to be processed once again. In the first run, however, the study participants believed they could bring the overall experience of the challenge into everyday school life one day, because they had learned a lot about classroom design – even beyond their own challenge. In the second and third run, the students were also satisfied with their results and believed these could be transferred well to the vocational schools because they were specifically developed for the respective school.

Transfer of the results from the point of view of third parties: In the first run, the results were presented to two university teachers and two MSVE research assistants. Their evaluations were the same as those of the students. In the second run, the results of the three challenges were returned to the vocational schools and evaluated as follows:

- Challenge “Designing an innovative learning space for media designers that combines virtual and real learning actions”: The head of the department noted that the results contain ideas that he would not have come up with and that will find their way into the

forthcoming creation of the learning space. About 60% of the presented concepts will be implemented. As an overall assessment, the head of the department stated the work result was good.

- Challenge “Development of a concept for the promotion of the media-didactic competence of teachers”: So far only the quality representative of the vocational school was presented with the results, who also formulated the challenge. He was very satisfied with the results and was looking forward to their presentation to school management and interested colleagues. It remains an open question, which results will be implemented in the school.
- Challenge “The stress-reducing teachers’ lounge”: Up to now there has been feedback that a further challenge has been requested for the coming semester, which also deals with room design. It is therefore assumed that the results were well received, but it remains to be seen which of them will be implemented.

In the third run, the results of the three challenges were presented twice to vocational schools and once to university teachers from MSVE and were evaluated as follows:

- Challenge “How to motivate people to become a teacher for vocational school in technical professions?” One teacher came and had a look at the ideas of the students. This topic was carried out by two groups (each of five students) with different focus. One group was focussing on engineers with work experience the other group on school graduates. The feedback of the teacher was that both results complemented each other well. He liked both results very much and said he would bring them to his school to discuss them with colleagues and school management.
- Challenge “The stress-reducing teachers’ lounge”: Three teachers came for the testing of the prototype and gave feedback to the result. During the testing were ideas were presented on how to modify the arrangement of the furniture and the functions of the room sections. The students gave the documentation of the challenge to the teachers who will also discuss this with the further staff at school.
- Challenge “Designing a learning space for the MSVE that is healthy, motivating, learner-centred, project-oriented and scientific but also optimal for digital learning”: This challenge was focussing on our own rooms and not on a vocational school. Therefore, five colleges examined the results and gave feedback to the students. They found the results good and stated they would take the ideas to adjust the space accordingly in the coming renovation. But they also pointed out

that we could take time to think more about these ideas and to optimise the solution. This led to the idea to let another group work on this challenge in the upcoming semester.

An attempt was made to answer the question “Is design thinking a beneficial approach for school development in vocational schools?” based on the results of the challenges carried out and the assessments of students and third parties. It became clear that it is helpful to take up real challenges from vocational schools and have the results evaluated by active school representatives. At the time of writing the article, final feedback from the participating schools was not yet available, which is why a final evaluation cannot be carried out. In addition, the number of six challenges is limited, which calls for further challenges to be carried out with vocational schools. However, design thinking seems to provide useful results for vocational schools, at least for teacher training. This also leaves the matter open as to whether design thinking offers enough space for the implementation of challenges in everyday school life.

5 Summary and outlook

Design thinking can be successfully taught in vocational teacher training within the framework of two hours per week. For this it is important that on the one hand the multidisciplinary teams are comprised of students from different professional fields. On the other hand, real challenges from the vocational schools are needed. Although a time budget of three to four hours per week is not necessary, it would be desirable in order to enable a didactic discussion in the seminar and to revise the findings about the prototype created during testing. One teacher should supervise no more than 20 students within four teams. Thus, the first research question, “How can teachers be educated for design thinking so that they can successfully work on design challenges in educational contexts?”, can be constructively answered by naming design recommendations and framework conditions.

For the second research question, “Is design thinking a useful approach for school development in German vocational schools?”, the findings of the second and third run indicate that the results of the challenges are useful for vocational schools, but a reliable evaluation is not yet available. Against the background of the small number of cases, the implementation and evaluation of further challenges is necessary. A new seminar is planned for the coming summer term of 2020. In addition, it should be evaluated, which of the results of the challenges

have really found their way into school development. It is conceivable that the vocational schools will make a significant contribution to the results, but that they will only implement the proposed solutions to a limited extent or not at all. Corresponding follow-up examinations are in preparation. In this context, the question of the extent to which design thinking has proven its worth in everyday school life also remains open. Are active teachers in the teaching profession able to come together in multidisciplinary teams and to carry out challenges accompanying the many other commitments in order to advance school development? Will school management find this approach beneficial and encourage working on challenges? In order to answer these questions, practicing students will be involved in the seminar in order to receive training in design thinking. This will create a transfer of know-how to vocational schools, which will create a base for teachers to try out design thinking in their everyday school life.

Based on the results presented here, there is significant potential for design thinking, which can also unfold in vocational schools. About school development and future technical work, which will increasingly require creative and multidisciplinary work in teams, further work is highly recommended.

References

- Allert, H., & Richter, C. (2011). Designentwicklung. Anregungen aus Designtheorie und Designforschung. In M. Ebner & S. Schön (Eds.), *Lehrbuch für Lernen und Lehren mit Technologien (L3T)*. Bad Reichenhall: BIMS e.V.
- Altrichter, H., Feldman, A., Posch, P., & Somekh, B. (2008). Teachers Investigate their Work. An Introduction to action research. Abingdon: Routledge.
- Bortz, J., & Döring, N. (2006). Forschungsmethoden und Evaluation (4. Auflage). Heidelberg: Springer Medizin.
- Brown, T. (2009). Change by design: how design thinking transforms organizations and inspires innovation. New York: Harper Collins.
- Burrell, A., Cavanagh, M., Young, S., & Carter, H. (2015). Team-Based Curriculum Design as an Agent of Change. *Teaching in Higher Education*, 20(8), 753-766.
- Danah, H., & Richardson, C. (2017). Teachers Are Designers. Addressing Problems of Practice in Education. *Phi Delta Kappan*, 99(2), 60-64.
- Fischer, M. (2015). Design Thinking im Seminarunterricht. Ein strukturierter Kreativprozess im Politikseminar. B. Berendt, H.-P. Voss & J. Wildt (Eds.), *Neues Handbuch Hochschullehre. Lehren und Lernen effizient gestalten. [Teil] C. Lehrmethoden und Lernsituationen. Aktivierende Lehrmethoden* (pp. 7-18). Berlin: Raabe.
- Gallagher, A., & Thordarson, K. (2018). Design thinking for school leaders. Five roles and mindsets that ignite positive change. Alexandria, Va.: ASCD.
- Hartmann, M. (2016). Analyse beruflicher Handlungsprozesse und Planung beruflicher Kompetenzentwicklung vor dem Hintergrund von Industrie 4.0. In J. Steffen, U. Schwenger & T. Vollmer (Eds.), *Digitale Vernetzung der Facharbeit* (pp. 27-54). Bielefeld: wbv.
- Heinrich, N. (2016). Informationstechnik als Querschnittsdimension gewerblich-technischer Facharbeit. In J. Steffen, U. Schwenger & T. Vollmer (Eds.), *Digitale Vernetzung der Facharbeit* (pp. 117-136). Bielefeld: wbv.
- Höllen, M. (2017). Start-up-Atmosphäre an der VHS: Design Thinking auch in der Weiterbildung? Ein unkonventionelles Format für die Tagung großstädtischer Volkshochschulen. *Dis.kurs*, 3, 40-42.
- Krüger, M. (2016). Wer – im Coburger Weg – was von wem wann mit wem wo, wie, womit und wozu lernen soll? In Hochschule Coburg (Ed.), *Gute Aussichten. Zwischenbilanz zum Projekt "Der Coburger Weg"* (pp. 48-57). Coburg.
- Neber, H. (2001). Kooperatives Lernen. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie*. Weinheim: BeltzPVU.
- Noel, L., & Liub, T. (2017). Using Design Thinking to Create a New Education Paradigm for Elementary Level Children for Higher Student Engagement and Success. *Design and Technology Education*, 22(1).
- Plattner, H., Meinel, C., & Weinberg, U. (2009). design THiNKiNG. Innovation lernen – Ideenwelten öffnen. München: mi-Wirtschaftsbuch.
- Schlausch, R., & Schütte, M. (2003). Zur partizipativen Reorganisation eines Unternehmens des Maschinen- und Anlagenbaus. *Zeitschrift für Arbeitswissenschaften*, 57(1), 42-57.
- Schmiedgen, J., Rhinow, H., Köppen, E., & Meinel, C. (2015). Parts Without a Whole? The Current State of Design Thinking Practice in Organizations. *Technical Reports by Hasso-Plattner-Instituts für Softwaresystemtechnik an der Universität Potsdam*, 97, Potsdam: Universitätsverlag.
- Statista (2018, July). Entwicklung der Gesamtzahl der anerkannten oder als anerkannt geltenden Ausbildungsberufe in Deutschland von 1971 bis 2018. Retrieved from <https://de.statista.com/statistik/daten/studie/156901/umfrage/ausbildungsberufe-in-deutschland/>
- Tremblay, D.-G., & Le Bot, I. (2000). The German Dual Apprenticeship System: An Analysis of Its Evolution and Present Challenges. Toronto (Ontario): York University.