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**Title** [Digitalisation of Design Research – A case study to illustrate the use of digital technologies and tools for collaboration in Design Research projects](#)

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**Abstract** Digital transformation affects all aspects of society, including educational and scientific areas. Therefore, digital technologies and tools also offer potentials in Design Research projects. A core element in the latter is the collaboration and interconnection between scientific and educational practice. The question, thus, arises how digital technologies and tools can support activities in Design Research projects, especially regarding the interconnection between researchers and practitioners. The aim of the article is to illustrate the use of digital technologies and tools for co-operation between practitioners and researchers during the phases of design, implementation and evaluation in a Design Research project in the field of vocational education. It can generally be determined that co-operation in the design phases can be managed with digital technologies and tools, however, face-

to-face communication is also important. One challenge can be described in the compatibility of the digital technologies used.

**Keywords** Digitalisation  
Design Research  
Tools  
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# Digitalisation of Design Research – A case study to illustrate the use of digital technologies and tools for collaboration in Design Research projects

Karl-Heinz Gerholz, Sebastian Ciolek, Anne Christina Wagner

## 1.0 Introduction

The phenomenon of digital transformation affects different working fields and the educational area. In the working fields, the introduction of digital technologies and tools is, on the one hand, linked to the objective to make working activities more effective and efficient (Fischer et al. 2018). On the other hand, new working tasks are emerging alongside the use of the digital technologies and tools. The work practice and the structure of tasks are changing. The latter represents the meaning of *transformation* during the age of digitalisation (Gerholz & Dormann 2017). In this way, the digital technologies and tools have the potential to enhance the quality of work (World Economic Forum 2016).

However, the changes and potentials of digital technologies and tools presented are also relevant for the science area as a working field for researchers and lead to changes in this field. The management of research projects is supported by digital tools (e.g. project plans, virtual communication with project partners). Digital tools (e.g. programmes such as MAXQDA or SPSS) assist in data collection, data evaluation and interpretation. Thus, digital technologies and tools support science activities and change their structure in some areas. Bearing this in mind, digital technologies and tools also offer potentials in Design Research projects. Design Research, especially in the educational area, is becoming a relevant research design (Pool & Laubscher 2016). A main characteristic in Design Research projects is the collaboration and interconnection between scientific and educational practice or researchers and practitioners. This indicates that the practice of Design Research is challenging whether, or to what extent, the active participants fulfil the characteristics mentioned or not. Therefore, the question arises how digital technologies and tools can support activities in Design Research projects, especially regarding the interconnection between researchers and practitioners.

The focus of the article is to illustrate the use of digital technologies and tools for co-operation between practitioners and researchers during the phases (design, implementation and evaluation) in a Design Research project. Firstly, we present the relevant activities regarding the co-operation of practitioners and researchers in Design Research (chapter 2) from a theoretical point of view. Secondly, suitable digital technologies and tools to work on the different phases are presented based on a case study. The case is represented by the Design Research project given (chapter 3). Based on the theoretical and case

perspective, the contributions of digital technologies and tools for the collaboration of researchers and practitioners are carved out (chapter 4).

## 2.0 Relevance and understandings of the design process in the Design Research approach

A central aim of Design Research projects is to produce new theories, artefacts or educational practices in a given and naturalistic context to reach a desirable objective (Barab & Squire 2004; Euler 2014). Thus, the starting point of Design Research processes is an existing educational challenge. Hence, a stable educational intervention or prototype using Design Research should be developed. Design Research projects show a cyclical architecture in their proceedings (Euler 2014, Gerholz 2014, Plomp 2013, Van den Akker 2007). Nevertheless, there are different concepts of how the design-cycles may look in detail. Reeves (2006, 58 ff.) presents a linear model with four phases: In phase one the collaborative analysis of the practical problem of both – researchers and practitioners – is important. Based on that, both parties develop solutions (phase two) which should be iteratively tested and refined (phase three) with the aim of describing design principles for the problem given (phase four). By contrast, McKenney & Reeves (2012) suggest a more generic model to conduct Design Research processes. Their model follows three phases in an iterative structure with a dual focus on theory and practice. In this model, the implementation is ongoing: (1) analysis and exploration, (2) design and construction, and (3) evaluation and reflection. The different concepts of design cycles reflect two characteristics of Design Research projects overall: firstly, the interconnection between design and research. Research and design are elements integrated into each other (Bannan-Ritland & Baek 2008) or run synchronously (Ejersbo et al. 2008) in some models. Euler described the connection as a win-win-situation: “Science can select its research topics from problems in practice, while developing solutions for practice is enhanced by resorting to scientific theories” (Euler 2014, 21). However, the fundamental interest of the researchers and practitioners remain preserved, but the actions of these two groups can vary during a Design Research project (Euler 2014). Secondly, the collaboration of practitioners and researchers is a main characteristic of Design Research. It is also a precondition for the interconnection of research and design (Gerholz 2014). McKenney & Reeves underline that collaboration between both parties enables, among other things, a better understanding of the underlying educational problem and a suitable realization of the design and development process. The practitioners, for instance, have a relevant practical knowledge and are sensitised to the target group. The researchers can help with the selection of the most fitting approaches for the development of the educational intervention and the evaluation of the designs realised (McKenney & Reeves 2012).

Bearing both characteristics in mind, the question arises, how the collaboration and interconnection between research and design can be implemented in the daily practice of Design Research projects. The phases of design are underexposed in the Design Research literature.

Reinmann (2014) described the design process as a scientific act in Design Research, which gives creativity a place. McKenney & Reeves (2012) conceptualize the design process in three steps. In *step one*, potential solutions are explored by generating and considering ideas and checking the feasibility of the ideas which are most promising given the educational problem. Step one should be closed with a first scaffold of the solution. *Step two* aims at the further development of the solution considering the context requirements and the definition of the detailed specifications. In *step three*, a first prototype is constructed. The three steps reflect not so much a linear process as interlocking gears. Easterday et al. (2017) understand the design process as an iterative matter with five different steps: (a) the *focus phase* refers to the scope of the project (e.g. identifying the general problem, initial direction of the project); (b) the *understand phase* aims at a deeper analysis of the problem (e.g. methods such as literature review or concept mapping); (c) the *define phase* includes the operationalizing of the aims and defining criteria to assess the achievement of the aims; (d) the *conceive phase* aims at the principles and the arguments for a prototype (e.g. working on blue prints); and (e) the *build phase* represents the realisation of the prototype.

A similarity between the approaches is that the perspectives of research and educational practice are considered during the design process. In addition, the iterative philosophy during the steps in the design process is shown. The process of design should be inspired by systematic and creative as well as intentional and inventive activities. However, the detailed co-operation between researchers and practitioners is often not directly mentioned. This reflects the openness in Design Research projects. Not everything can be strictly planned. Therefore, the approaches presented are rather heuristic for the structure of design processes.

In addition to the design and implementation of the prototypes, the evaluation of the prototypes implemented is also important in Design Research projects. This reflects the iterative idea of design, implementation and evaluation in design cycles. Bearing this in mind, research methods during the evaluation should also be used integratively. It is less a question of controlling all the influencing variables but rather one of observing, describing and reflecting the interconnection between the design or prototype and its effects in the context of application (Raatz 2015). Research methods also incorporate the unforeseen things (Reinmann & Sesink 2014), with the aim of shedding new light on and bringing new aspects into the next design cycle. This reflects the process of theory building. McKenney & Reeves (2012), for instance, differentiate between three types of evaluation in Design Research projects:

- (1) *Alpha testing* refers to the early assessments of the design ideas and prototype (e.g. coherence of the design, feasibility in the field, consideration of theoretical and practical insights). Alpha testing is anchored in an early stage of Design Research projects. Research methods could be the oral questioning of experts or the designers.
- (2) *Beta testing* aims at the evaluation of the implementation of the prototype in the educational context. The focus lies on the

functionality of an intervention and the interplay of intervention and context.

- (3) *Gamma testing* refers to the overall question: Under which conditions is an effective use of the prototype developed given? It is a matter of the final release or, more precisely, it is about a highly stable version of the prototype.

Regarding the three types of evaluation proposed, it is obvious that evaluation in Design Research projects depends on the progress of the design process. It is not a question of the reproducibility of effects; it is more a question of the discursive description of the interplay between design and implementation in a given context (Reinmann & Sesink 2014). This underlines the importance of the co-operation between researchers and practitioners. The daily life experiences of the practitioners can offer indicators for the objectives of the evaluation.

The interconnection and co-operation between research and practice is generally relevant in all phases – design, implementation and evaluation – of the design cycles (Gerholz 2014). One challenge in this context is often that practitioners and researchers must bridge larger distances and find common time slots. Usually, they are not working at the same place or organisation. Digital technologies and tools can help to foster the co-operation and collaboration during a Design Research project. We will outline in the following the potentials of digital technologies and tools in design and evaluation processes based on a case study of a Design Research project in vocational education.

### 3.0 Context of the case study

#### 3.1 Interest and setting of the tabletBS.dual project

The context of the case study is the tabletBS.dual project. It is a pilot project to implement tablets in vocational schools in a pedagogical way. The project is anchored in the Dual Vocational Education and Training (VET) system. The students' VET is organised at companies and vocational schools (Gerholz & Brahm 2014). The tabletBS.dual project is structured as a Design Research project incorporating 28 vocational schools. The main aims are the development of pedagogical prototypes for the usage of tablets in vocational schools and the description of effective learning design patterns to foster the vocational competencies of the VET students. Design and evaluation are co-operatively connected in four design cycles in the Design Research project. One design cycle is established in a school semester. Each design cycle integrates different elements of design, implementation and evaluation. These elements are bundled into three working packages.

All measures in the design process and evaluation in the working packages are conducted with digital technologies. Table 1 gives an overview of the structure of the Design Research project.

Table 1  
 Structure of Design Research in *tabletBS.dual*

Design Research Process		Design cycle 1	Design cycle 2	Design cycle 3	Design cycle 4
Design	Working package 1	Consulting and coaching the teachers to develop didactical prototypes for the use of tablets in school lessons through <i>digital consultation hours</i> , analogue workshops and a <i>consulting hotline</i> . A new lesson sequence (3 - 5 vocational lessons) with tablets were developed and implemented each school term with support from the researchers.			
	Working package 2	Regarding the digital transformation, the changing working requirements can be discovered through co-operation between the learning venues. These changes need to be considered and have to be reconstructed according to the educational goals of the school. For this, <i>webinars</i> are offered to teachers in the vocational schools and instructors in the companies to gain a mutual insight into changing working requirements in a vocational profile in times of digitalisation.			
Evaluation	Working package 3	Evaluation of lessons using tablets concerning experienced learning actions of VET students and the connection between the use of tablets in the vocational lessons and their effects on the learning process. According to McKenney & Reeves (2012), this can be seen as beta testing because the effects of the lessons as an intervention can be considered more closely. The use of digital surveys and interviews with digital tools bridges the physical distances.			

### 3.2 Theoretical context of the design process

The theoretical context of the Design Research project is based on (a) a curricular and (b) a pedagogical approach.

(ad a) Curricular approach

The curricula of vocational schools in the German VET system are structured in “learning areas”. Learning areas are pedagogical reconstructions of the working fields in a given vocational profile. The requirements to fulfil a working situation are the basis for the construction of learning situations (Dilger & Sloane 2007, Ertl & Sloane 2004, Gerholz & Sloane 2011). Learning situations constitute a learning area and can be described as problem-based case studies. Pedagogical methods should be informed by the vocational action process. The learning process of the VET students should be a complete action. This is similar to the competence-based education approach that learning processes should be aligned with needs in a society, an economic sector or community (Mulder 2012).

(ad b) Pedagogical approach

Learning situations represent, in the sense of a didactical adaption, the current requirements in a vocational working field. Studies have revealed that working requirements during the digital transformation are changing from operative tasks to planning and controlling tasks (Fischer et al. 2018, Geisberger & Broy 2012). Therefore, the application and use of digital devices and work techniques must be addressed and implemented at school. Design and reflection models for educational instruction are indispensable to realise this implementation of digital media into vocational educational processes (KMK 2017).



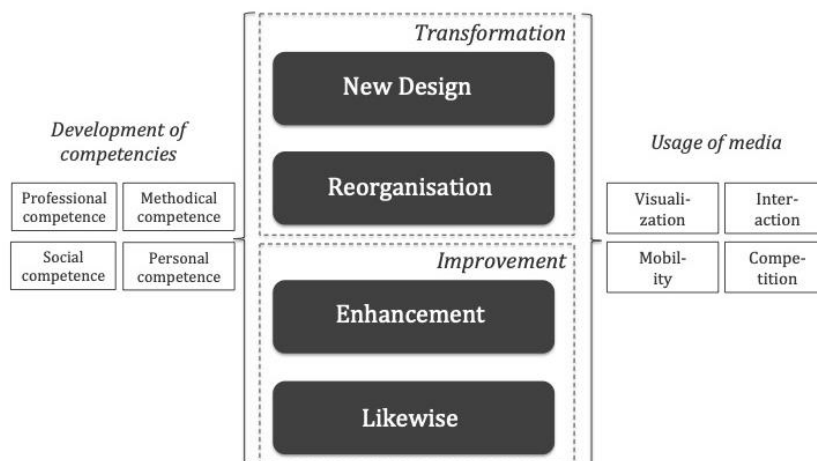


Figure 1. LEaRN model.

One possible way of using digital devices like tablets in schools is the LEaRN model that combines two perspectives: On the one hand, to simulate future skill requirements in a digitalised world of work with digital devices (development of competencies); and on the other hand, to use digital devices to support the learning processes (usage of media). Bearing both perspectives in mind, the intensity of digitalisation in VET lessons can be described in four levels. These levels represent the changing working requirements due to digital transformation (Gerholz 2020, Gerholz & Dormann 2017):

*(1) Likewise:* This level describes working activities previously carried out in an analogue form, which are now being replaced by digital technologies. An example are the documentation activities that were organised on paper and are now digitally implemented with digital devices.

*(2) Enhancement:* At this stage, digital technologies open up possibilities of improving or enhancing working processes through digital technologies that were previously not available in an analogue form. One example are the virtual communication processes that are carried out with the help of the Internet via video telephony.

*(3) Reorganisation:* The level of reorganisation includes working activities which can only be realised through digital technologies. This is the case, for instance, when previous operative activities are replaced by monitoring activities. A production process, for example, is controlled and monitored by a cyber-physical system and the employee only intervenes in the event of an error.

*(4) New Design:* Completely new working scenarios are emerging at this level. Workers, located in different parts of the world, are working together in virtual teams to solve a problem in the production process, which is controlled by a cyber-physical system. This virtual collaboration can be enhanced with digital devices, such as virtual reality glasses, which enable the creation of holograms in the form of a production process.

The levels focus on the changing working requirements in a digitalised world of work. In addition, digital devices can be used to support the learning processes. They provide access to a wider range of learning content and resources; learning processes can be made more active and independent or the attention of the pupils can be increased (Perrotta 2012). Differentiation can be made between the following in the



perspective of the LEaRN model (e.g. Gerholz & Dormann 2017; Honey & Hilton 2011): (a) visualization (e.g. YouTube videos, concept maps with tablets), (b) interaction (e.g. data exchange for partial results in a problem-solving process or virtual communication in a digital role play), (c) mobility (e.g. co-operating in a group via an online system) and (d) competition (e.g. whether learning outcomes have been achieved or not can be determined, for example, via classroom response systems, such as *Kahoot!*).

The LEaRN model represents a heuristic, which brings together the current discussion of the pedagogical potential of digital media and devices on the one hand, and offers orientation for vocational teachers to design learning situations with digital devices in a competence-based matter on the other hand. Thus, the LEaRN model is the conceptual framework in the Design Research project.

#### 4.0 Digital realisation of the design cycles

##### 4.1 Digital technologies and tools in the design processes

The design process in tabletBS.dual is performed in co-operation with the teachers at the vocational schools. Digital consultation sessions, workshops and a consulting hotline are offered to support the teachers in this design process. According to McKenney & Reeves (2012), the workshops can therefore be assigned to *step one in the design process* because the teachers develop a first structure and can discuss it with other teachers and the researchers in small groups. The webinars can be attributed to *step two*. In concrete terms, the suggestions from the practical experts can provide teachers with initial ideas for the actual implementation in the vocational lessons with tablets. The digital consultation session represents *step three*, where the researchers and practitioners, in collaboration, finalize this tablet lesson for a vocational profile.

###### *(1) Digital consultation sessions*

The design process focuses on the development of a vocational lesson regarding the LEaRN model. For this, we counselled the teachers in two digital consultation sessions in each design cycle. The meetings were arranged per e-mail and the teachers mailed teaching materials before the digital consultation sessions (for the preparation of the researchers). The consultation sessions lasted for about 30 minutes and were conducted via a virtual communication tool like Skype. Video conferencing tools were also approved in e-coaching as well (Ribbers & Waringa 2015, 14). The discussion about the vocational lessons with tablets developed by the teachers is central. From the perspective of action, it is necessary to take the vocational reality in the training companies into account. From the perspective of digital technology, the aim is to give advice about the effective use of tablets to support the learning process of the students (e.g. tools or apps). Video conferencing tools are appropriate for different reasons: firstly, Skype, for example, is a popular and versatile tool nowadays. Furthermore, it is possible to record the conversation – if the teachers agree – to make it available for the digital consultation session. In addition, it is possible to share the screen or/and documents with the conversation partner.

Utilising this function, a teacher in technical vocational education can show a simulation on an online platform to the researchers and (vice versa) the researchers can show certain settings with digital tools (e.g. padlet, OneNote) to the teacher.

### *(2) Online hotline*

By contrast, an online hotline has been installed for the teachers in tabletBS.dual for solving urgent problems and answering important questions. The teachers can describe the problem in a few sentences in a contact form. This is automatically transmitted via e-mail to the researchers. The difficulties could often be solved quickly in this way.

### *(3) Webinars*

Another aim of tabletBS.dual is the improvement of the co-operation of the learning venues. The two learning venues – training companies and vocational schools – come together in webinars, which are initiated and organised by the researchers. Experts of training companies show in the interactive live seminars how work and business processes are influenced by the digital transformation, now or in the future. It is important to give vocational teachers an orientation for the designing of authentic vocational lessons which consider the occurrences and changes in vocational everyday life due to digital transformation. The webinars, as an online in-service training, should sensitise the teachers to the vocational reality in companies. The webinars are implemented with collaborative software and web conferencing tools, such as Adobe Connect. Meanwhile, this is a positively tested tool in the continuing education of teachers (Peherstorfer 2011). It is simple for all participants to take part in the interactive webinars using Adobe Connect. The teachers only need a digital device (e.g. tablet, laptop, smartphone) with internet access. They can enter the webinar through a link without installing software. In addition, the teachers can watch the webinar anywhere and they can use all the options of collaboration (e.g. chat or take a vote within the webinar). Furthermore, it is possible to record the webinar. The recordings can then be made available to all teachers via email, so that even those who were unable to attend the live webinar will benefit. Only one webinar was held in the design cycles that have been completed so far.

## 4.2 Digital technologies and tools in the evaluation process

The objective of the beta testing (see chapter two) is to evaluate the lesson sequences with tablets implemented. The evaluation of the first and second design cycle is divided into two evaluation concepts.

The first evaluation concept analyses the learning situations while considering the LEaRN model. During the lesson sequences, students must answer questions about their emotional state (Schallberger 2005). Using a continuous state sampling method, students answer a short questionnaire on the tablet every 10 minutes after hearing a sound. This query is carried out with web-based evaluation and analysis tools, such as Unipark. The answering of the items can also be paused or interrupted. This significantly reduces the abort rate. The data is also

digitally available and can be easily transferred into the statistical programme. A further advantage is that each tablet enables the viewing format in the browser (Bryman 2016). The students are reminded of the survey by an audio recording. The sound recording is provided digitally to the teachers. The teacher must play it at the beginning of the lesson. Thus, the teacher does not have to remember the questionnaire during the lesson. In addition, the researchers interviewed VET students regarding the pedagogical approach of the lesson sequences by using a virtual video tool (appear.in). The interviewees can communicate and see each other over a great distance. The recording is done with separate programmes and devices. The conversations are videotaped and recorded with a dictation device with the support of PowerPoint. The video recording has the advantage that the statements of the students can be assigned. This allows a more precise evaluation with MAXQDA.

The second evaluation concept is extended over a period of four weeks at the vocational schools as a diary study. The evaluation interest here is to find out which media are used in vocational lessons and the respective highlights of learning experiences. Furthermore, the students fill out a digital questionnaire four times about their digital self-efficacy (Spannagel & Bescherer 2009). All evaluations are carried out online and digitally so that the research group does not have to be present. Students receive access to the questionnaires via a link and QR code. The web-based evaluation and analysis tools were used for both closed and open questions. Additionally, all data is already available in digital form without entering into the evaluation programme. This reduces the effort and allows a fast and accurate evaluation (Bryman 2016).

### 4.3 Evaluation of the used digital technologies and tools: First results

The Design Research project tabletBS.dual has already been running for more than a year. During this period, the practitioners and researchers have gained different experiences with the digital tools used in the design and evaluation processes. These experiences will be described in the following. In some cases, results of evaluations about the digital tools and technologies chosen will be used in a supportive manner.

#### 4.3.1 Reflection on the design and implementation process

##### *Experiences and evaluation of the digital consultation sessions*

We had two digital consultation sessions each with almost 20 vocational schools in the school year 2018/2019. Since Skype is an established tool for videotelephony, there were mostly no difficulties and the impression was given that most of the teachers already had their own Skype account. Only the teachers of one school did not want to use Skype, so the digital consultation sessions were conducted by telephone. The research team generally had the impression that the communication via Skype always took place in an appreciative and

productive atmosphere for both sides to design the lesson sequences with tablets. An online evaluation of the digital consultation hours was conducted at the end of the school year. The response rate was over 90 % (n = 20). The questionnaire rests upon the training evaluation inventory (TEI) developed by Ritzmann, Hagemann & Kluge (2014), which was adopted for the digital consultation sessions. The scales ranged from 1 = “does not apply at all” to 7 = “applies completely”. Table 2 shows the descriptive analysis.

Table 2  
*Evaluation of the digital consultation sessions (n=20) (Higher values on the Likert-scale represent positive agreements)*

Scale	Cronbachs $\alpha$	M	SD	Example
Subjective enjoyment	.92	5.16	1.44	Overall, I liked the digital consultation sessions.
Perceived usefulness	.97	4.46	1.58	I find the digital consultation sessions useful for the preparation of school lessons.
Subjective knowledge gain	.85	4.43	1.77	I have the impression that my knowledge has expanded on a long-term basis through the digital consultation sessions.
Attitude towards training	.95	4.11	1.59	I will apply what I learned in the digital consultation sessions in my day-to-day work.

The analysis reveals that the vocational teachers perceive the digital consultation sessions as useful instruments and note them as a benefit for the design of lesson sequences with tablets. We assume that most teachers consider Skype as an appropriate tool. Only three teachers reported on connection issues in the open questions and doubt the use of Skype (in contrast to a normal phone call). Five items related to the research team were also included in the questionnaire. The highest mean of 5.7 (SD = 1.34) is achieved by the item “University staff are easy to reach when questions or problems arise”. The item “University staff work well prepared”, was rated worst, whereby the mean of 5.2 with a standard deviation of 1.55 is also high in comparison. It can be concluded from this that the digital consultation sessions were well implemented and that the teachers were satisfied. Due to the good response, the digital consultation sessions will be continued unchanged in the following design cycles.

#### *Experiences with the online hotline*

It can be reported that the online hotline via the contact form was used less by the teachers. Most questions or problems had already been addressed and solved during the digital consultation sessions, so that only a few inquiries were made by means of the online hotline. However, it can be summed up that the offer of an online contact form is important for the design and implementation process because of the opportunity to interconnect researchers and practitioners in an easy way. The online hotline will be offered in following design cycles, even if it has not been very busy so far.

#### *Experiences and evaluation of the webinars*

As has already been mentioned, only one webinar was held in the previous design cycles. In the end, 40 teachers took part. The webinar was followed by an evaluation (n = 24). Respondents were asked to rate the webinar on a five-level Likert-scale. The scale ranged from 1 = “disagree completely” to 5 = “fully agree”. Table 3 shows selected results

concerning the aims of the webinar – the improvement of the co-operation of the learning venues.

Table 3  
*Assessments of relevance of the webinar (n=24) (Higher values on the Likert-scale represent positive agreements)*

Item	Min	Max	M	SD
The webinar provides an overview of changed requirements in the working world in the course of digital transformation.	1	5	4.08	1.139
The webinar makes a contribution to improved learning location cooperation.	1	5	3.25	1.113
The contents of the webinar are useful for my teaching at vocational school.	1	5	3.42	1.139
The webinar motivated me to go deeper into the subject.	1	5	3.29	1.197
The webinar made me aware of what needs to be taken into account when educating young people.	1	5	3.38	1.056

It could be stated that the webinar presented the changes in working processes due to digitalisation very well. The objective of improving the co-operation of the learning venues cannot be regarded as fully achieved. However, it is also evident that teachers still find it difficult to incorporate new working requirements into their lesson sequences. When asked in the open questions what to look out for at the next webinar, some teachers indicated that they would like to see concrete examples of implementations in vocational lessons. It seems that it is necessary to clarify the goal of the webinar next time because it was not the intention to give concrete examples for vocational lessons. However, teachers highlighted the digital implementation via Adobe Connect. The teachers especially liked the web access and the simple handling which enabled them to watch the webinar anywhere. The teachers were generally satisfied with the webinar.

#### 4.3.2 Reflection of the evaluation process

The online questionnaires worked very well on the whole. The stop-page rates in answering were very low and no queries on the part of the vocational school teachers regarding using the online questionnaires were raised. A solution is currently being sought to improve the provision of access data for the questionnaires to improve the quantitative survey. The aim is to reduce the workload on teachers and further digitalise the research process. The researchers are still too reliant on the audio file in the ten-minute survey that describes the emotional state of VET students during the lessons. Therefore, an app has to be developed for an automatic opening of the questions. The audio file will, therefore, no longer be necessary. In addition, delays in answering the questions are reduced and the students do not have to consider the browser because of the survey when it is possible in an offline mode. The app will generally make the quantitative survey process more efficiently.

According to the online interviews with the VET students, there is still a need for further development. The tool used appears to require a very stable Internet connection. Using Adobe Connect, a tool was found which copes better with weaker Internet connections. In

addition, the interview can be recorded simultaneously with the programme and the sound quality is much better. However, Adobe Connect requires an installation for Apple tablets. Therefore, we are still looking for a free web-based app or different solution.

A solution is sought in the second evaluation concept to increase the response rate of the diary study because the students often forget to fill it out. The research group is currently informing teachers about the missing digital diaries. In addition to that, it is searching for a tool that will automatically generate a reminder at the end of the school day. The response rate should be increased in the course of further studies.

## 5.0 Outlook

In this article the possibilities of using digital devices for design, implementation and evaluation processes based on a given Design Research project were presented. A main emphasis was to illustrate the collaboration between practitioners and researcher as a core element in Design Research projects with digital tools and technologies. Three main insights can be documented considering the case study presented:

### *(1) Potentials of 'blended' co-operation*

Instruments such as digital consultation sessions or webinars made it possible to install a virtual co-operation between researchers and practitioners. Collaboration is a main characteristic in Design Research projects, especially regarding a common understanding of the educational problem and the cooperative design process. However, based on the experiences of the researchers, the face-to-face workshops, where the parties got to know each other and the definition of a common working process, were an important part. Thus, orientating towards the phases of the design process of Easterday et al. (2017, see chapter 2), the face-to-face meetings were important for the focus and understand phases; the digital consultation sessions were productive in the design, conceive and build phases due to the fact that researchers and practitioners had already known and understood each other. In other words, blended communication in the sense of a mixture of face-to-face and virtual communication channels can be described as a key factor in the design processes to build up relationships and enable effective working at any time and place.

### *(2) Shared systems*

It turned out that one of the main advantages of virtual communication in the development process of the vocational lessons with tablets between teachers and researchers is that you can share your screen with others. Consequently, tools can be demonstrated clearly or annotations can be exactly assigned to the different teaching materials. Therefore, everyone knows exactly what is being talked about. By contrast, there were often misunderstandings in the consultation sessions via telephone because the teachers did not know exactly to which materials the comments and tips of the researchers related. The telephone consultation sessions with this school were, therefore, much more complex and also associated with more uncertainties. However, a stable Internet connection is considered a basic requirement.

Meetings were sometimes interrupted due to the poor Internet connection and a new appointment had to be arranged.

### *(3) Compatibility*

From a technical perspective, it is a challenge in the evaluation process to think of compatibility with the respondents' digital devices. It has turned out that the tools have to be set up and used differently for different devices. The vocational schools in the project tabletBS dual use different tablets. Some schools use Apple devices, others work with Android-based tablets, and still others use tablets with the Microsoft operating system. Regarding Adobe Connect, for example, the settings in Apple to activate the camera and microphone are different from the other operating systems. A short instruction has been developed for the teachers to choose the right settings in the different tablets because we noticed that sometimes there were difficulties in using the programme. Furthermore, it was a requirement while searching for appropriate tools that no installations are needed. The use of digital tools in Apple devices is usually associated with an installation, which is why some tools were out of the question from the outset. In other words, the compatibility of the digital technologies and tools used is an important factor, if the co-operation between practitioners and researchers are to be successful.



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