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Digitization and School Development: Results of an Interview Study for the Implementation of Digital Technologies at German Vocational Schools

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Abstract

Context: The digital transformation affects vocational schools and poses new requirements on teaching as well as on schools as an organization. For schools, the implementation of digital technologies in everyday school life is an innovation that entails a lengthy and complex process of change, since it affects a wide range of areas (e.g., teaching, teacher qualifications, technical equipment and technical support). Schools can actively shape this process as a part of school development involving the five dimensions of organizational, education, personnel, cooperation and technological development.

Approach: This interview study (n=46) looks at the school development of 16 vocational schools in one federal state in Germany to determine typical patterns of organizational design in the digitization process. This was done by a type-building content-structuring analysis. Assigning weights to each category, the differences in the schools' school development regarding the implementation of digital technologies can be observed.

Findings: Two profiles based on the five dimensions of school development were identified. Two school development dimensions seem to make the difference between the two profiles. The focus of the interviewed schools in school development is on personnel and

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technological development, which play a decisive role in the digitization process of schools. Both types have similarities as well as differences in the dimensions. In the area of personnel development, both profiles appear to be similarly conducive. The decisive factor is the extent to which digital technologies are used in the classroom, which is closely linked to teachers' attitudes toward digitization.

Conclusion: The outstanding importance of personnel and technological development demands investment in further qualifications for teachers on the one hand and in better IT equipment and processes on the other hand. Professional IT support that combines both perspectives thus seems essential for the future school development of German vocational schools to prepare them for the digital transformation.

Keywords: VET, Vocational Education and Training, VET in Schools, Digitalization, Educational Innovation, Organizational Development, Technological Change

1 Introduction

The digital transformation affects all aspects of society, including the economic and the education systems all over the world. Workplaces and business processes have become increasingly digitized, which also leads to changing requirements for employees (Bejaković & Mrnjavac, 2020; Goller et al., 2021; Pfeiffer, 2018; Vrana, 2016). It can be summarized under the term of digital literacy (e.g., Iordache et al., 2017; Schlottmann et al., 2021). Looking at schools in general and vocational schools in particular, this naturally has an impact on learning and teaching. Vocational schools are particularly affected by this change, as they need to incorporate the digitalized, vocational fields into their VET lessons and teaching respectively. They have an important part in young peoples' vocational training and their role as future employees (e.g., Dobricki et al., 2020; Gerholz et al., 2020). Consequently, it is crucial for vocational education to include digital technologies in the classroom, which can be understood as tools and devices (e.g., tablets) as well as software and apps (e.g., virtual reality, internet).

The simple use of digital technologies in the classroom however, does not lead to a sustainable improvement in learning and teaching; digitization within the school context implies a more widespread change (Islam & Grönlund, 2016). In addition to the pedagogical perspective on the use of digital technologies in the classroom, the effects at the schools' organizational level must also be considered. Following Bardone and Eradze (2022), it is a matter of the meso-level of a vocational education system. Vocational schools are institutions in which teachers are active participants in a given organizational context (e.g., Gessler et al., 2021; Kell, 1995). Organizational processes at schools are now more and more digitized (e.g., Cope & Kalantzis, 2016). From an international perspective, the

Corona pandemic functioned like a catalyst: Teacher conferences and meetings were held online, and document sharing was done via virtual platforms. The design of processes, organizational structures and responsibilities are essential for the implementation of digital technologies in the school. Thus, it requires changes at the school on administrative, organizational and cultural levels (Blau & Shamir-Inbal, 2017; Ottestad, 2008; Pettersson, 2018, 2021). Zhang (2010, p. 240) argues that "many technology-base learning initiatives adopt a reductionist, proceduralized approach to cultural change, assuming that deep changes can be naturally realized by introducing new technological tools, curriculum and textbooks, classroom activities, and assessment". Due to the digitization in schools and classrooms, changes in attitudes, values and structures are necessary to implement digital technologies as an innovation in schools.

One possible approach to this change is school development. Here, different dimensions of a school are mutually taken into account (Ilomäki & Lakkala, 2018; Rolff, 2016; Schulz-Zander, 2001; Sleegers & Leithwood, 2010). Since the conditions in schools vary greatly in terms of organization, personnel, education, cooperation and technology, the practice of school development also appears to be very heterogeneous. Schools attach different importance to the different dimensions of school development in the implementation process of digital technology. Both facilitating and hindering factors in the different dimensions play a decisive role for change.

Based on an interview study, the aim is to analyze whether typical patterns of the theoretical model of school development in the digitization process emerge in empirical reality. Thus, we want to identify enabling and hindering factors that might play a crucial role in the school development process. This is addressed by the following research questions:

- Are there typical patterns of school development in the implementation of digital technologies in schools?

- Which enabling and hindering factors play a decisive role in the different forms of school development?

2 Theoretical Framework and Previous Research

In order to answer the two research questions with the help of the interview study, it is first necessary to clarify on a theoretical level how change takes place in schools and what this means for school development.

2.1 Innovation and Change in School Context

Rogers (2003) understands innovation as an "idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12) and describes the diffusion process through four elements: The innovation itself, used communication channels, the time of the process, and the social system. According to Hall and Hord (2011), innovation itself can be viewed as change. Change must be understood as a long-term development process and not a singular event. According to Fullan, a school change process undergoes three central phases, which are presented in relation to the outcome. This is, ideally, that learning processes are improved and that the experience of change helps to facilitate the introduction of future innovations (Fullan, 2007). The phases of initiation, implementation and institutionalization can be differentiated. The first phase focuses on the introduction of a change and the retention of a course of action. Subsequently, the idea moves into an implementation or application process. This is where initial practical experience is gained. In this phase, the foundation for achieving the set goal is laid. The last phase is extended until the set goals are achieved and the innovation is anchored. Circular phase models can capture the complexity and dynamics of innovation processes (Burnes, 2004). However, linear models appear to be less comprehensive but more feasible in practice. Of course, in reality the process is not linear with definable phases: There are dependencies within the process, so that decisions in one phase can influence another phase.

The innovativeness of an organization depends on various factors. A positive factor is the open attitude towards innovations of the involved actors, especially the leaders. This depends strongly on their personality traits. Hall and George (1999) found very early that different change facilitator styles play an important role in the goal setting and vision development of a school. School principals are considered to have a great influence in forming the opinions and setting the goals of teachers, so that they can stimulate change and set clear goals for the school development (Geijsel et al., 2003; Johnson et al., 2012; Leithwood & Jantzi, 1999).

Within the organization, various factors have a positive influence while others hinder innovativeness (Hall & Hord, 2011; Rogers, 2003). Schools represent organizations of a special kind and can be seen as educational organizations with loosely coupled systems (Weick, 1976), in which teachers among themselves, as well as leadership and administration, are basically not very closely linked and operate independently. Other pictures see schools as 'front-line organizations', in which the teachers act as front units and are responsible for the development of the organization. However, communication and cooperation between the teachers are hardly developed (Bulla, 1982). Due to the loose coupling and low cooperation, there is a risk that innovations will not be carried into the wider school community because there is no exchange of information or collaboration due to a lack of contact points. Furthermore, teachers may find it difficult to learn from each other due to the low level of contact and lack of exchange, as teachers might not even know who is using digital technologies (e.g., Gerholz,

2019). Messmann and Mulder (2011) showed for vocational schools that precisely these informal and personal exchange processes between teachers and with school leadership have a decisive role in the development of innovations in schools. Beyond that, the existing capacities of the organization as a whole play a crucial role in the diffusion of innovations. For teachers, it has been shown both internationally and nationally that the workload of teachers is generally perceived as high and subjectively increases even more when using digital technologies (Bastian, 2017; Eickelmann, 2010; Schulz-Zander et al., 2003; Selwyn et al., 2017; Tynan et al., 2015; Volkov & Chikarova, 2021). This was also confirmed for distance education during the Covid pandemic (Niemi & Kousa, 2020). Nevertheless, it should be kept in mind that the use of digital technologies can reduce the workload in the long run through facilitating administration and organization (Kale & Goh, 2012; Selwood & Pilkington, 2005). With regard to the conditions for the successful implementation of digital technologies, Wagner (2024) has shown that the supportive effect of promoter activities plays a key role. Promoters are people who significantly promote the success of the innovation process through their actions. The expert promoter in particular plays a central role here. However, existing barriers to innovation (e.g., lack of qualifications of teachers) can promote the failure of the innovation process.

Factors regarding the organization that have a negative impact on its innovativeness, on the other hand, are the centralization of power and control to one or a few individuals and the formalization in terms of bureaucratic structures and processes (Rogers, 2003). Traditionally, schools in Germany have been organized in a bureaucratic and hierarchical manner as part of the entire education systems' evolution. New approaches, however, strive for greater autonomy of the individual school (e.g., Mintrop, 2015). Furthermore, system openness plays a role in the innovativeness of an organization as an external factor.

2.2 School Development With Digital Technology

The unsatisfactory state of studies on the degree of use of digital educational technologies in the classroom has long been proclaimed for the vocational education sector (Eder, 2015; Wilbers, 2012). For vocational education, for example, the Digital Education Monitor 2016 survey of vocational school teachers (n = 303) shows that digital technologies are mainly used for research (e.g., internet research), for presentation (e.g., educational videos, presentations) or in the form of digital texts as a replacement for copies (e.g., PDF documents) (Schmid et al., 2016). It is therefore about enriching traditional teaching and learning formats with digital educational technologies. However, teachers rarely use comprehensive learning management systems to prepare and follow up on lessons or learners create their own digital content (e.g., videos, blogs). Antonietti et al. (2022) have shown for vocational education, that the intention to use digital technology in teaching is associated with the beliefs of the teachers regarding the usefulness of technology.

This gives an idea of how extensive such change processes are in schools. In schools, change occurs as school development. School development can be understood as a continuous, intentional and planned transformation (Rolff, 1995). New concepts of school development include cooperation development as well as technological development in addition to the traditional development areas (organizational development, education development and personnel development) (Ilomäki & Lakkala, 2018; Schulz-Zander, 2001). This is intended to address the dynamic developments of digitization, which transfer the demands of a digitized workplace to schools. According to Pettersson (2021), the pedagogical and organizational perspective should always be considered in addition to the purely technological view in the digitization processes.

Organizational development (OE): The aim is to diagnose problems and develop interventions. For example, the organizational philosophy as the school's self-image and a conceptual approach for the implementation of digital technologies as a desired goal play an important role. A shared vision is relevant to continuous school development and improvement (Twining et al., 2013) and agreement on common goals and an intentional orientation support this (Creemers & Reezigt, 2005; Leclerc et al., 2012; Rogers, 2003). Of course, this can only ever be considered within the given framework conditions (e.g., financial, political).

Education development (ED): This does not only refer to the teaching in individual classes, but the systematic further development extends over the entire school. Therefore, the focus when using digital technologies in the classroom is also on overall technical and pedagogical processes. The development of standards helps to support learning and teaching in the organization as a whole (Brown & Duguid, 2001).

Personnel development (PE): Teachers can drive the implementation process within the school by actively participating, taking the initiative and exchanging ideas with other teachers and the school's principal. Sharing ideas and expertise among teachers has proven relevant to implementing innovations collaboratively (Chapman, 2008; Fullan, 2001; Leclerc et al., 2012; Pedder & MacBeath, 2008; Wong & Li, 2011). However, it is also about the teachers' concrete skills and abilities that are necessary for the implementation of the innovation (Organisation for Economic Co-operation and Development, 2010). Both internal and external in-service training programs for professional development play an important role to build up competences (Hakkarainen et al., 2001; Tedre et al., 2011). Furthermore, the promotion and involvement of teachers are relevant points along with motivational aspects, in which the principal takes on a special role (Harris, 2002; Rogers, 2003; Wong & Li, 2011).

Cooperation development (CD): Teacher cooperation within the school and networking with other schools are important components of school development for implementing digital technologies. Cooperation with companies is also of great value for vocational schools. The basic requirement for the use of cooperation is recognizing its potential as well as creating connections. This is the only way that cooperation can be realized. Networking unfolds

new perspectives and approaches to problems and their solutions and can thus improve existing practices (Harris, 2010).

Technological development (TD): The use of digital technologies in the classroom requires school-specific design and introduction processes to be sustainably successful as an innovation. The conditions, such as technical equipment, and a culture of support for using technology must be created (Wong & Li, 2011). Above all, functioning equipment in terms of technology is considered the basis for productive work.

This school development model was used to analyze conditions in vocational schools in a federal state in Germany during the Covid pandemic (Delcker & Ifenthaler, 2020). The results show that many schools were not sufficiently prepared for the requirements of teaching online from a technical point of view. The financial and time resources required for IT administration and equipment have not been sufficiently taken into account. Furthermore, the positive influence of school leadership and a clear and targeted approach to the introduction of online teaching was emphasized. Regarding the use of digital technologies, it was shown that teachers do not have sufficient skills and abilities for this. During the pandemic, the transition had to take place quickly and many teachers who had little previous contact with digital teaching were overwhelmed. Nevertheless, in the following, a study which describes the implementation of digital technologies at vocational schools far from the pandemic situation is presented.

3 Method

Building on the theoretical findings to date, the interview study conducted and the methodological approach to the evaluation are now presented in more detail.

3.1 Context of the Study

In Germany, educational policy is the responsibility of the 16 federal states. The context of the study is a tablet computer project in the federal state of Baden-Württemberg. 52 schools acted as project schools to implement tablet computers as a digital technology in the classroom. The project is anchored in the Dual Vocational Education and Training (VET) system. The students' VET is realized at companies and in vocational schools, while the lessons at school are intertwined with the in-company training (Gerholz & Brahm, 2014).

The objective of this project is the development and testing of tablet computer use for vocational schools. The schools alone were responsible for the realization of the implementation process of the tablet computers, with educational or didactic support through workshops and coaching. The schools were thus able to determine the project management themselves.

3.2 Methodical Design of the Study

The aim of the interview study was to capture the implementation process of digital technology as innovation in schools and to look at the organizational design. The interviews were performed as semi-structured interviews. The focus of the interviews was on processes, structures and responsibilities along the dimensions of school development. The interview study was administered from January 2019 to November 2020. The sample of the interview study consists of 16 schools that took part in the project. At each school, the interviews were conducted with three interviewees: The principal, the school's IT manager, and the head of department of the corresponding vocational training department that implemented the tablet computers in the classroom. Thus, a total of 46 interviews with 60 respondents serves as the sample size: 18 respondents from the principal's perspective, 20 respondents from the IT manager's perspective, and 22 respondents from the perspective of the leader of the vocational training department (9 female and 51 male). Some interviews were carried out in the schools themselves, while others had to take place online (via MS Teams, Zoom or Skype) due to the pandemic. The interviews lasted an average of 48 minutes.

The interviews were transcribed and analyzed with the MaxQDA software. A type-forming content-structuring analysis (Kuckartz, 2018) was carried out to classify different forms of the design of the school development process of the schools. The data material was first coded into main categories along the five dimensions of school development based on theory – organizational development, personnel development, education development, collaboration development, and technological development. In order to further differentiate the category system based on these five main categories, subcategories were formed inductively on the basis of the interview material. The aim was to create profiles derived from the categorical analysis that were as internally homogeneous as possible and as externally heterogeneous as possible. In chapter 4.2, the various categories, their frequencies and exemplary quotations are presented in tabular form as part of the presentation of results. This information is set in relation to the dimensions of school development and systematically prepared for both profiles examined.

After the final coding of all the material, according to Schreier (2012) a quantitative presentation of the results was addressed. For this, a weighting was done to consider the individual dimensions of school development in different schools that are approached in separate ways with varying intensity. These differences in school development in the implementation of digital technologies are considered by weighting each category. With regard to school development as a whole, it is assumed that hindering conditions can be neutralized by positive factors and, conversely, positive factors can be cancelled out by hindering conditions. In the weighting, hindering, negative factors (e.g., lack of motivation of the teachers) were weighted with the factor -1. Conditionally hindering factors that, for example, cannot be directly influenced by the school, such as the insufficient availability of in-service training, were weighted

with -0.5. Neutral factors were given a weighting of 0. The same procedure was followed for the positive factors. Fully conducive factors (e.g., clear goal setting) were given a weighting of +1. Conditionally conducive factors that are not within the school's control, such as supportive policies, were given a weighting of +0.5. The weighting was carried out for each interview according to the number of mentions per category. The interviews with the three different perspectives of a school were then combined to obtain a mean value for the school as a case. In this way, a weighted average value was formed for each school and each dimension of school development. For every school, a specific pattern of the characteristics of the school development dimensions thus emerged. Subsequently, schools with similar patterns were grouped together in order to classify the schools according to their design of school development. The patterns were identified mainly visually by displaying radar charts. The five dimensions of school development served as axes. The further inward the line runs, the more the factors in the school are perceived as negative or hindering by the interviewees. A positive perception of the school development dimensions, on the other hand, is represented by a point further out on the axis.

4 Results

The results of the interview study are presented on the basis of the methodological approach described above. For this, the two identified profiles of school development are first compared in an overview. The differences between the two profiles are then contrasted along the school development dimensions.

4.1 Profiles of School Development

Based on the previously described analysis process, two profiles of schools that pursue different approaches in designing school development for the implementation of digital technology can be distinguished. A total of 3,571 text passages were coded as relevant for the evaluation. The two identified profiles are presented below based on the most relevant and differentiated aspects. It can be seen that in particular the two school development dimensions of personnel development and technological development play a significant role in the distinction.

Profile I:

All schools of profile I mainly focus on the dimension of personnel development in school development. Based on the weighting, this represents the most positively pronounced dimension in each case. The other dimensions of school development do not prove to be nearly as well-developed as personnel development. Here, the conducive factors partially compensate the hindering factors. Figure 1 shows the radar chart exemplarily for a school of this profile. Ten schools were assigned to this profile.

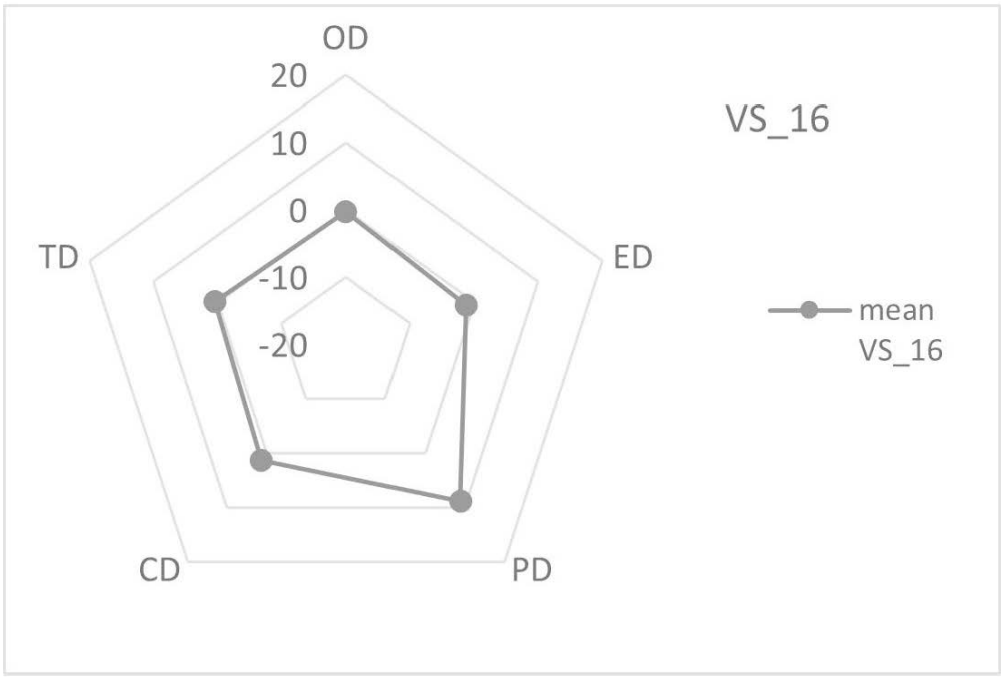

Figure 1: Example Vocational School_16 for Profile I

Profile II:

Schools of this profile pursue positive technological development in addition to conducive personnel development. The two dimensions are almost identically positive, while the other three dimensions, as in profile I, are perceived as far less beneficial or positive. Figure 2 shows an example of the radar chart for a school of this profile. Five schools were assigned to this profile.

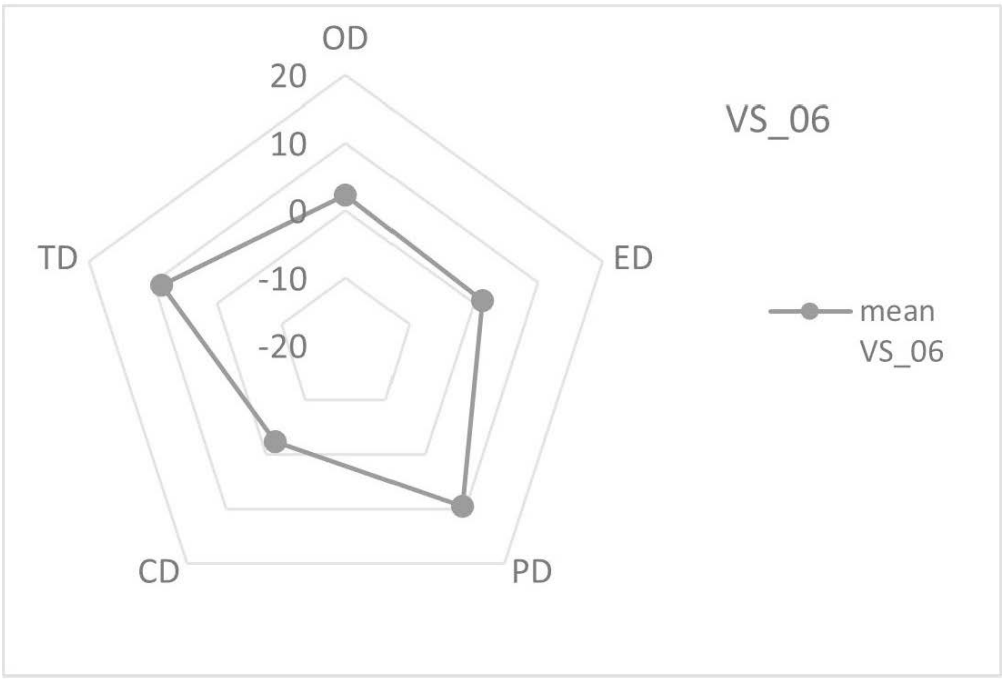

Figure 2: Example Vocational School_06 for Profile II

4.2 Description of the Profiles of School Development

The description of the profiles is structured according to the five dimensions of school development: Organizational development, educational development, personnel development, cooperation development and technological development.

4.2.1 Organizational Development

Table 1 shows the mentions and exemplary quotes for the different categories of organizational development for profile I and II.

Table 1: Mentions for Organizational Development

Organizational development	*Profile I*	*Profile II*	*Example quote*
Conditions			
Supportive political conditions	14 (6%)	14 (7%)	'Perhaps we should add that we are grateful for these terms of use, which were made available by the Ministry of Education. The training companies and everyone took note of them and signed them. That was a great thing.' (VS_10 School principal, 65)
Hindering political conditions	143 (57%)	116 (60%)	'There is still no list from the Ministry of Education or anyone else that clearly identifies apps that are acceptable under data protection law, for example.' (VS_10 School principal, 64)
Supportive financial conditions	45 (18%)	21 (11%)	'But only because we are well supported by the school district and don't really have to worry about money.' (VS_14 School principal, 46)
Hindering financial conditions	47 (19%)	41 (21%)	'The county generously provides us with equipment, software, hardware. The problem is the budget for support does not increase to the same extent.' (VS_01 School principal, 22)
	249	192	
Organizational philosophy			
Innovation-open atmosphere	66 (30%)	46 (34%)	'At the beginning - a project is agile in principle. We solve the problems we face, then expand the project accordingly and then build on the experience.' (VS_08 Head of Department, 24)
Non-innovation-open atmosphere	12 (6%)	8 (6%)	'There's a picture on the wall about change management - because teachers are even more conservative in this area. They don't want any changes.' (VS_02 School principal, 12)
Clear goal-setting	26 (12%)	20 (15%)	'And I think we all have one goal: that we want to develop our school; that we know that if we stand still, we are not participating. And we prefer to participate and design.' (VS_08 Head of Department, 80)
Unclear goal-setting	9 (4%)	0 (0%)	'But that's the way it's going at the moment, it's not very goal-oriented. Technology is purchased, but there is no real idea of what can be done with it and where it should go.' (VS_05 Head of Department, 42)
Structured approach	54 (25%)	39 (29%)	'We have a ticket system, which means that the teacher can reach all administrators via e-mail from the PC in the classroom and they are very well coordinated so that the colleague who is then assigned to the respective campus then take care of the problem.' (VS_10 School principal, 54)
Unstructured approach / no concept	51 (23%)	23 (17%)	'That's another problem that I have: we didn't have a reflective discourse in the team about the meaning of the whole thing, and we didn't develop a concept from that about how we actually want to teach. I would have liked that, but we just couldn't manage it.' (VS_04 School principal, 22)
	218	136	

Both profiles see the political conditions in tendency more negative. The respondents' criticism mainly relates to a lack of legal assurance of technology use regarding data protection and the central provision of legally compliant IT solutions.

It (the state of Baden-Württemberg) gives out what's not allowed (…), and there's not a proper catalogue (…). So that means it's always such a grey area, they always say "go for it", but you never know if it's actually, so it's not officially allowed. (VS_05 head of department, 8)

Positive policy conditions refer to, for example, the provision of terms of use for the tablets. However, the few positive mentions for profile I show that respondents are very critical of the political framework.

Predominantly both profiles show an innovative atmosphere. Non-supportive aspects are mentioned much less frequently. Nonetheless, school is also described as a "non-innovative place" (VS_12 IT manager, 57), which illustrates that teachers are often skeptical or resistant to innovations and changes at the beginning. In profile II, the schools' ability of goal setting and proceeding in a structured and planned manner are much more substantive than in the schools belonging to profile I. For profile II, all mentions regarding the goal setting in the implementation process indicate that a clear goal is pursued. "We have a common vision" (VS_08 Head of Department, 82). No school of profile II describes an unclear goal and considerably more mentions point to developing a concept, which indicates that a structured approach was adopted (e.g., an implemented ticket system for IT problems). Fixed processes in the sense of standards are defined for many procedures. For profile I schools, it is not that clear.

The financial conditions are assessed as neither clearly positive nor clearly negative by the schools of both identified profiles as this depends very much on the school district. A wealthy district can support its schools financially better (e.g., in the roll-out of Wi-Fi) than it is the case in a structurally weak district. The financial conditions are assessed more positively by profile I schools than by profile II. For profile I schools, the negative evaluations of the financial situation refer more on personnel situation than on technical equipment, while in profile II, financial obstacles with respect to personnel and technical conditions are mentioned about equally often.

4.2.2 Educational Development

Table 2 shows the mentions and exemplary quotes for the different categories of education development for profile I and II.

Table 2: Mentions for Educational Development

Education development	*Profile I*	*Profile II*	*Example quote*
Use of technology			
high	20 (42%)	25 (74%)	'It works completely digitally. We no longer hand out sheets of paper or anything like that.' (VS_06 Head of Department, 8)

middle	21	7	'But I assume that at the moment the possibilities of using a tablet are not being exploited. Or with these new processes, also new thinking ... like a paperless office, we're maybe just at a third, if that. On the technical side, I keep hearing that there are breakdowns.' (VS_16 School principal, 50)
	(44%)	(21%)	
low	7	2	'Overall, my impression is that these digital tools are used very little.' (VS_04 Head of Department, 8)
	(15%)	(6%)	
	48	34	
Focus in the implementation			
Critical focus	12	3	'And they are more concerned with dealing with the technology than with thinking about how to use it in the classroom.' (VS_14 IT manager, 44)
	(92%)	(50%)	
Critical adaption	1	3	'What I see as a problem is that we in the teaching team ultimately did not manage to develop something like a common conception of the work across the different subjects. ... Everyone just jumped on their own device and started teaching and trying things out. But in my opinion, a common line did not really emerge.' (VS_04 School principal, 27)
	(8%)	(50%)	
	13	6	

At profile I schools, digital technologies seem to be used regularly (not always), but not universally. It strongly depends on the teacher, the class and the subject. Individual teachers in selected classes work very intensive with the tablets, as these are also project classes. If the school is considered in its entirety, the use is much less frequent and only selective (e.g., through digital quizzes). In profile II schools, digital technologies seem to be used more frequently in the classroom. Again, differences within the school can be seen, but paper and traditional chalkboards are almost no longer used in the classroom. "That means we have our complete teaching material – from the start of the lesson to the results – completely digital" (VS_06 Head of Department2, 8).

Furthermore, respondents of profile I report about the wrong focus in the classroom much more frequently than respondents of profile II. It is often seen as problematic that at the beginning of the implementation process the technology was the focus. The technical barriers seemed so great that the initial focus was on solving these problems, so that only later the pedagogically sensible use came into view. Profile II schools are less likely to report such critical focus. Overall, however, it is evident from fewer mentions that incorrect processes do not play a decisive role in the implementation.

4.2.3 Personnel Development

Table 3 shows the mentions and exemplary quotes for the different categories of personnel development for profile I and II.

Table 3: Mentions for Personnel Development

Personnel development	*Profile I*	*Profile II*	*Example quote*
Prior knowledge			
Broad	25	16	'The teachers in the tablet teams are so well trained that they can always support the students.' (VS_08 Head of Department, 40)
	(33%)	(31%)	
Limited	28	16	'But I do get feedback from colleagues that they would like more support. When I ask them more precisely, these are often problems that are already documented somewhere, or they are very similar problems that arise.' (VS_08 IT manager, 36)
	(37%)	(31%)	
Lack of	23	19	'Some teachers didn't even know what to do with the tablet at first. Which programs they could use. That was the biggest problem.' (VS_14 Head of department, 80)
	(30%)	(37%)	
	76	51	
Willingness and motivation			
High motivated	113	51	'There are a few female colleagues ... who want to go ahead and try things out, discover new things, and also test new things.' (VS_08 IT manager, 6)
	(43%)	(32%)	
Low motivated	68	49	'The group is getting smaller and smaller from the - yes opponents I don't even want to say now - yes from the sceptics let's say.' (VS_10 School principal, 26)
	(26%)	(31%)	
Supportive colleagues	70	56	'Of course, we are also a small group and we are very communicative. So, if a problem occurred somewhere, we always discussed it afterwards in the break or in the meeting.' (VS_06 Head of department, 45)
	(27%)	(35%)	
Non-supportive colleagues	12	4	'There were also many disagreements and quarrels, because of course everyone was dissatisfied: we teachers, but also me...there was a lot of frustration among each other, although actually no one was responsible for it.' (VS_02 IT manager, 10)
	(5%)	(3%)	
	263	160	
Personnel management			
High support	38	21	'No obstacles are placed in the way either. Rather, because we emphasize digital competence, it is approved and authorized. There would have to be serious things for it not to be approved.' (VS_02 Head of department, 72)
	(29%)	(34%)	
Low support	15	8	'So, you put it more on a voluntary basis. So far.' (VS_16 Head of department, 85)
	(11%)	(13%)	
High involvement	60	23	'And what is also perhaps added to this, the freedom that the school management grants us in this context, which in principle extends to the submission of proposals for filling the subjects with corresponding colleagues. ... On the whole, we have a great deal of freedom, to put it that way.' (VS_15 Project leader, 12)
	(45%)	(37%)	

Low involvement	20 (15%)	10 (16%)	'So, there was very little discussion, and not all the teachers at the school were asked what they thought.' (VS_01 Head of Department, 82)
	133	62	
In-service training			
Use of external training	17 (12%)	13 (13%)	'And, of course, they then go on external training courses in order to be able to continue their own development.' (VS_09 School principal, 72)
High benefit of external training	21 (15%)	9 (9%)	'There are, of course, many training courses for digital media. There are nationwide training courses, such as MoLoL or Edunautic, soon to be held in Hamburg. There is this really big, super big training event where we send teachers.' (VS_08 Head of Department, 109)
Low benefit of external training	30 (21%)	19 (19%)	'So, you go on one of these training courses. You're there for two days, hear all kinds of things that you can't use at your own school, come back and you're done.' (VS_15 IT manager, 100)
Use of internal training	50 (35%)	39 (38%)	'I offered two events myself. One was Formative Assessment and Feedback tools and the other one was, because this was also requested, the application of a password manager on an mobile device.' (VS_08, IT manager, 68)
High benefit of internal training	19 (13%)	19 (18%)	'1-1-5 Further training. ... That's 1 topic, 1 hour, 5 colleagues. We have a marketplace where everyone can put down their needs as "search and find". So someone offers something, if 5 people are interested in it, then this training is done for one hour. So to say mini further trainings. ... We're pretty flexible about that now. And that is used. We've done three of them now.' (VS_08 Head of Department, 109)
Low benefit of internal training	6 (4%)	3 (3%)	'But there was no training concept in the school now. So unfortunately. Yes, I would do it differently next time.' (VS_12 IT manager)
	143	102	

In the area of personnel development, there are only minor differences between the school profiles. For both profiles an equal status of prior knowledge of the use of digital technologies can be stated. Missing prior knowledge refers to a lack of fundamental knowledge about how technical devices work and how to use programs. Broad and deep previous knowledge generally relates only to a small group of people. There is only a slight tendency for teachers of profile II schools to have broader previous knowledge.

Furthermore, it is evident in both profiles that there are mostly committed and motivated teachers. Only a few teachers offer resistance and are completely opposed to digitization. Most of the colleagues see great potential in digitization and are willing and motivated to learn and develop further. "When they go out, they have to work, they have to function in a company, in a digitalized company. And that's why we prepare them, and it's a lot of joy to be able to shape that" (VS_02 School principal, 32).

This group of colleagues is widely perceived as conducive and supportive for both profiles. It is about helping each other with technical problems or asking a colleague when developing teaching material. This is also partly represented digitally using internal school discussion forums (e.g., Microsoft Teams). However, more mentions in profile I than in profile II suggest

that the other teachers are perceived as not supportive. Teachers feel they are 'lone warriors'. There is no diffusion of innovation throughout the whole school, so that a lack of exchange processes and communication among teachers hinder the implementation process.

The management structures of the schools of both profiles are characterized by a high level of personnel support (e.g., by providing time for the development of teaching materials with tablet use) and a high level of personnel involvement (e.g., in decision-making processes). Overall, the leadership style is perceived as supportive and the school management acts as a team.

For in-service training a distinction can be made between internal training courses, which the schools conduct themselves, and externally offered training courses organized by the federal state as the official authority. Both profiles primarily use internal training for further qualification. These are basic introductions to the use of tablets and training on specific apps or tools. There is a trend away from large events toward training in small groups and even one-on-one sessions. External training courses therefore play only a subordinate role for both profiles, because they are sometimes perceived as unsuitable for the own school. "Some say, "that was really good", but the majority still comes back and says, "that was rather a waste of time. (...) Once again, we sat around for two days and achieved nothing" (VS_09 School principal, 74).

4.2.4 Cooperation Development

Table 4 shows the mentions and exemplary quotes for the different categories of cooperation development for profile I and II.

Table 4: Mentions for Cooperation Development

Cooperation development	*Profile I*	*Profile II*	*Example quote*
Cooperation partners			
Universities	5 (4%)	5 (7%)	'Or we have had a very intensive cooperation with the university here for years in the context of Learning Factory 4.0. And the students are there on site. They have ... a factory, i.e. Industry 4.0 there. A big story. And they are there by the hour/day, and vice versa the students also come to us.' (VS_12 School principal, 67)
School district	20 (16%)	6 (9%)	'I need the people who are sitting at the back. And in this case, it's the school district. As I mentioned earlier, the school authority, the city, has also recognized the signs of the times - we are also an IT region, etc. - and has developed its own IT department for the city, which is now also the contact for schools.' (VS_02 School principal, 54)
Federal state	9 (7%)	6 (9%)	'So, for the tablet project, we had a special consultant there who advised us on how to manage these processes. When it comes to the systematic introduction of such tablets.' (VS_11 IT manager, 29)

Companies	58	34	'We are also very much involved in this, which actually has everything to do with digitization. There are still several companies with us, external companies in cooperation with us, who want to sponsor a machine and then build an entire industrial system.' (VS_11 IT manager, 142)
	(47%	(49%)	
Schools	31	19	'So, I think it took a lot of external influence to get us to the point where we are now. So, without networking or our partner schools we wouldn't be where we are today.' VS_01 Head of department, 83)
	(25%)	(27%)	
	123	70	
Degree of realization			
High	18	11	'This means that the link between school and industry here is incredibly close, much closer than anywhere else. We are also supported in such a way ... we don't have to buy a machine. So machine manufacturers ... are keen to have a machine in our school that is also used in the region. You can imagine that a company buys eight machines and says "and the ninth one comes to the school.' (VS_11 School principal, 127)
	(30%)	(30%)	
Middle	14	5	'We could ask for a lot more support from outside, from the companies" (VS_01 Head of Department, 75)
	(23%)	(14%)	
Low	11	11	'We have relatively few cooperation with other schools' (VS_12 School principal, 160)
	(18%)	(30%)	
Not realised wish	18	10	'Yes, but that's also a shame somewhere, because know-how is lost at some point. So, the knowledge management, that is gone at some point.' (VS_06 Head of Department, 127)
	(30%)	(27%)	
	61	37	
Intention of realization			
Pedagogical development	7	5	'And that is the exchange that has always helped us the most. Because we saw what the others were doing, what problems they had and how they solved them. ... We said, "Now we're going to develop a pedagogical concept".' (VS_03 Head of Department, 62)
	(41%)	(45%)	
Compensation of resources	10	6	'And he then decides with the students whether it belongs to them in the end or whether the company takes it back. Some companies also give it to you as a gift from the students after their time at school, so that we can take them into our inventory.' (VS_02 IT manager, 13)
	(59%)	(55%)	
	17	11	

The respondents named various cooperation partners. The form of cooperation differs widely, ranging from informal and loose cooperation to institutionalized and formal contracts. Cooperation with other schools and companies is particularly prominent for both profiles. In cooperation with other schools, problems in the implementation process can be informally discussed and solutions from other schools can be adapted. Cooperation with companies also largely results from the fact that the vocational schools work together with the training companies as part of the learning venue cooperation due to the dual training system (Gerholz & Brahm, 2014). The training companies play an important role in financing the tablets. In addition, there are also collaborations with IT service providers who technically support the schools in the implementation of digital technologies.

The various collaborations have different intentions. On the one hand, the aim is to further develop teaching with tablets on a pedagogical level. This seems to be somewhat more important for profile I than for profile II. Pedagogical development takes place mainly through exchange with other schools. Another purpose of cooperation is to compensate for existing resource or capacity limitations. For this purpose, the schools mainly work together with companies (e.g., with IT service providers).

4.2.5 Technological Development

Table 5 shows the mentions and exemplary quotes for the different categories of technological development for profile I and II.

Table 5: Mentions for Technological Development

Technological development	*Profile I*	*Profile II*	*Example quote*
Attitude towards digitizaton/technology			
Accepted	54 (52%)	49 (96%)	'Essential. The potential is there. We will have to transform ourselves. It's only a question of time. And the sooner we join in, the more we can also help shape things and not be driven by the development of strangers.' (VS_08 Head of Department, 2)
Unclear	28 (27%)	1 (2%)	'All these apps that are out there, this is all nice and great, and they are also many games, but whether they really have this benefit in detail that is doubtful. So, I am very skeptical.' (VS_05 School principal, 40)
Rejected	22 (21%)	1 (2%)	'So, what's the point if every colleague has a Surface or an iPad? It's nice that he or she has it, but I can also do my online shopping, so I don't really need it for that.' (VS_05 Head of Department, 42)
	104	51	
Hardware and software			
High satisfaction hardware	69 (28%)	61 (31%)	'We have equipped all the rooms now. There are no more overhead projectors or anything. And all the possibilities that I go with devices in the WLAN. All teachers are equipped with tablet in two months. That's already working. We are asked very often. We can hardly keep up. How did you do that?' (VS_06 School principal, 38)
Low satisfaction hardware	27 (11%)	17 (9%)	'Here on site is really bad for me when I have 10 classes and only for one class I have tablets.' (VS_10 School principal, 156)
High satisfaction software	68 (27%)	74 (37%)	'We use everything that is available to us. First and foremost, the office programs that we already have. But we also use external platforms, such as Zoom Pad, to enable better cooperative work. Or things like Classroomscreen to promote class management.' (VS_06 Head of Department, 8)
Low satisfaction software	86 (34%)	46 (23%)	'The other side - and this was the much, much more difficult and stressful side for us - was the technical side. a) Establishing the infrastructure, that is, we had to make sure that the ... network administrators create wifi. Quite difficult. b) We had to make sure that we could exchange data on the technical side.' (VS_03 Head of Department, 6)
	250	198	

Perception of the IT-manager			
Positive	29 (35%)	28 (61%)	'So, we have a real lucky strike with our colleague and it works great and also the students now really do it on their own, that they contact him and sometimes they say themselves, they are shocked when suddenly the door opens and he is already there and comes personally to take care of the problem.' (VS_01 Head of Department, 89)
Negative	55 (65%)	18 (39%)	'The big disadvantage is, of course, that certain technical problems cannot be solved immediately because the colleagues are also teaching or perhaps not in the school.' (VS_08 IT management, 26)
	84	46	

In profile I schools, attitudes toward technology and digitization present a differentiated picture. On the one hand, an advantage of the use of digital technologies in the classroom is seen, but, on the other hand, there is also a clear rejection of technology and it is evident that some teachers still have doubts (e.g., radiation from Wi-Fi). Profile II schools show a much clearer view. Technology and digitization are fully supported here and there are almost no critical and doubting objections at the schools.

> *Although I need more preparation time, it is easier for me to implement it (…) because it can be designed in a much more student-active way. I think (...) that the students also have a strong feeling of benefit when they become active themselves. (VS_09 IT manager and head of department, 2)*

Overall, profile II schools are more satisfied with the available hardware and software. In most cases, all classrooms are fully technically equipped with computers, beamers and tablets and each teacher has their own tablet. In addition, the schools are generally satisfied with the software that is used (e.g., Office365, functioning and fast WLAN). For profile I schools more problems are reported. These relate to the internet connection, which in some cases is also not yet available in all classrooms, as well as cloud solutions used for working in class.

Differences between the identified profiles are also evident in the perception of the tasks of the IT managers at the schools. It should be emphasized that profile II schools report more experiences that are positive. The work of those responsible is mainly appreciated, as technical problems can be solved quickly and reliably. However, the time required for technical rollout is seen as a negative factor. In the profile I schools, there is also criticism that the IT managers are teachers themselves and that the time spent solving technical problems is at the expense of their own teaching. Ultimately, the schools would like to have support that is more flexible.

5 Discussion

The results of the interview study show a possible differentiation between the ongoing school development processes to implement digital technologies based on profiles. In general, all

five dimensions of school development play a role for school development. However, the two dimensions of personnel and technology development are particularly relevant for differentiating between the two profiles. These two will therefore be focused on subsequently. Personnel development is basically similarly conducive in both profiles identified in the study. In profile II schools, digital technologies and tablets in particular seem to have arrived sustainably in the classroom and to be used frequently and on a daily basis for learning and teaching. The extent of digital technology use is related to teachers' previous experiences as well as their attitudes about the potential of digital technologies for learning (Drossel et al., 2017; Fraillon et al., 2014; Penuel, 2006). Fraillon et al. (2020) have shown that, in an international comparison, teachers in Germany have rather little experience in dealing with digital technologies and use them less in a teaching-related way. With our study we have shown that it depends more on the school profile than on national affiliation. However, these experiences and the safe use of digital technologies are essential for technologies to become an integral part of everyday teaching. The study from Fraillon et al. (2020) also showed that teachers in other countries, such as Denmark or Portugal, have longer experience with digital technologies in school and thus achieve a higher level of digitization in the classroom.

Technological development can be identified as a crucial variable in the school development process to implement digital technologies. The results show that much depends on the perception of the benefits of digital technologies and the awareness of their potential for learning and teaching. Previous studies have identified teacher attitudes as key factors (Fraillon et al., 2014; Lawrence & Tar, 2018; Tondeur et al., 2017). Fraillon et al. (2020) were able to show internationally that teachers in Germany are more critical of digital technologies than teachers in other countries that are already more advanced in the digitalization of education (e.g., Chile, Denmark, Portugal). This appears to be a critical point in the success of change and has been shown to be much more evident in profile II schools than profile I schools. The positive or negative perception of digital technologies correlates with the actual use in the classroom (Fraillon et al., 2020). The more positively a teacher assesses digital technologies, the more frequently he or she uses them in his or her own teaching, and vice versa. Based on an international meta-analysis, Tondeur et al. (2017) point out that the relationship between pedagogical beliefs and technology use must be seen as bi-directional. "Technology-rich learning experiences have the potential to change teachers' beliefs toward more student-centered, constructivist beliefs, while at the same time, teachers with constructivist beliefs are more likely to adopt technology in student-centered ways" (Tondeur et al., 2017, p. 562). This can be confirmed in the present study as well. Profile II shows a much more positive attitude towards the potential of digital technologies than profile I and uses digital technologies more intensively in the classroom. Frequent and regular use can therefore lead to a reduction in critical attitudes toward digitization, although a positive attitude toward digitization is at the

same time a requirement for technology use. It therefore depends on the personal attitudes and affinity for digitization and technology of those involved.

Furthermore, satisfaction with the school's technical equipment is higher for profile II schools. Sufficient technical equipment is, of course, essential to adequately use digital technologies in the classroom (Kale & Goh, 2012). Overcoming this structural barrier appears to be a success factor in the digitization process. This is also accompanied by a more positive perception of the work of IT managers in profile II. The presence of technical support (e.g., by a competent school IT manager) plays a central role in the success of the digitization process (Anderson, 2007; Islam & Grönlund, 2016; Penuel, 2006). The results of the study show that schools often feel unable to cope with these tasks because the teachers who take on the job of IT manager at the school are not sufficiently qualified. They have acquired the relevant IT knowledge on their own and thus regularly reach the limits of their ability to solve technically complex problems. Schools often lack the budget for professional IT service providers, so problems are often solved in an amateur way with the available capacities. Thus, there is a call for appropriate action at the policy level and the funding of technical support. Even though schools and education systems are structured and organized differently internationally, teachers are not IT specialists in their basic qualifications. Therefore, professional IT support for teachers seems to be relevant internationally, even if it depends on the national and regional context. To this end, Tedre et al. (2011) propose a broad support model that suggests different sources of support and maintenance. This provides for regional, national, and international support, as well as peer-to-peer support and support from technical vendors, among others. Comprehensive and widespread support structures can support the successful implementation of digital technologies and technology.

A key factor in the sustainability of the digitization process is a school's strategic approach. Profile II schools seem to have a clear objective in the sense of a shared vision. They proceed according to a plan and have developed own concepts for the implementation process. Especially in an initiation phase, defining clear goals and expectations is essential for the development process (Leclerc et al., 2012). Studies have shown that school leadership plays a crucial role in this process (Islam & Grönlund, 2016). Digitizing a school requires leadership that develops a vision, embraces change as a process, and can motivate and engage teachers to participate (Anderson, 2007). Wong and Li (2011) were able to show that transformational leadership has a great impact on school climate in terms of the positive handling of mistakes, openness, and collegiality. The interviews revealed that the leadership structures in both identified profiles are characterized by a high level of personnel involvement and personnel promotion, but that a clear objective is not evident in all schools.

6 Conclusion

The interview study conducted shows that schools are taking different approaches in the digitization process. The two identified profiles show typical patterns regarding the design of the school development dimensions. As Delcker and Ifenthaler (2020) have already shown, the present study also illustrates the interdependencies of the dimensions. Working on one dimension, such as in-service training for teachers on how to use a digital technology (Personnel Development), leads to further development of teaching at the pedagogical level (educational development). Therefore, it can be concluded that there is not one right starting point or one right way for a school's digitization process. Systematic further development of the school always leads to change via the interdependence of the dimensions. This illustrates the relevance and usefulness of this approach for the international context. Due to the heterogeneity of education systems, a strict "recipe" for successful change would be inappropriate and only valid for the respective context. The holistic approach of the school development dimensions makes it possible for each school as well as each national education system to find individual starting points for the digitization process. Successful school leadership means identifying the school's strengths and weaknesses and strategically aligning its development with digital transformation. In terms of the findings presented here, the focus is on the balance between personnel and technology development. Both should be related to each other and considered together in the leadership of the school management.

Limitations of the study relate to various aspects. The considered schools are project schools, which, for example, were financially supported by the training companies for the purchase of tablets or received special support and framework conditions for teaching with the tablets. The transferability to a school outside the project is therefore limited. In addition, all project schools are vocational schools. Other types of schools, e.g., elementary schools, might have completely different framework conditions. School development could therefore be quite different here. With 16 schools from one federal state, the interview study also does not come close to providing a complete picture of vocational schools in Germany.

In the context of the project, however, valuable insights into the current status of school development can be gained. According to the profiles, it makes sense from an education policy perspective to offer specific support. On the one hand, this should relate to further qualifications and effective in-service training concepts, and on the other hand, it should focus on technological support. At this point, technological support comprises not only technical equipment, but also technical support or organizational solutions. As a combination of these two important aspects - personnel development and technological development - it seems appropriate to provide schools with IT specialists. These IT experts have technical know-how and can thus support the school's IT administration so that teachers can better concentrate on the pedagogical aspects of their jobs, namely teaching.

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Ethics Statement

This study considered all research ethics regulations of the university and the participating schools. The procedures fulfill the requirements of the IJRVET's ethical statement. The requirement for informed consent was also carefully considered and fulfilled.

References

Anderson, C. J. (2007). *A Delphi study of the strategies that will help superintendents overcome the barriers to the implementation of one-to-one laptop programs in K–12 schools*. University of La Verne [Doctoral dissertation].

Antonietti, C., Cattaneo, A., & Amenduni, F. (2022). Can teachers' digital competence influence technology acceptance in vocational education? *Computers in Human Behavior*, 132. https://doi.org/10.1016/j.chb.2022.107266

Bardone, E., & Eradze, M. (2022). Theorizing transformative educational technology as a meso-related venture. In D. Secchi, R. Gahrn-Andersen & S. J. Cowley (Eds.), *Organizational cognition. The theory of social organizing* (pp. 99–119). Routledge.

Bastian, J. (2017). Tablets zur Neubestimmung des Lernens? Befragung und Unterrichtsbeobachtung zur Bestimmung der Integration von Tablets in den Unterricht. In J. Bastian & S. Aufenanger (Eds.), *Tablets in Schule und Unterricht. Forschungsmethoden und –perspektiven zum Einsatz digitaler Medien* (pp. 139–173). Springer VS.

Bejaković, P., & Mrnjavac, Ž. (2020). The importance of digital literacy on the labour market. *Employee Relations, 42*(4), 921–932. https://doi.org/10.1108/ER-07-2019-0274

Blau, I., & Shamir-Inbal, T. (2017). Digital competences and long-term ICT integration in school culture: The perspective of elementary school leaders. *Education and Information Technologies, 22*(3), 769–787. https://doi.org/10.1007/s10639-015-9456-7

Brown, J. S., & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organization Science, 12*(2), 198–213. https://doi.org/10.1287/orsc.12.2.198.10116

Bulla, H. G. (1982). *Probleme einer Organisationsentwicklung in der Schule. Analysen, Konzepte und ein Rahmenmodell zur Strategie des Survey Feedback*. Peter Lang.

Burnes, B. (2004). Kurt Lewin and complexity theories: Back to the future? *Journal of Change Management, 4*(4), 309–325. https://doi.org/10.1080/1469701042000303811

Chapman, C. (2008). Towards a framework for school-to-school networking in challenging circumstances. *Educational Research, 50*(4), 403–420. https://doi.org/10.1080/00131880802499894

Cope, B., & Kalantzis, M. (2016). Big data comes to school: Implications for learning, assessment, and research. *AERA Open, 2*(2), 1–19. https://doi.org/10.1177/2332858416641907

Creemers, B., & Reezigt, G. (2005). Linking school effectiveness and school improvement: The background and outline of the project. *School Effectiveness and School Improvement, 16*(3), 359–371. https://doi.org/10.1080/09243450500234484

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education, 30*(1), 125–139. https://doi.org/10.1080/1475939X.2020.1857826

Dobricki, M., Evi-Colombo, A., & Cattaneo, A. (2020). Situating vocational learning and teaching using digital technologies - A mapping review of current research literature. *International Journal for Research in Vocational Education and Training, 7*(3), 344–360. https://doi.org/10.13152/IJRVET.7.3.5

Drossel, K., Eickelmann, B., & Gerick, J. (2017). Predictors of teachers' use of ICT in school – the relevance of school characteristics, teachers' attitudes and teacher collaboration. *Education and Information Technologies, 22*(2), 551–573. https://doi.org/10.1007/s10639-016-9476-y

Eder, A. (2015). Akzeptanz von Bildungstechnologien in der gewerblich-technischen Berufsbildung vor dem Hintergrund von Industrie 4.0. *Journal of Technical Education, 3*(2), 19–44. https://doi.org/10.25656/01:11573

Eickelmann, B. (2010). *Digitale Medien in Schule und Unterricht erfolgreich implementieren. Eine empirische Analyse aus Sicht der Schulentwicklungsforschung*. Waxmann.

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). *Preparing for life in a digital world. IEA International Computer and Information Literacy Study 2018 international report*. Springer. https://link.springer.com/content/pdf/10.1007%2F978-3-030-38781-5.pdf

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Gebhardt, E. (2014). *Preparing for life in a digital age: The IEA International Computer and Information Literacy Study international report*. Springer. https://doi.org/10.1007/978-3-319-14222-7

Fullan, M. (2001). *The new meaning of educational change* (3. ed.). Routledge Falmer.

Fullan, M. (2007). *The new meaning of educational change*. Teachers College, Columbia University.

Geijsel, F., Sleegers, P., Leithwood, K., & Jantzi, D. (2003). Transformational leadership effects on teachers' commitment and effort toward school reform. *Journal of Educational Administration, 41*(3), 228–256. https://doi.org/10.1108/09578230310474403

Gerholz, K.-H. (2019). How do the new outcome-oriented instruments arise in the faculty? In M. A. Peter & S. M. Weber (Eds.), *Organization and newness. Discourses and ecologies of innovation in the creative university* (pp. 21–30). Brill NV.

Gerholz, K.-H., & Brahm, T. (2014). Apprenticeship and vocational education. In C. Harteis, A. Rausch & J. Seifried (Eds.), *Discourses on professional learning: On the boundary between learning and working* (pp. 143–158). Springer.

Gerholz, K.-H., Ciolek, S., & Wagner, A. (2020). Digitalisation of design research –A case study to illustrate the use of digital technologies and tools for collaboration in resign research projects. *Journal of Educational Design Research, 4*(1), 1–17, http://doi.org/10.15460/eder.4.1.1452

Gessler, M., Bohlinger, S., & Zlatkin-Troitschanskaia, O. (2021). International vocational education and training research: An introduction to the special issue. *International Journal for Research in Vocational Education and Training, 8*(4), 1–15. https://doi.org/10.13152/IJRVET.8.4.1

Goller, M., Caruso, C., & Harteis, C. (2021). Digitalisation in agriculture: Knowledge and learning requirements of german dairy farmers. *International Journal for Research in Vocational Education and Training, 8*(2), 208–223. https://doi.org/10.13152/IJRVET.8.2.4

Hakkarainen, K., Muukkonen, H., Lipponen, L., Ilomäki, L., Rahikainen, M., & Lehtinen, E. (2001). Teachers' information and communication technology (ICT) skills and practices of using ICT and their pedagogical thinking. *Journal of Technology and Teacher Education, 9*(2), 181–197.

Hall, G. E., & George, A. A. (1999). The impact of principal change facilitator style on school and classroom culture. In H. J. Freiberg (Ed.), *School climate: Measuring, improving and sustaining healthy learning environments* (pp. 171–191). Falmer.

Hall, G., & Hord, S. (2011). *Implementing change: Patterns, principles, and potholes* (3rd ed.). Allyn and Bacon.

Harris, A. (2002). Effective leadership in schools facing challenging contexts. *School Leadership and Management, 22*, 15–26. http://doi.org/10.1080/13632430220143024a

Harris, A. (2010). Leading system transformation. *School Leadership and Management, 30*, 197-207. https://doi.org/10.1080/13632434.2010.494080

Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: Innovative digital school model. *Research and Practice in Technology Enhanced Learning, 13*(25). https://doi.org/10.1186/s41039-018-0094-8

Iordache, E., Mariën, I., & Baelden, D. (2017). Developing digital skills and competences: A quick-scan analysis of 13 digital literacy models. *Italian Journal of Sociology of Education, 9*(1), 6–30. http://doi.org/10.14658/pupj-ijse-2017-1-2

Islam, S., & Grönlund, Å. (2016). An international literature review of 1:1 computing in schools. *Journal of Educational Change, 17*(2), 191–222. https://doi.org/10.1007/s10833-016-9271-y

Johnson, E. D., Bird, F. L., Fyffe, J., & Yench, E. (2012). Champions or helpers: Leadership in curriculum reform in science. *Journal of University Teaching & Learning Practice, 9*(3). https://doi.org/10.53761/1.9.3.7

Kale, U., & Goh, D. (2012). Teaching style, ICT experience and teachers' attitudes toward teaching with Web 2.0. *Education and Information Technologies, 19*(1), 1–20. http://doi.org/10.1007/s10639-012-9210-3

Kell, A. (1995). Organisation, Recht und Finanzierung der Berufsbildung. In R. Arnold & A. Lipsmeier (Eds.), *Handbuch der Berufsbildung* (pp. 369–397). Leske + Budrich.

Kuckartz, U. (2018). *Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstütung*. Beltz Juventa.

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International, 55*(1), 79–105. http://doi.org/10.1080/09523987.2018.1439712

Leclerc, M., Moreau, A. C., Dumouchel, C., & Sallafranque-St-Louis, F. (2012). Factors that promote progression in schools functioning as professional learning community. *International Journal of Education Policy & Leadership, 7*(7), 1–14. http://doi.org/10.22230/ijepl.2012v7n7a417

Leithwood, K., & Jantzi, D. (1999). The relative effects of principal and teacher sources of leadership on student engagement with school. *Educational Administration Quarterly, 35*(5), 679–706. https://doi.org/10.1177/0013161X99355002

Messmann, G., & Mulder, R. H. (2011). Innovative work behaviour in vocational colleges: Understand who and why innovations are developed. *Vocations and Learning, 4*, 63–64. http://doi.org/10.1007/s12186-010-9049-y

Mintrop, R. (2015). Public management reform without managers: the case of German public schools. *International Journal of Educational Management, 29*(6), 790–795. https://doi.org/10.1108/IJEM-06-2015-0082

Niemi, H. M., & Kousa, P. (2020). A case study of students' and teachers' perceptions in a Finnish high school during the COVID pandemic. *International Journal of Technology in Education and Science (IJTES), 4*(4), 352–369. https://doi.org/10.46328/ijtes.v4i4.167

Organisation for Economic Co-operation and Development. (2010). *Inspired by technology, driven by pedagogy. A systemic approach to technology-based school innovations*. Educational research and innovation. OECD Publishing. https://www.oecd.org/en/publications/inspired-by-technology-driven-by-pedagogy_9789264094437-en.html

Ottestad, G. (2008). Schools as digital competent organizations: Developing organisational traits to strengthen the implementation of digital founded pedagogy. *International Journal of Technology, Knowledge and Society, 4*(4). http://doi.org/10.18848/1832-3669/CGP/v04i04/55913

Pedder, D., & MacBeath, J. (2008). Organisational learning approaches to school leadership and management: teachers' values and perceptions of practice. *School Effectiveness and School Improvement, 19*(2), 207–224. https://doi.org/10.1080/09243450802047899

Penuel, W. R. (2006). Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education, 38*(3), 329–348. http://doi.org/10.1080/15391523.2006.10782463

Pettersson, F. (2018). Digitally competent school organizations – developing supportive organizational infrastructures. *International Journal of Media, Technology & Lifelong Learning, 14*(2), 132–143. http://doi.org/10.7577/seminar.2976

Pettersson, F. (2021). Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technology, 26*, 187–204. https://link.springer.com/article/10.1007/s10639-020-10239-8

Pfeiffer, S. (2018). The "Future of Employment" on the shop floor: Why production jobs are less susceptible to computerization than assumed. *International Journal for Research in Vocational Education and Training, 5*(3), 208–225. https://doi.org/10.13152/IJRVET.5.3.4

Rogers, E. M. (2003). Diffusion of Innovations. *The Free Press*.

Rolff, H.-G. (1995). Steuerung, Entwicklung und Qualitätssicherung von Schulen durch Evaluation. In A. Christel & H.- G. Rolff (Eds.), *Zukunftsfelder von Schulforschung* (pp. 375–392). DSV.

Rolff, H.-G. (2016). *Schulentwicklung kompakt. Modelle, Instrumente, Perspektiven*. Beltz.

Schlottmann, P., Gerholz, K.-H., & Winther, E. (2021). Digital Literacy für Wirtschaftspädagog*innen – Modellierung des domänenspezifischen Fachwissens in der beruflichen Lehrerbildung. *bwp@ Berufs- und Wirtschaftspädagogik – online, 40*, 1–20. https://www.bwpat.de/ausgabe40/schlottmann_etal_bwpat40.pdf.

Schmid, U., Goertz, L. & Behrens, J. (2016). *Monitor Digitale Bildung. Berufliche Ausbildung im digitalen Zeitalter*. Bertelsmann Stiftung. https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/Studie_Monitor-Digitale-Bildung_Berufliche-Ausbildung-im-digitalen-Zeitalter_IFT_2016.pdf.

Schreier, M. (2012). *Qualitative content analysis in practice*. Sage.

Schulz-Zander, R. (2001). Neue Medien als Bestandteil von Schulentwicklung. In S. Aufenanger, R. Schulz-Zander & D. Spanhel (Eds.), *Jahrbuch Medienpädagogik I*. (pp. 263–281). Leske + Budrich.

Schulz-Zander, E., Dalmer, R., Petzel, T., Büchter, A., Beer, D., & Stadermann, M. (2003). *Innovative Praktiken mit Neuen Medien in Schulunterricht und Organisation (IPSO). Nationale Ergebnisse der internationalen IEA-Studie SITES Modul 2*. https://www.yumpu.com/de/document/read/6860478/nationale-ergebnisse-der-internationalen-iea-studie-sites-modul-2

Selwood, I., & Pilkington, R. (2005). Teacher workload: Using ICT to release time to teach. *Educational Review, 57*(2), 163–174. http://dx.doi.org/10.1080/0013191042000308341

Selwyn, N., Nemorin, S., & Johnson, N. (2017). High-tech, hard work: An investigation of teachers' work in the digital age. *Learning, Media and Technology, 42*(4), 390–405. http://doi.org/10.1080/17439884.2016.1252770

Sleegers, P., & Leithwood, K. (2010). School development for teacher learning and change. In P. Peterson, E. Baker & B. McGaw (Eds.), *International Encyclopedia of Education* (3rd Edition, pp. 557–562). Elsevier.

Tedre, M., Hansson, H., Mozelius, P., & Lind, S. (2011). Crucial considerations in one-to-one computing in developing countries. In P. Cunningham & M. Cunningham (Eds.), *IST-Africa 2011 Conference Proceedings*. IIMC International Information Management Corporation.

Tondeur, J., van Braak, J., Ertmer, P.A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Education Tech Research Dev, 65*, 555–575. https://doi.org/10.1007/s11423-016-9481-2

Twining, P., Raffaghelli, J., Albion, P., & Knezek, D. (2013). Moving education into the digital age: The contribution of teachers' professional development. *Journal of Computer Assisted Learning, 29*(5), 426–437. http://doi.org/10.1111/jcal.12031

Tynan, B., Ryan, Y., & Lamont-Mills, A. (2015). Examining workload models in online and blended teaching. *British Journal of Educational Technology, 46*(1), 5–15. https://doi.org/10.1111/bjet.12111

Volkov, Y. G., & Chikarova, G. I. (2021). Digital transformation of Russian society as a condition of forming young teachers' professional identity in a big city. *World Journal on Educational Technology: Current Issues, 13*(2), 288–296. http://doi.org/10.18844/wjet.v13i2.5713

Vrana R. (2016). Digital literacy as a boost factor in employability of students. In S. Kurbanoğlu et al. (Eds.), *Information Literacy: Key to an Inclusive Society. ECIL 2016. Communications in Computer and Information Science*, *vol 676*. Springer. https://doi.org/10.1007/978-3-319-52162-6_17

Wagner, A. (2024). *Schulentwicklung in der digitalen Transformation. Eine fuzzy-set Qualitative Comparative Analysis schulischer Innovationsprozesse*. Wbv.

Weick, K. E. (1976). Educational organizations as loosely coupled systems. *Administrative Science Quarterly, 21*(1), 1–19. http://doi.org/10.2307/2391875

Wilbers, K. (2012). Entwicklung der Kompetenzen von Lehrkräften berufsbildender Schulen für digitale Medien. *Berufsbildung in Wissenschaft und Praxis, 41*(3), 38–41.

Wong, E. M. L., & Li, S. C. (2011). Framing ICT implementation in a context of educational change: A structural equation modelling analysis. *Australasian Journal of Educational Technology, 27*(2), 361–379. http://doi.org/10.1080/09243450801896809

Zhang, J. (2010). Technology-supported learning innovation in cultural contexts. *Educational Technology Research & Development, 58*(2), 229–243. https://doi.org/10.1007/s11423-009-9137-6

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