Transforming Vocational Schools – Digitalisation in School Development

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Abstract

The increasing impact of digitalisation on everyday life and the workplace requires new digital competencies to facilitate the socio-economic participation of citizens. One major avenue to support young people in the changing world is through education. This thesis therefore examines the development of vocational schools in the context of digitalisation. Theoretical considerations about school quality and models of school development form the basis for a multi-perspective research approach, including the five main stakeholder groups in Germany's dual system of vocational training, namely students, teachers, school leaders, parents and training companies. The thesis focuses on the development of schools as organisational units which operate in a larger educational context.

In the third chapter, curricular standards are investigated as external influence factors using a text-mining approach. The chapter examines in which ways these standards correspond to national requirements and how they can provide guidance for stakeholders at the school level. The fourth chapter focuses on the situation of teachers when school leaders decide to introduce digital practices into a school's routines. The fifth and sixth chapters combine the interpretation of quantitative and qualitative data in a mixed-method approach to emphasise the relationships between stakeholders and different areas of school development, especially during a phase of distance learning. Practical implications of digitalisation for the development of vocational schools are derived from the research work in chapter seven. These include the significance of a shared vision, clear cooperation strategies and a manageable number of educational tools. Furthermore, the need to review the established models of school development in the context of digitalisation and the characteristics of vocational schools is discussed. This thesis claims that it is insufficient to view digitalisation merely as an influencing factor on the different fields of school development. Through new modes of exchange, digitalisation fundamentally transforms the relationship between the stakeholders of development at vocational schools. The way education, organisation, personnel, cooperation and technology interact is transforming at the qualitative, quantitative, spatial and temporal level.

Zusammenfassung

Der zunehmende Einfluss der Digitalisierung auf den Alltag und Arbeitsplätze macht die Entwicklung neuer, digitaler Kompetenzen notwendig, um die sozio-ökonomische Teilhabe aller Bürger zu sichern. Aus diesem Grund untersucht die vorliegende Thesis die Entwicklung berufsbildender Schulen vor dem Hintergrund der Digitalisierung. Theoretische Überlegungen zu Schulqualität und Modelle von Schulentwicklung bilden die Grundlage eines multiperspektivischen Forschungsansatzes, der die fünf Interessengruppen des dualen Ausbildungssystems in Deutschland miteinbezieht: Schüler und Schülerinnen, Lehrpersonen, Schulleitungen, Eltern und Ausbildungsbetriebe. Die Thesis stellt die Entwicklung von Einzelschulen in den Vordergrund. Diese Einzelschulen operieren innerhalb eines größeren Bildungskontextes. Im dritten Kapitel werden Bildungspläne mit Hilfe eines Text-Mining Ansatzes als externe Einflussfaktoren untersucht. Das Kapitel begutachtet, in wie fern der Inhalte der Bildungspläne mit nationalen Anforderungen übereinstimmen und geht der Frage nach, wie Bildungspläne als Orientierungshilfen für die Akteure auf der Schulebene dienen können. Das vierte Kapitel fokussiert die Situation in der sich Lehrpersonen befinden, wenn digitale Werkzeuge und Methoden in die Abläufe einer Schule eingeführt werden. Im fünften und sechsten Kapitel werden die Ergebnisse eines Mixed Method Designs interpretiert. Quantitative und qualitative Daten werden herangezogen, um die Beziehung zwischen den Akteuren und den verschiedenen Bereichen von Schulentwicklung im Zusammenhang mit digitalem Fernunterricht hervorzuheben. Auswirkungen der Digitalisierung für die Praxis, die aus der vorliegenden Thesis abgeleitet werden können, werden im siebten Kapitel dargestellt. Im Vordergrund stehen eine gemeinsame Vision, klare Kooperationsstrategien und eine überschaubare Anzahl pädagogischer Werkzeuge. Zusätzlich wird die Notwendigkeit diskutiert, etablierte Modelle von Schulentwicklung unter der Berücksichtigung von Digitalisierung und den besonderen Charakteristika berufsbildender Schulen zu überdenken. Die Thesis versucht herauszustellen, dass Digitalisierung nicht nur als Einflussfaktor auf die einzelnen Bereiche von Schulentwicklung gesehen werden darf. Vielmehr führen neue Wege des Austauschs zu grundsätzlichen Veränderungen in den Beziehungen zwischen den verschiedenen Akteuren und Bereichen berufsbildender Schulen. Das Zusammenwirken von Unterricht, Organisation, Personal, Kooperation und Technologie wandelt sich auf qualitativer, quantitativerer und zeitlicher Ebene.

For Erwin Massa,
teacher, guide and dearest friend

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1. Introduction

1.1 Motivation

In September 2021, humanity witnessed the first all-civilian orbital space mission, 52 years after Apollo 11 successfully landed on the moon (Thompson, 2021). Neil Armstrong took his first steps on earth's satellite just 66 years after the brothers Wright conducted their motorized maiden flight in 1903. From a chronological perspective, the life of the ancient Egyptian queen Cleopatra is located closer to the moon landing than to the completion of the Great Pyramid of Giza. It therefore does not come as a surprise that Elon Musk is already fantasising about the colonisation of Mars (Musk, 2020).

The radical technological development of the modern era, which began with the industrial revolution in the middle of the 18th century, took place at an astonishing and overwhelming pace. Manual labour was replaced by steam machines, which themselves became less necessary with the invention of combustion engines, until electric generators began to provide the power for the ever-growing number of factories. More and more people moved to the cities to sell their manpower for cash, instead of struggling as farmers or day labourers in the countryside. In the cities, electricity slowly found its way from factories into the households of all social ranks. These residences, which had been a combination of dwelling place and workstation for thousands of years, became the counterpart to the workplace. The process shaped Western society's perception of privacy and public life (Barker & Hamlett, 2010). The growing narrowness in the cities is representative of the socio-cultural upheavals developing hand-in-hand with the economic changes. New political tendencies emerged from the willingness of citizens to participate in the political discourse as well as from the inequality between the wealthy and the poor.

The search for prosperity and growth gradually shaped societies and nations, but also the relationship between these two concepts: growing nationalism and imperialism can be interpreted as the main courses for the world-wide conflicts in the first half of the 20th century, resulting in the disintegration of old power structures and a new understanding of state and democracy (Thieme, 2017). Simultaneously, the First and Second World War sustainably propelled research and development in all scientific fields, culminating in the arms race of the Cold War era. While research facilities in the Eastern and Western hemispheres tried to surpass each other in the construction of technology which would give one of the two Blocs the upper hand in the global conflict, knowledge, information and communication itself became valuable

goods.

Touraine (1972) and Bell (1975) coined the term post-industrial society to characterise a society in which knowledge and information create more economic wealth than the manufacturing sector. The increasing value of information was further examined by Porat in the late 1970s. He developed the term information economy, defining an economy in which the information sector workforce outnumbers that of industry and agriculture (Porat, 1977). Further technological developments, especially the growth and spread of the Internet, significantly changed the value of information. Webster (2014) uses the term information society to accommodate for the relevance of information in modern human society. In his view, economy, technology, occupation, space and culture are evolving around information and knowledge: Information and Communication Technology (ICT) is increasingly spreading across the globe in the form of personal computers, smartphones and Internet connections (DataReportal, 2021). More and more people are employed in the ICT sector (OECD, 2014), while the perception of time and distance have been changed by the implementation of broadband Internet connections, video conferencing tools (K. Massner, 2021) and instant messaging services (Cameron & Webster, 2005). The digital space is being used to "participate in the production and distribution of culture" (Balkin, 2003, p. 1) and the consumption of digital media (Andersen & Strömbäck, 2021; Weingartner, 2021).

The significance of these trends for the field of education can be shown from two perspectives, one that focuses on competencies and one that focuses on the facilitation of those competencies through educational tools and methods (Collins & Halverson, 2018). In a changing world, people require new digital competencies to be able to participate in society (Buentello-Montoya et al., 2021; Ilomäki et al., 2016; Janssen et al., 2013). The Digital Competence Framework of Citizens, or DigComp 2.0, lists five main fields of digital competencies (Vuorikari et al., 2016). These competencies include the capability to operate "various digital technologies, such as mobile devices, apps, network services and so on" (Falloon, 2020). Another aspect is data literacy, the skill to search, evaluate and manage digital data (Henderson & Corry, 2021; Koltay, 2017; Tsai & Wu, 2021). Communication and collaboration using digital technology is considered a part of digital competencies as well (López-Meneses et al., 2020). Digitally competent citizens additionally need to be able protect their personal data (Horn & Otto, 2021; Schüller, 2020), but also their physical and psychological health (Larsson-Lund, 2018; LoBuono et al., 2021). Evaluating the impact of ICT usage on the environment is a key concern of the sustainability understanding of digital competencies (Chekanushkina et al., 2021; Luthra & Mangla, 2018). The fifth aspect of digital

competencies is often summarised as problem solving (Godhe, 2019). From a technical perspective, problem solving can be interpreted as repairing or fixing digital tools and digital environments (Osiurak & Heinke, 2018). Problem solving also includes the capacity to identify personal development goals and to make the right decisions on how to overcome skill and knowledge gaps. Creative and innovative digital solutions are listed under problem solving as well. Facilitating the competencies to enable citizens to make informed decisions (Ganz et al., 2019; M. Schneider, 2018), participate in socio-political discourses (Calderón Gómez, 2021; P. König & Wenzelburger, 2019; M. H. Nguyen et al., 2020), assert themselves on the job market (Kiss, 2017; Pichler & Stehrer, 2021), express their creativity, and address problems is the primary responsibility of education.

Following Collins and Halverson (2018), digitalisation also expands the tools and methods used in education. ICT can be used in the classroom in the form of various tools, such as computers (Falck et al., 2018; Mims-Word, 2012; Patterson & Patterson, 2017), tablet PCs (Conrad & Schumann, 2021; Delcker et al., 2016; Ifenthaler & Schweinbenz, 2016; Montrieux et al., 2015; Otterborn et al., 2019), smartphones (Hochberg et al., 2018; Lindberg et al., 2017) or interactive whiteboards (Hennessy, 2017; Mata et al., 2016; Tosuntaş et al., 2015). ICT is also a key factor for designing new modes of instruction such as flipped classroom settings (Mohamed & Lamia, 2018; Strelan et al., 2020; Zainuddin et al., 2019) and blended learning approaches (Dziuban et al., 2018; Hrastinski, 2019) or for the implementation of gamification in educational settings (Sangkyun Kim et al., 2018; Majuri et al., 2018). At the same time, educators can scale the provision of instructions, transforming the traditional classroom. Through online education (Damşa et al., 2021; McPherson & Bacow, 2015) and Massive Open Online Courses (Egloffstein, 2018; Hoxby, 2014; Shapiro et al., 2017) the boundaries of the classroom are dissolved in terms of classroom size as well as temporal and geographical location.

In addition, new forms of digital media can be used to convey the content of educational processes. Videos (Bateman & Schmidt-Borcherding, 2018; Carmichael et al., 2018), podcasts (L. König, 2021; O'Callaghan et al., 2017), games (Hawlitschek & Joeckel, 2017; Lamb et al., 2018; Platz et al., 2021) or educational apps (Cherner et al., 2014; O'Callaghan et al., 2017) are examples of formats which complement the printed book, traditional worksheets or overhead projector presentations.

Furthermore, digitalisation is entering education as its own form of content. Educators are providing learning material about data privacy and protection, the history of the Internet, sociological approaches to the information society, the potential of the Internet of Things or the

technical details of Industry 4.0 (Angell & Tewell, 2017; Roll & Ifenthaler, 2021; Voas & Laplante, 2017; Webb et al., 2017).

New ways of assessing and evaluating learning processes and outcomes have also entered the field of education. Students no longer have to wait for revisions if their online assignments are automatically checked and graded. Instead of writing lengthy papers, they are tasked with website design, video production or virtual poster preparation to verify and record their learning activities (C. W. Chen, 2018; Hall & Jones, 2021). Stakeholders can provide their institutions with cost-effective, scalable tools to evaluate the educational organisation at its different levels and from multiple perspectives (Delcker & Ifenthaler, in press; Huber & Helm, 2020). While school leaders can survey teachers, students or parents at the macro level, teachers might use short quizzes or other online tools to get feedback from their students at the classroom level (Peña-Lévano, 2020; Zou & Lambert, 2017). ICT and especially Artificial Intelligence can further enhance educational processes and support personalised learning. Machine Learning algorithms, Educational Data Mining and Natural Language Processing have the potential to be used in Intelligent Tutor Systems, Learning Analytics applications and automated recommendation solutions (Ifenthaler et al., 2020; Kärner et al., 2021; Murphy, 2019; U. Schmid et al., 2021; Schumacher & Ifenthaler, 2017; Seufert et al., 2021; Zawacki-Richter et al., 2019). The statement regarding changing competencies, tools and contents is relevant for the entirety of the vocational educational training system: all domains can be found within the vocational schools, but also at the workplace of apprentices in the training companies (Berisha-Gawlowski et al., 2020; Euler & Wilbers, 2018; Freiling & Mozer, 2020; Harteis, 2018).

The potential of ICT to facilitate students' digital competencies does not arise out of the technology itself. On the contrary, the meaningful integration of ICT into the context of education is characterised by reciprocal dependencies (Bulman & Fairlie, 2016; A. Delgado et al., 2015). In particular, teachers' own competencies to integrate ICT in the classroom (Hsu, 2015; Koehler et al., 2014; Kuijpers et al., 2010; Mishra & Koehler, 2008; Tondeur et al., 2018), suitable didactical concepts (Drossel & Eickelmann, 2017; Ilomäki, 2008; Lewin & McNicol, 2015), an understanding of stakeholders' attitudes (Guggemos & Seufert, 2021; Håkansson Lindqvist & Pettersson, 2019; Tondeur et al., 2017) as well as the digital and organisational infrastructure at the school (Francom, 2020; Kerres, 2020; Pettersson, 2018) stand out as key factors which support students learning through digitalisation.

In the past, the education system in Germany has not been able to systematically and broadly integrate ICT into its schools and universities. In an international comparison, the technological infrastructure to support ICT is underdeveloped (Fraillon et al., 2020). Although a wireless

LAN connection is available to 50% of the students, only a third of vocational schools are equipped with a fibre optic connection between the school network and the Internet (European Commission, 2019; McCoy et al., 2016). Fraillon et al. (2020) see the students' lack of ICT competencies as a direct result of these infrastructural conditions: almost 30% of German students show very low or low ICT competencies. The problematic infrastructure and the usage habits of the German teachers are mutually dependent. Compared to their European colleagues, teachers in Germany implement ICT less frequently into their classes. Teachers are further held back by the fact that ICT is not as present in teacher education programmes and K-12 curricula in Germany as in other countries (Labusch et al., 2020). Until recently, it appeared as if the various areas of ICT and their potentials for education were stuck in an entrenched circle: even where investments into infrastructure were made, teachers struggled to make meaningful changes to their teaching practices because they did not possess the necessary competencies. In return, the learning outcomes for students didn't improve. And these experiences were encountered by a hesitant public. As a result, the public pressure on policy makers stayed relatively low and digitalisation was not integrated into state-wide curricula. Unchanged curricula prevented further investments into technological infrastructure, as well as improvements of pre-service and in-service teacher training, leading to a further stagnation of ICT implementation processes in educational institutions.

The slow implementation of digitalisation in school development has negative consequences for all students and institutions in Germany's educational system. But Germany's vocational schools are particularly affected. The requirements of future theoretical and practical digital competencies emerge at the intersection of institutionalised learning and practical training (Berisha-Gawlowski et al., 2020; Euler & Wilbers, 2018; Freiling & Mozer, 2020). The work reality of apprentices in training companies and the educational environment of vocational schools are drifting apart. While employers demand skills in the operation of increasingly complex machines and deeper understanding of processes in highly digitalised workplaces (Billett, 2020), vocational schools fail to provide basic digital infrastructure or didactical concepts to facilitate these competencies (Fraillon et al., 2020).

The circumstances in the educational system in Germany in general and at the vocational schools in particular are gradually changing. The transformation process is mainly initiated by motivated school leadership and teachers at the school level (Zylka, 2018). At the political level, the Standing Conference of the Ministers of Education and Cultural Affairs (*Ständige Konferenz der Kultusminister der Länder* – KMK) published a nation-wide strategy for the future development of education in Germany in December 2016 called '*Bildung in der digitalen*

Welt' (education in the digital world). This strategy is supposed to create the foundation for further digitalisation processes through the implementation of curricula changes, the revision of teacher education, infrastructural investments, educational media development, the introduction of e-government programmes and the creation of a comprehensive legal framework (KMK, 2017b). The '*DigitalPakt Schule*' (digital pact for schools) of the KMK is closely connected to this strategy and focuses on the regulation of the financial responsibilities of the federal states in cooperation with the federal government (KMK, 2019a). Supplementary agreements to the digital pact for schools have been concluded in the wake of the COVID-19 pandemic in 2020 and 2021, when schools were forced to switch from on-site teaching to forms of digital distance teaching. Stakeholders and decision makers at vocational schools need further support to be able to profit from the changing legal conditions and enhance the implementation of digitalisation at their respective institutions. The aim of this thesis is therefore to provide the vocational schools in the German state of Baden-Württemberg with feasible ideas and recommendations for the integration of digitalisation into school development, based on multi-perspective theoretical assumptions and empirical methods.

1.2 Research Questions of this Thesis

Vocational schools are one of the main facilitators of digital competencies in Germany's vocational and educational training system (Deissinger, 2015; Euler, 2013; Haasler, 2020; Niegemann, 2020; Pilz & Wiemann, 2021). Their capability to prepare students for a successful life in a world that is increasingly permeated by digitalisation depends on various issues. Formal standards can predefine learning content and learning goals (Harvey & Green, 1993). Teachers' competencies (Caena & Redecker, 2019; Redecker, 2017), based on their attitudes (Falloon, 2020; Guggemos & Seufert, 2021) and training (Roll & Ifenthaler, 2021; Sánchez-Cruzado et al., 2021; Tondeur et al., 2017, 2018), determine how effectively they can use the available tools in their teaching (Gil-Flores et al., 2017; Huber & Helm, 2020; Kerres, 2020). Ultimately, vocational schools, as organisational entities, are being tasked to merge the manifold determinants of digital education and the perspectives of different stakeholders to foster future-oriented learning environments(Eickelmann & Gerick, 2018; Ilomäki & Lakkala, 2018; Rolff & Thünken, 2020; Zylka, 2018).

The research questions guiding this thesis therefore focus on a multitude of areas and perspectives. Curricula guidelines present an important factor for the goals that vocational schools choose in school development processes (Ifenthaler, 2019; Matos et al., 2019; Webb et

al., 2017). Consequently, this thesis examines the formals standards which stakeholders at vocational schools find in the form of curricular requirements in the context of digital competencies (RQ1). Furthermore, the thesis seeks to identify organisational and infrastructural prerequisites within a school which enable teachers to integrate digital teaching methods (Bellin-Mularski et al., 2016; Fraillon et al., 2020) and to overcome the challenges of the switch from traditional online training to digital formats (RQ2) (Heinen & Kerres, 2015; Sokal et al., 2020). The perspective of teachers has to be expanded to include the multiple stakeholder interests at vocational schools, especially those of students, parents, school leaders and training companies. This includes the connection between students' perceived learning success and the organisational conditions at vocational schools in times of digital distance learning, another research question of this thesis (RQ3). Consequently, the thesis raises the question whether the digitalisation of vocational schools can be enhanced through the ideas, attitudes and preferences of the different individuals who distinguish these special forms of educational institutions (RQ4). Four research studies were conducted to investigate contextual factors, perspectives of multiple stakeholders and the interdependency of organisation, class room practice, personnel, technology and cooperation at vocational schools in the German state of Baden-Württemberg. The thesis investigates:

- the formal integration of digitalisation into vocational school curricula
- teachers' perspective on the introduction of digital distance learning
- school organisational settings as an influence on students' perceived learner success
- stakeholders' experience with digital distance learning in a time of crisis.

A graphical representation of the research foci and the related studies can be found in Figure 1-1. The methodological approaches and a quantitative summary of the studies can be found in Table 1-1.

Figure 1-1

Research Foci and Related Studies

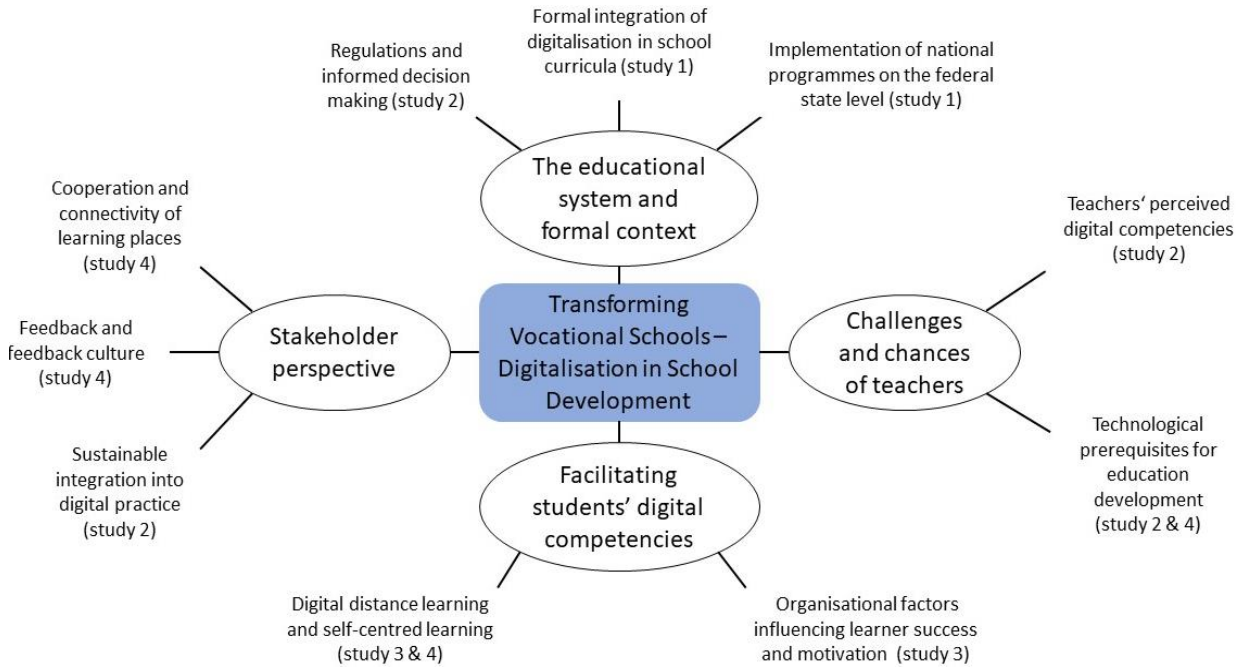


Table 1-1

Summary of Research Studies included in this Thesis

Study Chapter	Study 1 Chapter 3	Study 2 Chapter 4	Study 3 Chapter 5	Study 4 Chapter 6
Research question	RQ1	RQ2, RQ4	RQ3	RQ3,RQ4
Reference	Delcker, J (accepted). Digitalization in the Curricula of Vocational Schools Text Mining as an Instrument of Curricula Analysis. *Tech Know Learn*.	Delcker, J. & Ifenthaler, D. (2021). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 30(1), 125–139.	Delcker, J., & Ifenthaler, D. (in press). Distance learning and the influence of schools' organisational characteristics on the students perceived learning success. In V. Dennen, C. Dickson-Deane, X. Ge, D. Ifenthaler, S. Murthy, & J. C. Richardson (Eds.), *Global perspectives on educational innovations for emergency situations.* Springer.	Delcker, J. & Ifenthaler, D. (under review). Distance learning and the transformation of vocational schools from a qualitative perspective. *Front.Educ.*
Research design	Mixed method design	Qualitative research approach	Quantitative research approach	Qualitative research approach
Methods	Text-mining, content analysis	Guided interview	Questionnaire	Structuring content analysis
Sample size	830 documents	*N* = 18	*N* = 3872	*N* = 1493
Research foci	Curricula as context factors of school development	Teachers' challenges and coping strategies in the introduction phase of digital distance learning	Influence of organisational development on the perceived learning success of students	Students', teachers', school leaders', parents' and training companies' perception of digital distance learning

1.2.1 Digitalisation in the Curricula of Vocational Schools (Study 1)

The first study investigates an important contextual factor with regard to the integration of digitalisation in vocational school development. 831 state-wide curricula of vocational schools are analysed for the occurrence and the specific usage of keywords of digitalisation. The primary research question focuses on the identification of apparent indicators for digitalisation in the formal documents. It examines whether the inclusion of digitalisation in the curricula is connected to the heterogeneity of the different types of vocational schools and their respective stakeholders.

The second research question examines the alignment of the analysed curricula with the KMK strategy Education in the Digital World. The study aims to emphasise the need for a holistic approach to the necessary competencies stated in the KMK strategy rather than focusing on a technical perspective

1.2.2 Teachers' Perspective on School Development at German Vocational Schools during the COVID-19 Pandemic (Study 2)

The second study focuses on the perspective of teachers on the introduction of digital teaching practices at vocational schools. Besides the intrapersonal prerequisites for teaching with technology and the change in learning and teaching attitudes, preconditions concerning schools as part of a learning organisation are examined. A qualitative interview study including $N = 18$ participants is conducted to identify challenges for teachers, the role of school leadership, and cooperation between stakeholders. The goal of the study is to examine factors which support teachers in overcoming challenges in the transformation process from on-site to digital distance education. The first research question investigates the influence of a school's technological infrastructure, including hardware, software, server structure, network capabilities and technological support. The second research question explores the significance of organisational development as a support for teachers, such as a school's agenda, communication strategies and support for collaboration. Success factors and limitations of digital teaching and learning are examined by the third research question. The final research question widens the perspective from the transition phase towards the sustainable integration of digitalisation in school development, focusing on the areas which teachers deem helpful for their teaching and learning.

1.2.3 Distance Learning and the Influence of Schools' Organisational Characteristics on Students' Perceived Learning Success (Study 3)

In the third study, the influence of organisational characteristics on students' perceived learning success is evaluated. The study is part of the project Check-up Distance Learning carried out in cooperation with the Ministry for Culture, Youth and Sport of Baden-Württemberg. A total of 1763 students from 15 vocational schools in Baden-Württemberg, Germany provided data to examine which various organisational factors affect their learning and how they do so, including teachers' adaption to the COVID-19 crisis, assessment regulations and clearness of procedure instructions amongst other things. The second research question of the study addresses the implementation of media expansion plans as an instrument for school development with regard to students' perceived learning success.

The data collection process for this paper includes the data of additional stakeholders, namely teachers, parents, school leadership and training companies. School leaders are provided with a detailed descriptive data report as a summary of the stakeholders' perception of school development.

1.2.4 Distance Learning and the Transformation of Vocational Schools from a Qualitative Perspective (Study 4)

The data collection in Study 3 includes an open question format. The answers of $N = 1493$ participants are used to examine two research questions. The first addresses the perspective of students, teachers, parents, school leaders and training companies with regard to the digital distance situation at 15 vocational schools. The identification of vocational school-specific factors is paramount. The goal is to enhance the data collection of Study 3 to further improve the research instrument, by uncovering items which have not been sufficiently considered. In a second research question, practical ideas and suggestions from within the different stakeholder groups are identified, emphasising their role in the digitalisation of vocational school development.

1.3 Structure of the Thesis

This thesis is organised into seven chapters. A description of the motivation to investigate digitalisation in school development with regard to vocational schools is described in Chapter 1. The chapter highlights the important changes in education taking place on a global scale: the prevalence of ICT has a deep impact on all fields, and as a result, stakeholders in education have to revise their theoretical concepts and practical approaches. Chapter 2 outlines the theoretical foundation of this thesis, including the definition of key constructs. The position of vocational schools as an important part of Germany's dual system is explained. The term "school quality" and its multiple meanings are critically discussed. These considerations form the basis for different perspectives on school development and can be used to make a conceptual distinction between school development and school reform. Three different models are specifically discussed in this chapter. The models illustrate the various development fields which are essential for the successful integration of digitalisation into school development.

In Chapters 3, 4, 5 and 6, the four research studies forming the major empirical contribution of the thesis are presented. Chapter 7 then summarises the main findings of the thesis. Implications for the theory and practice of school development at vocational schools are derived, keeping in mind the limitations of the work. A final conclusion takes a look at arising research questions and opportunities, incorporating approaches from adjacent research areas.

1.4 References

Andersen, K., & Strömbäck, J. (2021). Media Platforms and Political Learning: The Democratic Challenge of News Consumption on Computers and Mobile Devices. *International Journal of Communication*, *15*.

Angell, K., & Tewell, E. (2017). Teaching and Un-Teaching Source Evaluation: Questioning Authority in Information Literacy Instruction. *Comminfolit*, *11*(1), 95. https://doi.org/10.15760/comminfolit.2017.11.1.37

Balkin, J. M. (2003). Digital Speech and Democratic Culture: A Theory of Freedom of Expression for the Information Society. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.470842

Barker, H., & Hamlett, J. (2010). Living above the Shop: Home, Business, and Family in the English '"Industrial Revolution."' *Journal of Family History*, *35*(4), 311–328. https://doi.org/10.1177/0363199010373544

Bateman, J., & Schmidt-Borcherding, F. (2018). The Communicative Effectiveness of Education Videos: Towards an Empirically-Motivated Multimodal Account. *Multimodal Technologies and Interaction*, *2*(3), 59. https://doi.org/10.3390/mti2030059

Bell, D. (1975). *The Coming of post-industrial society : a venture in social forecasting* (5.). Heinemann Educational Publisher.

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-Service Teachers' Perceptions of School Development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Berisha-Gawlowski, A., Caruso, C., Goller, G., & Harteis, C. (2020). Auswirkungen der Digitalisierung industrieller Arbeit auf die berufliche und allgemeine Bildung. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56). wbv Media GmbH & Co. KG.

Billett, S. (2020). Developing a Skillful and Adaptable Workforce: In E. Wuttke, J. Seifried, & H. M. Niegemann (Eds.), *Vocational Education and Training in the Age of Digitization* (pp. 251–272). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.15

Buentello-Montoya, D. A., Lomelí-Plascencia, M. G., & Medina-Herrera, L. M. (2021). The role of reality enhancing technologies in teaching and learning of mathematics. *Computers & Electrical Engineering*, *94*, 107287. https://doi.org/10.1016/j.compeleceng.2021.107287

Bulman, G., & Fairlie, R. W. (2016). Chapter 5 - Technology and Education: Computers, Software, and the Internet. In E. A. Hanushek, S. Machin, & L. Woessmann (Eds.), *Handbook of the Economics of Education* (Vol. 5, pp. 239–280). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-444-63459-7.00005-1

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Calderón Gómez, D. (2021). The third digital divide and Bourdieu: Bidirectional conversion of economic, cultural, and social capital to (and from) digital capital among young people in Madrid. *New Media & Society*, *23*(9), 2534–2553. https://doi.org/10.1177/1461444820933252

Cameron, A. F., & Webster, J. (2005). Unintended consequences of emerging communication technologies: Instant Messaging in the workplace. *Computers in Human Behavior*, *21*(1), 85–103. https://doi.org/10.1016/j.chb.2003.12.001

Carmichael, M., Reid, A.-K., & Karpicke, J. D. (2018). *Assessing the Impact of Educational Video on Student Engagement, Critical Thinking and Learning: The Current State of Play*. SAGE Publications. www.sagepublishing.com

Chekanushkina, E. N., Timoshchuk, N. A., Kolyvanova, L. A., & Fakhrutdinova, E. V. (2021). *Social and Environmental Competence as a Component of University Graduate's Competitiveness BT - Engineering Economics: Decisions and Solutions from Eurasian Perspective* (S. I. Ashmarina, V. V. Mantulenko, & M. Vochozka (Eds.); pp. 676–681). Springer International Publishing.

Chen, C. W. (2018). Developing EFL students' digital empathy through video production. *System*, *77*, 50–57. https://doi.org/10.1016/j.system.2018.01.006

Cherner, T., Dix, J., & Lee, C. (2014). Cleaning Up That Mess: A Framework for Classifying Educational Apps. *Contemporary Issues in Technology and Teacher Education*, *14*(2), 158–193.

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: the digital revolution and schooling in America* (2nd ed.). Teachers College Press.

Conrad, M., & Schumann, S. (2021). Emotionales Erleben beim Lernen mit Tablet-PCs im Wirtschaftsunterricht: Berufsbildung. Zeitschrift für Theorie-Praxis-Dialog. *Berufsbildung. Zeitschrift Für Theorie-Praxis-Dialog*, *75*(187), 13–15.

Damşa, C., Langford, M., Uehara, D., & Scherer, R. (2021). Teachers' agency and online education in times of crisis. *Computers in Human Behavior*, *121*, 106793. https://doi.org/10.1016/j.chb.2021.106793

DataReportal. (2021). *Digital 2021 Global Digital Overview*. https://datareportal.com/reports/digital-2021-global-digital-overview

Deissinger, T. (2015). The German dual vocational education and training system as 'good practice'? *Local Economy: The Journal of the Local Economy Policy Unit*, *30*(5), 557–567. https://doi.org/10.1177/0269094215589311

Delcker, J., Honal, A., & Ifenthaler, D. (2016). Mobile device usage in higher education. *Proceedings of the 13th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2016*.

Delcker, J., & Ifenthaler, D. (n.d.). Distance learning and the influence of schools' organizational characteristics on the students perceived learning success. In V. Dennen, C. Dickson-Deane, X. Ge, D. Ifenthaler, S. Murthy, & J. C. Richardson (Eds.), *Global perspectives on educational innovations for emergency situations*. Springer.

Delgado, A., Wardlow, L., O'malley, K. J., & Mcknight, K. M. (2015). *Educational Technology: A Review of the Integration, Resources, and Effectiveness of Technology in K-12 Classrooms.*

Drossel, K., & Eickelmann, B. (2017). Teachers' participation in professional development concerning the implementation of new technologies in class: a latent class analysis of teachers and the relationship with the use of computers, ICT self-efficacy and emphasis on teaching ICT skills. *Large-Scale Assessments in Education*, *5*(1), 19. https://doi.org/10.1186/s40536-017-0053-7

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, *15*(1), 3. https://doi.org/10.1186/s41239-017-0087-5

Egloffstein, M. (2018). Massive Open Online Courses in Digital Workplace Learning. In D. Ifenthaler (Ed.), *Digital Workplace Learning* (pp. 149–166). Springer International Publishing. https://doi.org/10.1007/978-3-319-46215-8_9

Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen,*

29(4), 111–115.
Euler, D. (2013). *Germany´s dual vocational training system - a model for other countries?* Bertelsmann Stiftung. https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Bibliothek/Doi_Publikationen/GP_Germanys_dual_vocational_training_system.pdf
Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1
European Commission. (2019). *2nd survey of schools: ICT in education. Objective 1: Benchmarking progress in ICT in schools*. European Commission. https://doi.org/10.2759/23401
Falck, O., Mang, C., & Woessmann, L. (2018). Virtually No Effect? Different Uses of Classroom Computers and their Effect on Student Achievement. *Oxford Bulletin of Economics and Statistics*, *80*(1), 1–38. https://doi.org/10.1111/obes.12192
Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4
Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5
Francom, G. M. (2020). Barriers to technology integration: A time-series survey study. *Journal of Research on Technology in Education*, *52*(1), 1–16. https://doi.org/10.1080/15391523.2019.1679055
Freiling, T., & Mozer, P. (2020). Digitale Lernformen unterstützen die Lernortkooperation in der beruflichen Bildung! In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf: Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 139–152). wbv Media GmbH & Co. KG.
Ganz, W., Dworschak, B., & Schnalzer, K. (2019). Competences and Competence Development in a Digitalized World of Work. In I. Nunes (Ed.), *Advances in Human Factors and Systems Interaction. AHFE 2018. Advances in Intelligent Systems and Computing* (Vol. 781, pp. 312–320). https://doi.org/10.1007/978-3-319-94334-3_31
Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057
Godhe, A.-L. (2019). Digital Literacies or Digital Competence: Conceptualizations in Nordic Curricula. *Media and Communication*, *7*(2), 25–35. https://doi.org/10.17645/mac.v7i2.1888
Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*, 1–11. https://doi.org/10.1016/j.chb.2020.106613
Haasler, S. R. (2020). The German system of vocational education and training: challenges of gender, academisation and the integration of low-achieving youth. *Transfer: European Review of Labour and Research*, *26*(1), 57–71. https://doi.org/10.1177/1024258919898115
Håkansson Lindqvist, M., & Pettersson, F. (2019). Digitalization and school leadership: on the complexity of leading for digitalization in school. *The International Journal of Information and Learning Technology*, *36*(3), 218–230. https://doi.org/10.1108/IJILT-11-2018-0126
Hall, N. M., & Jones, J. M. (2021). Student-Produced Podcasts as a Teaching and Learning Tool. *American Journal of Distance Education*, 1–13.

https://doi.org/10.1080/08923647.2021.1995256
Harteis, C. (2018). *Machines, Change and Work: An Educational View on the Digitalization of Work* (pp. 1–10). https://doi.org/10.1007/978-3-319-63257-5_1
Harvey, L., & Green, D. (1993). Defining Quality. *Assessment & Evaluation in Higher Education*, *18*(1), 9–34. https://doi.org/10.1080/0260293930180102
Hawlitschek, A., & Joeckel, S. (2017). Increasing the effectiveness of digital educational games: The effects of a learning instruction on students' learning, motivation and cognitive load. *Computers in Human Behavior*, *72*, 79–86. https://doi.org/10.1016/j.chb.2017.01.040
Heinen, R., & Kerres, M. (2015). Individuelle Förderung mit digitalen Medien. Handlungsfelder für die systematische, lernförderliche Integration digitaler Medien in Schule und Unterricht. In *Individuell fördern mit digitalen Medien – Chancen, Risiken, Erfolgsfaktoren* (pp. 96–161). Bertelsmann-Stiftung.
Henderson, J., & Corry, M. (2021). Data literacy training and use for educational professionals. *Journal of Research in Innovative Teaching & Learning*, *14*(2), 232–244. https://doi.org/10.1108/JRIT-11-2019-0074
Hennessy, S. (2017). International Experiences with Intergrating Interactive Whiteboards: Policy, Practice, Pedagogy and Professional Development. In R. Maclean (Ed.), *Life in Schools and Classrooms: Past, Present and Future* (pp. 633–650). Springer Singapore. https://doi.org/10.1007/978-981-10-3654-5_38
Hochberg, K., Kuhn, J., & Müller, A. (2018). Using Smartphones as Experimental Tools—Effects on Interest, Curiosity, and Learning in Physics Education. *Journal of Science Education and Technology*, *27*(5), 385–403. https://doi.org/10.1007/s10956-018-9731-7
Horn, N., & Otto, P. (2021). *Data protection versus functionality: the dilemma of German schools*. Heinrich Böll Stiftung. https://www.boell.de/en/2021/04/15/Data-protection-versus-functionality-the-dilemma-of-German-schools
Hoxby, C. M. (2014). The economics of online postsecondary education: MOOCs, nonselective education, and highly selective education. *The American Economic Review*, *104*(5), 528–533.
Hrastinski, S. (2019). What Do We Mean by Blended Learning? *TechTrends*, *63*(5), 564–569. https://doi.org/10.1007/s11528-019-00375-5
Hsu, Y. S. (2015). The development of teachers' professional learning and knowledge. In *Development Of Science Teachers' TPACK: East Asian Practices* (pp. 3–15). Springer Singapore. https://doi.org/10.1007/978-981-287-441-2_1
Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability*, *32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y
Ifenthaler, D. (2019). *MEPS – Medienentwicklungsplanung für Schulen in Baden-Württemberg. Bericht zum Projekt des Kultusministeriums Baden-Württemberg*. Kultusministerium Baden-Württemberg.
Ifenthaler, D., Gibson, D., Prasse, D., Shimada, A., & Yamada, M. (2020). Putting learning back into learning analytics: actions for policy makers, researchers, and practitioners. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-020-09909-8
Ifenthaler, D., & Schweinbenz, V. (2016). Students' Acceptance of Tablet PCs in the Classroom. *Journal of Research on Technology in Education*, *48*(4), 306–321. https://doi.org/10.1080/15391523.2016.1215172
Ilomäki, L. (2008). *The effects of ICT on school: teachers' and students' perspectives* [University of Turku]. https://www.utupub.fi/bitstream/handle/10024/42311/B314.pdf?sequence=3&isAllowed

=y
Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8
Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. *Education and Information Technologies*, *21*(3), 655–679. https://doi.org/10.1007/s10639-014-9346-4
Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., & Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Computers & Education*, *68*, 473–481. https://doi.org/10.1016/j.compedu.2013.06.008
K. Massner, C. (2021). The Use of Videoconferencing in Higher Education. In *Communication Management [Working Title]*. IntechOpen. https://doi.org/10.5772/intechopen.99308
Kärner, T., Warwas, J., & Schumann, S. (2021). A Learning Analytics Approach to Address Heterogeneity in the Classroom: The Teachers' Diagnostic Support System. *Technology, Knowledge and Learning*, *26*(1), 31–52. https://doi.org/10.1007/s10758-020-09448-4
Kerres, M. (2020). Against All Odds: Education in Germany Coping with Covid-19. *Postdigital Science and Education*, *2*(3), 690–694. https://doi.org/10.1007/s42438-020-00130-7
Kim, S., Song, K., Lockee, B., & Burton, J. (2018). What is Gamification in Learning and Education? In S. Kim, K. Song, B. Lockee, & J. Burton (Eds.), *Gamification in Learning and Education: Enjoy Learning Like Gaming* (pp. 25–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-47283-6_4
Kiss, M. (2017). *Digital Skills in the EU labour market*. European Parliamentary Research Service. http://hdl.voced.edu.au/10707/455741.
KMK. (2017). *The Standing Conference's "Education in the Digital World" strategy - Summary*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2017/KMK-Strategie_Bildung_in_der_digitalen_Welt_Zusammenfassung_en.pdf
KMK. (2019). *Basic Structure of the Education System in the Federal Republic of Germany*. KMK. https://www.kmk.org/fileadmin/Dateien/pdf/Dokumentation/en_2019.pdf
Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J. M. Spector, M. D. Merill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology: Fourth Edition* (4th ed., pp. 101–111). Springer Science+Business Media. https://doi.org/10.1007/978-1-4614-3185-5
Koltay, T. (2017). Data literacy for researchers and data librarians. *Journal of Librarianship and Information Science*, *49*(1), 3–14. https://doi.org/10.1177/0961000615616450
König, L. (2021). Podcasts in higher education: teacher enthusiasm increases students' excitement, interest, enjoyment, and learning motivation. *Educational Studies*, *47*(5), 627–630. https://doi.org/10.1080/03055698.2019.1706040
König, P., & Wenzelburger, G. (2019). Why parties take up digitization in their manifestos. *Journal of European Public Policy*, *26*(11), 1678–1695. https://doi.org/10.1080/13501763.2018.1544268
Kuijpers, J. M., Houtveen, A. A. M., & Wubbels, T. (2010). An integrated professional development model for effective teaching. *Teaching and Teacher Education*, *26*(8), 1687–1694. https://doi.org/10.1016/j.tate.2010.06.021
Labusch, A., Eickelmann, B., & Conze, D. (2020). ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland. In *ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland*. Waxmann Verlag GmbH.

https://doi.org/10.31244/9783830993087
Lamb, R. L., Annetta, L., Firestone, J., & Etopio, E. (2018). A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations. *Computers in Human Behavior*, *80*, 158–167. https://doi.org/10.1016/j.chb.2017.10.040
Larsson-Lund, M. (2018). The digital society: Occupational therapists need to act proactively to meet the growing demands of digital competence. *British Journal of Occupational Therapy*, *81*(12), 733–735. https://doi.org/10.1177/0308022618776879
Lewin, C., & McNicol, S. (2015). Supporting the Development of 21st Century Skills through ICT. *KEYCIT 2014 - Key Competencies in Informatics and ICT*, *7*, 181–198.
Lindberg, O. J., Olofsson, A. D., & Fransson, G. (2017). Same but different? An examination of Swedish upper secondary school teachers' and students' views and use of ICT in education. *The International Journal of Information and Learning Technology*, *34*(2), 122–132. https://doi.org/10.1108/IJILT-09-2016-0043
LoBuono, D. L., Shea, K. S., Tovar, A., Leedahl, S. N., Mahler, L., Xu, F., & Lofgren, I. E. (2021). Acceptance and perception of digital health for managing nutrition in people with Parkinson's disease and their caregivers and their digital competence in the United States: A <scp>mixed-methods</scp> study. *Health Science Reports*, *4*(4). https://doi.org/10.1002/hsr2.412
López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology*, 69–88. https://doi.org/10.14742/ajet.5583
Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, *117*, 168–179. https://doi.org/10.1016/j.psep.2018.04.018
Majuri, J., Koivisto, J., & Hamari, J. (2018). *Gamification of Education and Learning: A Review of Empirical Literature.*
Mata, L., Lazar, G., & Lazar, I. (2016). Effects of study levels on students' attitudes towards interactive whiteboards in higher education. *Computers in Human Behavior*, *54*, 278–289. https://doi.org/10.1016/j.chb.2015.07.044
Matos, J., Pedro, A., & Piedade, J. (2019). Integrating Digital Technology in the School Curriculum. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(21), 4. https://doi.org/10.3991/ijet.v14i21.10863
McCoy, S., Lyons, S., Coyne, B., & Darmody, M. (2016). *Teaching and Learning in Second-Level Schools at the Advent of High Speed Broadband*. The Economic and Social Research Institute. www.esri.ie
McPherson, M. S., & Bacow, L. S. (2015). Online higher education: Beyond the hype cycle. *The Journal of Economic Perspectives*, *29*(4), 135–154.
Mims-Word, M. (2012). The Importance Of Technology Usage In The Classroom, Does Gender Gaps Exist. *Contemporary Issues in Education Research (CIER)*, *5*(4), 271. https://doi.org/10.19030/cier.v5i4.7271
Mishra, P., & Koehler, M. (2008). Introducing Technological Pedagogical Content Knowledge. *Teachers College Record*, *9*.
Mohamed, H., & Lamia, M. (2018). Implementing flipped classroom that used an intelligent tutoring system into learning process. *Computers & Education*, *124*, 62–76. https://doi.org/10.1016/j.compedu.2018.05.011
Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and Learning with Mobile Technology: A Qualitative Explorative Study about the Introduction of Tablet Devices in Secondary Education. *PLOS ONE*, *10*(12), e0144008. https://doi.org/10.1371/journal.pone.0144008

Murphy, R. (2019). *Artificial Intelligence Applications to Support K–12 Teachers and Teaching: A Review of Promising Applications, Challenges, and Risks*. RAND Corporation. https://doi.org/10.7249/PE315

Musk, E. (2020). *"Mars, here we come!!"* https://twitter.com/elonmusk/status/1336810077555019779?s=20

Nguyen, M. H., Hunsaker, A., & Hargittai, E. (2020). Older adults' online social engagement and social capital: the moderating role of Internet skills. *Information, Communication & Society*, 1–17. https://doi.org/10.1080/1369118X.2020.1804980

Niegemann, H. M. (2020). Introduction–A Look Back Ahead. In E. Wuttke, J. Seifried, & H. M. Niegemann (Eds.), *Vocational Education and Training in the Age of Digitization* (pp. 15–20). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.4

O'Callaghan, F. V., Neumann, D. L., Jones, L., & Creed, P. A. (2017). The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues. *Education and Information Technologies*, *22*(1), 399–415. https://doi.org/10.1007/s10639-015-9451-z

OECD. (2014). *Measuring the Digital Economy*. https://doi.org/https://doi.org/https://doi.org/10.1787/9789264221796-en

Osiurak, F., & Heinke, D. (2018). Looking for intoolligence: A unified framework for the cognitive study of human tool use and technology. *American Psychologist*, *73*(2), 169–185. https://doi.org/10.1037/amp0000162

Otterborn, A., Schönborn, K., & Hultén, M. (2019). Surveying preschool teachers' use of digital tablets: general and technology education related findings. *International Journal of Technology and Design Education*, *29*(4), 717–737. https://doi.org/10.1007/s10798-018-9469-9

Patterson, R. W., & Patterson, R. M. (2017). Computers and productivity: Evidence from laptop use in the college classroom. *Economics of Education Review*, *57*, 66–79. https://doi.org/10.1016/j.econedurev.2017.02.004

Peña-Lévano, L. (2020). Personalizing Online Classes: The Use of Evaluation and Participation Tools. *Applied Economics Teaching Resources (AETR)*. https://doi.org/10.22004/ag.econ.302622

Pettersson, F. (2018). Digitally Competent School Organizations – Developing Supportive Organizational Infrastructures. *Seminar.Net*, *14*(2), 132–143. https://journals.oslomet.no/index.php/seminar/article/view/2976

Pichler, D., & Stehrer, R. (2021). *Breaking Through the Digital Ceiling: ICT Skills and Labour Market Opportunities* (No. 193). https://wiiw.ac.at/breaking-through-the-digital-ceiling-ict-skills-and-labour-market-opportunities-dlp-5597.pdf

Pilz, M., & Wiemann, K. (2021). Does Dual Training Make the World Go Round? Training Models in German Companies in China, India and Mexico. *Vocations and Learning*, *14*(1), 95–114. https://doi.org/10.1007/s12186-020-09255-z

Platz, L., Jüttler, M., & Schumann, S. (2021). Game-Based Learning in Economics Education at Upper Secondary Level: The Impact of Game Mechanics and Reflection on Students' Financial Literacy. In C. Aprea & D. Ifenthaler (Eds.), *Game-based Learning Across the Disciplines. Advances in Game-Based Learning* (pp. 25–42). Springer. https://doi.org/10.1007/978-3-030-75142-5_2

Porat, M. U. (1977). *The Information Economy: Definition and Measurement* (OT Special Publication; ...). U.S. Government Printing Office. https://eric.ed.gov/?id=ED142205

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu* (Y. Punie (Ed.)). Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107466/pdf_digcomedu_a4_final.pdf

Rolff, H.-G., & Thünken, U. (2020). Digital gestütztes Lernen: Praxisbeispiele für eine

zeitgemäße Schulentwicklung. In *Digital gestütztes Lernen*. Beltz Verlagsgruppe.
Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4
Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher Digital Literacy: The Indisputable Challenge after COVID-19. *Sustainability*, *13*(4), 1858. https://doi.org/10.3390/su13041858
Schmid, U., Blanc, B., Toepel, M., Pinkwart, N., & Drachsler, H. (2021). *KI@Bildung: Lehren und Lernen in der Schule mit Werkzeugen Künstlicher Intelligenz*. https://www.mmb-institut.de/wp-content/uploads/KI@Bildung_Schlussbericht.pdf
Schneider, M. (2018). Digitalization of Production, Human Capital, and Organizational Capital BT - The Impact of Digitalization in the Workplace: An Educational View. In C. Harteis (Ed.), *The Impact of Digitalization in the Workplace. Professional and Practice-based Learning* (Vol. 21, pp. 39–52). Springer International Publishing. https://doi.org/10.1007/978-3-319-63257-5_4
Schüller, K. (2020). *Future Skills: a Framework for Data Literacy - Competence Framework and Research Report*. https://doi.org/10.5281/ZENODO.3946067
Schumacher, C., & Ifenthaler, D. (2017). Features Students Really Expect from Learning Analytics. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.06.030
Seufert, S., Guggemos, J., Ifenthaler, D., Ertl, H., & Seifried, J. (2021). *Künstliche Intelligenz in der beruflichen Bildung Zukunft der Arbeit und Bildung mit intelligenten Maschinen?!* Franz Steiner Verlag. https://elibrary.steiner-verlag.de/book/99.105010/9783515130752
Shapiro, H. B., Lee, C. H., Wyman Roth, N. E., Li, K., Çetinkaya-Rundel, M., & Canelas, D. A. (2017). Understanding the massive open online course (MOOC) student experience: An examination of attitudes, motivations, and barriers. *Computers & Education*, *110*, 35–50. https://doi.org/10.1016/j.compedu.2017.03.003
Sokal, L., Trudel, L. E., & Babb, J. (2020). Canadian teachers' attitudes toward change, efficacy, and burnout during the COVID-19 pandemic. *International Journal of Educational Research Open*, *1*, 100016. https://doi.org/10.1016/j.ijedro.2020.100016
Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review*, *30*, 100314. https://doi.org/10.1016/j.edurev.2020.100314
Thieme, T. (2017). Die Staatsform Monarchie im 21. Jahrhundert – Typologie, Überblick und Vergleich. *Totalitarianism and Democracy*, *14*(2), 309–332. https://doi.org/10.13109/tode.2017.14.2.309
Thompson, A. (2021). *SpaceX launches four civilians into orbit on historic Inspiration4 flight | Space*. https://www.space.com/spacex-launches-inspiration4-civilian-orbital-mission
Tondeur, J., Aesaert, K., Prestridge, S., & Consuegra, E. (2018). A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies. *Computers & Education*, *122*, 32–42. https://doi.org/10.1016/j.compedu.2018.03.002
Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap! *Australasian Journal of Educational Technology*, *33*(3). https://doi.org/10.14742/ajet.3504
Tosuntaş, Ş. B., Karadağ, E., & Orhan, S. (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education*, *81*, 169–178. https://doi.org/10.1016/j.compedu.2014.10.009
Touraine, A. (1972). *Die postindustrielle Gesellschaft* (E. Moldenhauer & A. Touraine (Eds.); 1. Aufl.). Suhrkamp.
Tsai, M.-J., & Wu, A.-H. (2021). Visual search patterns, information selection strategies, and information anxiety for online information problem solving. *Computers & Education*,

172, 104236. https://doi.org/10.1016/j.compedu.2021.104236
Voas, J., & Laplante, P. (2017). Curriculum Considerations for the Internet of Things. *Computer*, *50*(1), 72–75. https://doi.org/10.1109/MC.2017.27
Vuorikari, R., Punie, Y., Carretero, S., & Van Den Brande, L. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens* (pp. 1-). Publications Office of the European Union. https://doi.org/10.2791/11517
Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). Computer science in K-12 school curricula of the 2lst century: Why, what and when? *Education and Information Technologies*, *22*(2), 445–468. https://doi.org/10.1007/s10639-016-9493-x
Weingartner, S. (2021). Digital omnivores? How digital media reinforce social inequalities in cultural consumption. *New Media & Society*, *23*(11), 3370–3390. https://doi.org/10.1177/1461444820957635
Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S. K. W. (2019). A systematic review of flipped classroom empirical evidence from different fields: what are the gaps and future trends? *On the Horizon*, *27*(2), 72–86. https://doi.org/10.1108/OTH-09-2018-0027
Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0
Zou, D., & Lambert, J. (2017). Feedback methods for student voice in the digital age. *British Journal of Educational Technology*, *48*(5), 1081–1091. https://doi.org/10.1111/bjet.12522
Zylka, J. (2018). *Digitale Schulentwicklung: Das Praxisbuch für Schulleitung und Steuergruppen*. Beltz.

2. Conceptual Foundation of the Thesis

Explicit definitions are required to develop empirical research questions from existing theoretical preliminary considerations and to incorporate the results of empirical works into theory. The following chapter presents a summary of the vocational school and training system (VET) in Germany, with a focus on the federal state of Baden-Württemberg. The description of the VET includes a short summary of the important stakeholders involved in the development of vocational schools. The discourse about school quality establishes the term as a key aspect of school development processes. The last section covers three models of school development and puts them in the context of digitalisation in vocational schools. The strengths and weaknesses of the different models are discussed, as well as their relevance for the further research process of this thesis.

2.1 Vocational Schools in Germany

Responsibility for the education system in Germany lies with the 16 German federal states, based on their sovereignty in matters of education and culture (Arends, 2017). This sovereignty is one of the reasons for the various types of schools in the heterogeneous education systems of the federal states. While this also includes the different vocational schools, the purpose of the vocational schools across Germany can be classified into three main objectives: the promotion of economic productivity, social integration and individual development (Euler, 2013).

Vocational schools in Germany are an important part of the German vocational and training system (VET) (Protsch & Solga, 2016), covering 324 recognised apprenticeships (BIBB, 2021). While training companies provide practical competencies and real-life conditions, vocational schools facilitate mostly theoretical knowledge to support students in completing their vocational training (Gessler, 2017). This dual principle, better known as the dual system, impacts the learning in the vocational context in several ways: the integration of theory (school) and practice (training company) links thinking and action, both from a systemic and a case-based perspective. As a result, the vocational students acquire skills that are relevant for individual businesses and training companies, but also for the professional branch and the labour market in its entirety (Euler, 2013). The shared responsibility of schools and training companies is reflected in the financing structure of the dual system. While the state covers the cost of the school-based components, the training companies pay for the firm-based component (Protsch & Solga, 2016).

In accordance with German federal law, attending vocational school up to the age of 18 is mandatory (Deissinger, 2015). As an extension of federal law, students in Baden-Württemberg who have an apprenticeship contract with a training company are required to attend a vocational school for at least three years, regardless of their age (Vossenkuhl, 2010). This time can be reduced if the students already attended a vocational school based on a different training programme. Compulsory school attendance can also directly be included into apprenticeship contracts (IHK Stuttgart, 2021).

The International Standard Classification of Education framework (ISCED) can be used to compare education systems across different countries and to view the VET from an international perspective. Two main cross-classification variables are used in the framework. The first, the level of education, ranges from early childhood education (level 1) to the doctoral level (level 9). The second variable is the field of education, for example science, health or law (OECD, 2015). The vocational schools are assigned to the ISCED levels 3 (upper secondary education) and 4 (post-secondary non-tertiary education/tertiary education) and aim at providing students with the necessary skills for those workplace environments which do not require a university degree. In Baden-Württemberg, up to 15 different (sub-)types of vocational schools can be included under the ISCED levels 3 and 4 (Delcker & Ifenthaler, 2020). The mean student age is 20 years and most students finish their vocational school training between the ages of 20 and 22 (BIBB, 2020). Six main types of vocational schools can be identified in Baden-Württemberg (statistik-bw, 2020), which concentrate on improving the current education level of students as related to their chosen career. For example, the so-called *Berufskolleg* (vocational college) can be attended by students wishing to acquire general skills and knowledge for the workplace. In the *Berufsschule* (part-time vocational school), the educational progress is strongly intertwined with practical vocational training (Deissinger, 2015), emphasising subject-specific knowledge in areas such as commerce, electronics, metallurgy or health. In the so-called *Berufsschulzentren* (vocational school centres), different types of vocational schools are combined into one organisational unit. The structure of these organisational units can vary between different vocational centres, based on the type of included vocational schools, the offered vocational training programmes or the disciplines taught.

The vast number of different types of school enables students and stakeholders to find the right type of school for their current level of knowledge and the skills they require. In addition, the school system values transition and permeability into the higher ISCED levels (Pleshakova, 2019). It is common practice to graduate from a vocational school, join the workforce for some time, and then to continue one's education by obtaining a university degree (Virdia & Schindler,

2019). On the other hand, especially low-achievers in the lower ISCED levels of the VET system are at risk of remaining stuck in qualification processes which do not effectively enhance their chances in the labour market (Brzinsky-Fay & Solga, 2016).

The basic structure of vocational teacher education in Germany is similar in all federal states. Teacher education for vocational schools occurs mainly in universities, where pre-service teachers are taught the theoretical background of at least school subjects. In the second phase of teacher education, a two-year teacher training combines practical class teaching in schools with a specialised programme at teacher-training institutions (Cortina & Thames, 2013). It is relatively common for teachers at vocational schools to have a practical background in the fields they teach, because of the subject-specific, workplace-related knowledge being provided at the vocational schools (Schelten, 2009). In many cases, they worked in their specific fields for some time before becoming teachers.

Terhart (2019) describes the system of initial teacher education in Germany as intensive and ambitious. On the other hand, the in-service teacher education is not well developed because it is mainly conducted through seminars and workshops, which might not meet the requirements for individual teacher development. Although teachers are obliged to participate in in-service teacher education programmes in all 16 federal states, there are no reliable statistics for the number and quality of seminars and workshops they attend (Grothus et al., 2018).

One problem facing the vocational school system is a lack of teachers. The reduction of teachers' social mobility is seen as one reason for the predicted lack of teachers in Germany (Terhart, 2019). The diminished mobility results from the different and complex school systems throughout the various federal states (Scheller, 2018). Federalism in the educational sector makes it difficult for the education systems to adapt to changing international standards, to include findings from educational science, or to react to technological innovation (K. K. Wong et al., 2018).

Five main stakeholder groups involved in school development can be derived from the considerations on vocational schools in Germany. The first is the students of the vocational schools. The second group consists of the teachers, who are the main facilitators of education within the schools. School leadership in the vocational schools is mainly in the hands of principals and their representatives. Depending on the size of the school and their specific organisational structure, leadership teams are implemented. Principals, representatives, leadership teams and school administration are all included in the 'school leadership' stakeholder group. Although many of the students in vocational schools are adults, parents can

be considered as the fourth group of stakeholders. Finally, training companies, as important cooperation partners and the second half of the dual system, form the fifth stakeholder group.

Other stakeholders in the development of vocational schools in the context of digitalisation can be identified, such as the federal administration, national policy makers and society as a whole. The following sections on school quality and school development explain the selection of the stakeholders and their role for vocational schools in greater detail.

2.2 School Quality

School quality is one of the most central terms in the field of school development (Kasper, 2017). When school development is understood as the development of single schools, school quality can be interpreted as the main objective of school development. The complex interactions and interdependencies have been identified in the theoretical discussion of school development. The OECD's short definition for the term 'quality' can be used as a starting point for the attempt at a classification: quality is the "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" (Glossary of Statistical Terms, 2006; International Organization for Standardization, 2015). Quality describes the state of an object in relation to the expectation of an individual towards this object. This relationship between individual and object is one of the key differences between quality and other descriptive terms, such as size, consistency of substance or temperature. An observed object is always bigger or smaller than another one, independently of the observer. A product is made out of a certain material, or its temperature can be objectively measured. In contrast, whether a product or service is of good or bad quality is highly dependent on the needs of the observer, for example a customer. Suppliers of products or services can consequently adjust the quality of the provided goods or facilities to match the quality expectations of the customers, based on their specific requirements.

While this definition of quality might be sufficient from an economic or technological viewpoint, it has many shortcomings when used for schools. First of all, it can be argued whether a school provides a product or a service (Harvey & Green, 1993). The competencies students possess after they finish schools could be interpreted as the outcome of a production process. After a student enters school, the teachers start to shape the existing knowledge and skills (the base product) through instruction, based on a curriculum. This curriculum serves as a blueprint for the desired competencies (the end product) a student should hold after graduation. Much like an assembly line, different teachers shape different parts of the student's

competencies through different subjects. But very unlike a real factory, the competencies which emerge from the educational processes differ between the students. This is, among other factors, due to the individual competencies which students possess at the start the schooling process, their individual interests and learning preferences, the variance in teachers' instructional methods and their influence on students' learning (Panayiotou et al., 2014).

The same arguments hold for the interpretation of education as a service. If two customers buy the same service, such as a data plan from an Internet provider or a ticket for public transportation, they will end up with the same service. They will have the same amount of data or will end up at the same bus stop. Even if a school provides the same service to all students, the outcome will always be based on the different individuals. The education as a product as well as the education as a service perspective both fail to integrate the interrelation between students and teachers and their individual characteristics, which play a major role in educational processes (Drachsler & Kirschner, 2012; Gagné et al., 2005). Scapp (2016) underlines another important aspect when he states that the educational process starts before a student enters school and continues even after the students leaves the school. The trend towards the commercialisation of schools and the transformation of education into a product, especially in the US, has been critically reviewed. Researchers have raised concerns about students' health and the risk of segregation between students or different socio-economic backgrounds (Molnar, 2003).

The second part of the OECD definition includes specified or implied needs. While the requirements for a product or a service can often be exactly specified, for example the storage capacity of a USB drive or the transmission speed of a cable connection, the requirements of different stakeholders in the school context are seldom precise or measurable. Not uncommonly, the needs of different stakeholders are even contrary or might be mutually exclusive. A prominent example for a quantifiable requirement which is difficult to measure is the quality of teaching as part of school quality (Goos & Salomons, 2017; Johansson & Myrberg, 2019; Kunter & Baumert, 2007; Praetorius et al., 2017). The number of students per class is an example for a requirement which is valued differently by different stakeholders. Research suggests that students benefit from smaller number of students per class (Blatchford et al., 2011; De Paola et al., 2013; Hattie, 2005, 2012). On the other hand, fewer students per class require a higher number of teachers, which results in rising labour costs for the school administration (Brewer et al., 1999; Reichardt, 2000).

The problematic specification of needs with regard to school quality carries over to the implied needs. Put simply, an implied need for school quality is the education of students, but

the question of the educational content and the educational methods which characterise a high quality school are constantly reshaped and re-evaluated by society (Lucey, 2003; Mitter, 1987) and cannot be predefined as implied needs.

The insufficient possibility to merge the ISO definition with the school context necessitates further considerations. The examples illustrate that school quality can be hierarchically embedded into the context of educational quality. Educational quality can be used as a term that describes features of quality which hold for all educational processes and institutions (Colby & Witt, 2000; Dib, 1988; Duvekot, 2015; Fennes & Otten, 2008; Vilcea, 2014), including the different types, forms and levels schools, from pre-primary to tertiary education (Lichtenberg, 2015; S. L. Schneider, 2021). Consequently, school quality can be used as a collective term for the validation of characteristics of the school as a single entity, such as teaching quality (Creemers et al., 2013; Kyriakides et al., 2013; Panayiotou et al., 2014; Scott, 2016; Stronge, 2018), infrastructural quality (J. M. P. Q. Delgado, 2016; Fu et al., 2021; Mishnick, 2017; Walbe Ornstein et al., 2009; Whitehead et al., 2013), professional school leadership (Barblett & Kirk, 2018; Mitchell et al., 2015; Pietsch et al., 2016) or interoperability.

Harvey and Green (2000) underline the multiperspectivity of school quality. They identify five interrelated perspectives which suit specific characteristics of school quality, namely Quality as Exception, Quality as Consistency, Quality as Expediency, Quality as Adequate Equivalent and Quality as Transformation. Quality as Exception (1) includes the concept of quality as exclusiveness, such as elite schools or universities. This traditional idea implies the notion that quality is connected to a certain form of uniqueness, which contradicts the possibility to gradually measure quality. Two additional concepts can be attributed to Quality as Exception through the introduction of standards. These standards can either be satisfied or surpassed. Surpassing standards as a quality characteristic for a school combines outstanding preconditions, such as school equipment or a preselection of students, and outstanding results. While this perception might contradict the intended equal support of all children (Gerecht, 2006), it can be also used as a legitimisation for the promotion of intellectually gifted students (Persson, 2010). Harvey and Green (2000) emphasise the inseparability of teaching standards and quality, as depicted by Church (1988), and the autonomy of educational institutions to determine individual standards. The institutions can therefore detach themselves from the concept of exclusiveness or uniqueness. Simultaneously, the possibility to compare different institutions based on standards is decreased.

Quality as Consistency (2) strongly focuses on processes and is related to the implied needs. From this perspective, a high-quality result is achieved through an educational process which

takes place flawlessly. The avoidance of mistakes during the process is supposed to be guaranteed by all members of the organisation. A transmission of these assumptions into educational organisations can be problematic, because a standardisation of educational processes is only feasible and reasonable to a certain degree. In addition, faultless learning and the denial of possible failure contradicts established learning theory (Metcalfe, 2017; Tulis et al., 2016).

Quality as Expediency (3) connects quality with consumer demand and the mandate of institutions. This facet has already briefly been touched on above, when the question of education as a product or service was raised. Harvey and Green acknowledge the fact that the needs of customers can change. Additionally, the needs of customers are mediated through "available technology and time" (Harvey & Green, 2000, p. 9). This mediation process can also be found in schools. Schools are hardly able to create the perfect educational product for every student. Instead, teachers much more often design educational instructions in a way that fits the interests, preferences and competencies of the majority of students in the classroom to facilitate their learning process (Lee & Hannafin, 2016; Walker & Baets, 2009; K. M. Wong, 2021). In contrast to the learner demand approach, the mandate of the institutions approach shifts the perspective to the self-imposed quality criteria of educational institutions. A school is of good quality when it meets its chosen goals. Programmes, methods and tools to control for and fulfil intra-institutional expediencies are covered by the terms educational quality control (Boyle & Bowden, 1997), quality assurance (ET2020 Working Group on Schools, 2018) or quality management (Crissien-Borrero et al., 2020; Sahney et al., 2008). A key issue for both the learner approach and the institution approach is the difficulty to identify the specific needs and expectations, because they are constantly changing as well as changing dependently of each other (Jacob & Wilder, 2010; Lobo & Gurney, 2014; Mori & Stracke, 2021; OECD, 2007; Poedjiastutie & Oliver, 2017; Sloat et al., 2018).

The fourth dimension of quality is Quality as Adequate Value. The presumed laws of economy form the basis of this approach. It is assumed that educational institutions strive for the most efficient use of funds to reach their goals when they are under the pressure of competition. The most efficient institution is the one with the highest quality. The allocation of funds for research projects (McNay, 2015; Tuffaha et al., 2019) or the public sector (Almarri & Boussabaine, 2017; Siemiatycki & Farooqi, 2012) are known examples for this perspective on quality. In Germany, especially universities and their affiliated research facilities are influenced by this approach through the introduction of international ranking systems (Çakır et al., 2015; Mahat, 2007; Vernon et al., 2018) or the introduction of the Excellence Initiative

(Imboden et al., 2016). Oelkers postulates an increasing competition between the schools on the K-12 level in Germany, which he traces back to parents' and students' freedom of choice with regard to school sites (Oelkers, 2007). Very similarly to the Quality as Expedience approach, the determination of what is considered as value in the context of education and how that value can be measured is problematic for this interpretation of the term quality.

Harvey and Green (2000) name Quality as Transformation as the fifth perspective on quality. They distinguish between the enhancing and the empowering of the participants in an educational process. During the process, value is added through the enhancement of "knowledge, skills and abilities of students" (Harvey & Green, 1993, p. 25), for example by the ability to speak a new language, refreshing knowledge to be updated to new industrial standards or the development of skills to operate a specific machine. An empowering transformation gives the participants control over the learning process. Participants can be involved in the process through student evaluation (Clayson & Haley, 2011; Spooren et al., 2013; Uttl et al., 2017), the provision of standards (Bleiberg, 2021; Gorlewski, 2013; Kulgemeyer & Schecker, 2014), the implementation of learning contracts (Anderson et al., 2014; Frank & Scharff, 2013; Ismail & Yusof, 2012) or the development of critical thinking skills (Brečka et al., 2022; Cáceres et al., 2020), amongst other things. Ditton and Müller (2011) summarise the different perspectives on school quality into the following definition:

> "School quality is a multidimensional construct whose definition requires consideration of the interdependence between contextual factors, educational factors and target group factors" (Ditton & Müller, 2011, p. 104).

Approaches to influence school quality can be identified as the main objective and purpose of school development (Reezigt & Creemers, 2005). The considerations of the different factors play an important role for the understanding of the varying perspectives on school development in terms of content, stakeholders and models.

2.3 School Development

The approaches to a definition of school quality provide the basis for a central contradistinction with regard to the term school development. The various interdependent factors which have been identified in the previous chapter can be allocated into two groups (Muftić, 2012; Silcox et al., 2012; Silcox & MacNeill, 2021). The first group consists of factors outside of the influence sphere of schools as single organisational entities or single educational institutions, such as state-wide curricula (Seleznyov & Czerniawksi, 2020), the allocation of public funding (Sugarman et al., 2016), or the availability of broadband infrastructure (Fox & Jones, 2019). From a hierarchical perspective, these factors are affected by a top-down approach: decision-makers from the outside re-shape educational institutions and processes (Rolff, 2019). The term school reform is used in this thesis to describe the top-down approaches that originate at a social and administrative level outside of single schools. From an international perspective, Hopmann (2003) identifies two major patterns, with which educational systems evaluate the impact of school reforms, namely product control and process control. Product control has traditionally been the dominant form in England as well as the USA (Linn, 2001) and focuses on external, centralized examinations such as the Scholastic Aptitude Tests or the American College Testing (Almerino et al., 2020; Croft & Beard, 2021; Nettles, 2019). While these output-based examinations might allow educational decisionmakers to compare the results of educational processes on a national scale, they are often criticised for "monitoring outcomes while leaving many other aspects of the educational system unregulated" (Lundahl et al., 2017, p. 56). In contrast, process control puts an input-based emphasis on the regulation of curricula and structured teacher education (Terhart, 2006, 2019; Waldow, 2014). The strong position of the teachers and the regulation of curricula have been identified as partially opposed principals, resulting in a situation in which changes in curricula seldomly find their way into the classroom (Hopmann, 2003).

Factors in the second group are much more likely to be developed within a single school as a single educational institution. A single school in this regard is characterised through specific location factors, also describable as the specific social, organisational and infrastructural construct it forms. Examples for factors in this group are school leadership (Barblett & Kirk, 2018; Bellin-Mularski et al., 2016; Mulford, 2003; Whitehead et al., 2013), on-going teacher training (Gudmundsdottir & Hatlevik, 2018; Roll & Ifenthaler, 2021; K. K. Wong, 2018), classroom activities (Dadds, 2020; Eickelmann et al., 2020; Spiteri & Chang Rundgren, 2020), cooperation (Aprea et al., 2020; Delcker & Ifenthaler, 2020; Jensvoll & Lekang, 2018; Jurkowski & Müller, 2018) and technological infrastructure (Gil-Flores et al., 2017). In contrast

to school reforms, the single school approach can be described as bottom-up (Rolff, 2019). The term school development is used in this thesis to refer to the approaches which aim to enhance school quality from within a single school, based on its specific location factors. Following the definition by Rolff (1995), school development is a continuous, intentional and planned transformation at all levels of a school, involving all stakeholders of the school.

Although a clear distinction is made between the term school reform and school development as part of the theoretical foundation of this thesis, the strong interrelationship between the constructs has to be explicitly emphasised. The reciprocation of top-down school reform and bottom-up school development always has to be part of the considerations, as a logical consequence of the reflections on school quality, independently of the theoretical or methodological research approaches taken. This shown clearly in the model of Ditton and Müller (2011): the teaching activities and especially the teaching content within the classroom (part of school development) are inseparable from the national school curricula and teacher training programmes at universities (part of school reform). Furthermore, the desired outcomes of the educational process, such as a successful professional qualification and the ability for social participation (part of school reform) is strongly intertwined with the culture of a school, teacher-student relationships and the teaching process (part of school development). Nonetheless, the differentiation between school reform and school development is a valuable starting point for the generation and classification of school development models and what they should contain.

Over the years, research has created a variety of school development models. These models of school development focus on different stakeholders or different development goals within the school, often considering different types of schools or educational levels. Some models only concentrate on a single aspect of school quality: the Talent Development Model of McPartland et al. (1998) specifically targets dropout rates as a development goal. Other development goals for school development models are diversity (Aguado et al., 2003; Carrington & Robinson, 2004), school climate (Rudasill et al., 2018; Salle et al., 2015), cooperation (Drossel & Eickelmann, 2017; Mylonakou Keke & Kekes, 2007; Sabry & Bruna, 2007) or on-going teacher education (Hana et al., 2013; H. T. M. Nguyen, 2017; Scantlebury et al., 2008), to name but a few. These models often establish their specific topic of interest as a theoretical as well as practical moderating or mediating variable to enhance the educational process within a school.

The research literature presents additional school development models which aim directly at the improvement of students' achievements (Caputo & Rastelli, 2014; Kuijpers et al., 2010; Teodorović, 2011) and the quality of teaching (Adolfsson & Håkansson, 2019; Mulford, 2003;

Sinakou et al., 2019). The terms quality of teaching, students' achievement, effective teaching, educational process or learning environment might have different nuanced meanings in all of the models mentioned above, but a common perspective on school development can be recognised in all of them: the focal point of school development models is the facilitation of students' subjects-specific and interdisciplinary competencies. The empirical analysis of school development models and their influence on the schools as organisations show varying results. A meta-analysis of whole-school development programmes shows very small to small effect sizes ($.09 < d < .15$) on students' achievements, with an increasing effect for schools with financially disadvantaged students (Borman et al., 2003). In school leadership effect studies, an average effect size of 0.06 of leadership on students' achievement has been found (Scheerens, 2012). Heck and Hallinger (2010) identify teachers' perception of school improvement capacity as an indicator for the achievement of students. Amongst other things, school improvement capacity contains continuous professional learning, open communication and the implementation of state curricular standards. Consequently, the perceived ability of teachers to shape their school in the form of collective leader ship, the motivation of teachers and the work settings of teachers have a significant effect on students' achievement as well (Leithwood & Mascall, 2008). Furthermore, the motivation of teachers can be described as part of teachers' well-being, which is strongly associated with the administrative and instructional management skills of principals (Liebowitz & Porter, 2019; Sebastian et al., 2019).

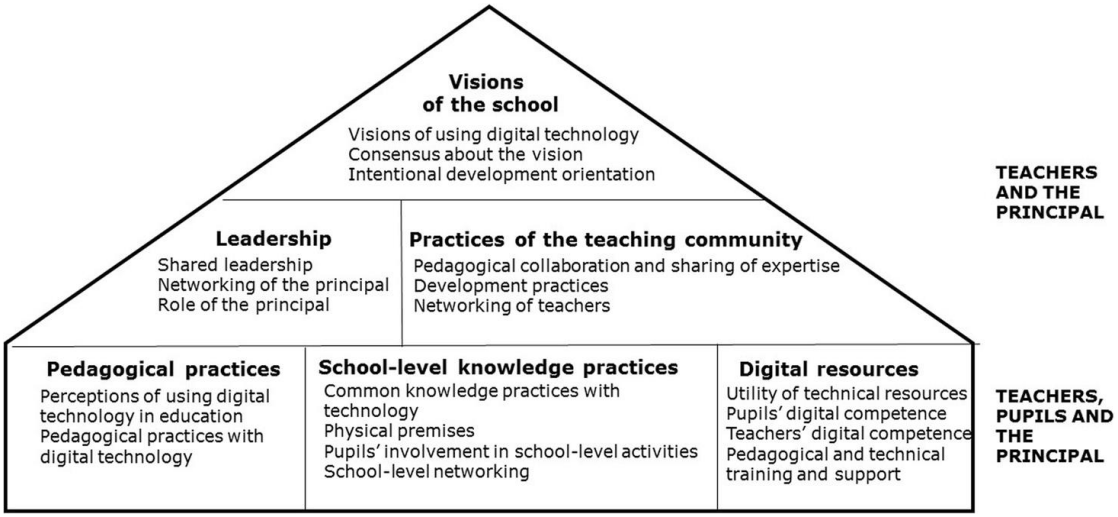
Based on these observations, three models of school development will be further examined. Their commonality lies in the expressed focus on the facilitation of students' subject-specific and interdisciplinary competencies in the context of digitalisation. Furthermore, these specific models, or parts of them, can be transferred to the characteristics of the vocational schools in Baden-Württemberg.

2.3.1 The Innovative Digital School Model

The innovative digital school (IDI school) model developed by Ilomäki and Lakkala differentiates between 6 different elements which are relevant for the development of schools in the context of digital technology. The model is shown in Figure 2-1 (Ilomäki & Lakkala, 2018).

Figure 2-1

The Innovative Digital School Model (Ilomäki & Lakkala, 2018)



The model places the agreed *vision of the school* for the use of digital technology on top of a multilevel structure (Twining et al., 2013). The vision, which is mainly created by the teachers and the principal, serves as a superstructure for the other elements. The other stakeholders can use the vision as a guidance and reflection point when they are reworking the lower-level elements. Below the vision of the school are the two elements *leadership* and *practices of the teaching community* (Harris, 2010; Leclerc et al., 2012). They include the networking practices of the principal and teachers, as well as the sharing of expertise, understanding of one's role and on-going professional training. The third level of elements adds the pupils as an additional group of stakeholders. The level consists of the *pedagogical practices* with technology (Donnelly et al., 2011), but also the perception of their usage in the classroom (Barnes & Kennewell, 2017; Ifenthaler & Schweinbenz, 2013, 2016) and education (Moreira et al., 2019; Ramírez-Rueda et al., 2021). *School-level knowledge practices* integrates the school as a building into the model (Cleveland & Fisher, 2014). This element also includes pupils' involvement with the school outside of classroom activities (Katsenou et al., 2015; M.-T. Wang & Degol, 2016; M.-T. Wang & Hofkens, 2020). The networking, collaboration and cooperation of the different stakeholders inside and outside of the school are part of the element as well

(Cornelissen et al., 2017; Santi et al., 2009). The last element in the IDI school model is *digital resources*. It combines the digital competencies of teachers (Caena & Redecker, 2019; Howard et al., 2020; Koehler et al., 2014; Mishra & Koehler, 2008; Redecker, 2017) and students (Hernández-Lara et al., 2019; Menon et al., 2019; Roll & Ifenthaler, 2020a), as well as pedagogical and technological support.

The comprehensive and detailed inclusion of dimensions of digitalisation in school development is one of the strengths of the model. This way, the monodimensional perspective on digitalisation in schools as merely digital teaching practices or digital infrastructure is dissolved. Another strength is the emphasis on a digital vision as a mutual educational and social belief, because it shapes a common goal for all stakeholders. In addition, the model assigns the six element groups to the principals, teachers and students as stakeholders of digitalisation in school development, with a strong focus on the principals as leaders of change (DuFour & Mattos, 2013). At first glance, recommendations and implications for real-life practice can be derived from the model, because the elements are segmented into concrete smaller parts, such as the role of the principal.

However, a more detailed inspection of the models reveals some problems and weaknesses in its adaptation in practice, especially with regard to vocational schools. The IDI school model fails to integrate some parts on a contextual level, such as state-wide curricula as an important influential factor of school development processes, like the pedagogical practices and the vision of the school. Another aspect that is missing from the model is the involvement of parents in school development (Erdener & Knoeppel, 2018; Sanders & Epstein, 2005). While the absence of parental influence in the model might be of limited relevance, the lacking cooperation with training companies is more problematic from the perspective of vocational schools (Delcker & Ifenthaler, 2020). This important feature of school development in vocational schools can be identified as a shortcoming in all the models which are presented in the theoretical part of this thesis.

2.3.2 The Three-Way Model of School Development

In the late 1990s, Rolff conceptualised his Three-Way Model of School Development (Rolff, 1998). The model was revised to integrate the impact of digitalisation on schools and school development, focusing on digital supported learning as the centre of school development processes (Rolff & Thünken, 2020). Rolff uses the term 'way' to describe three different dimensions of school development, comparable to the elements in the IDS school model presented earlier. These ways are Personnel Development (PD), Education Development (ED) and Organisation Development (OD).

Personnel Development includes the on-going qualification of school administration, teachers and school leaders and the establishment of a feedback culture (Edgerly et al., 2018; Keeley, 2020). Rolff implements practical methods and examples for PD into his description of the model, such as supervision (Brandon et al., 2018), class observations (Page, 2016) and the introduction of multi-disciplinary teams (Böhm-Kasper et al., 2016; Sonntag & Veber, 2014). He underlines the importance of PD as a combination of personnel management, staff training and employee facilitation (Buhren & Rolff, 2011). The facilitation of educators' digital competencies (Caena & Redecker, 2019; Redecker, 2017) is a major part of PD.

Education Development focuses on classroom activities and lists an increasing personalisation of methods, materials and pedagogical practices as important elements (Graham et al., 2019; Shemshack & Spector, 2020). This includes the strengthening of stakeholders' self-regulated learning competencies (Boekaerts & Corno, 2005; C.-M. Chen, 2009; Jossberger et al., 2010). Subject-specific and interdisciplinary learning is another part of ED in the Three-Way Model. Like Ilomäki and Lakkala (2018), Rolff and Thünken emphasise the need for the "consequent realization of inclusion" in the light of the growing heterogeneity of students (Rolff & Thünken, 2020, p. 11). The term 'learning culture' that is used in the dimension of ED can be linked to the already mentioned feedback culture: in combination with education climate and school agenda, the terms can be described as a form of vision for the school, in reference to Ilomäki & Lakkala's IDI model.

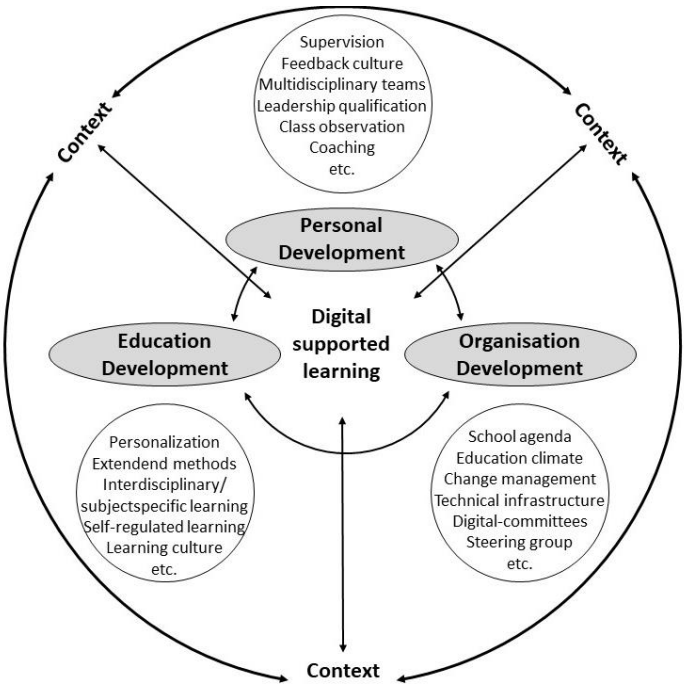
Organisation Development contains elements which influence the development of the school on an organisational level. OD is "open, goal oriented, [and] planned" (Rolff & Thünken, 2020, p. 10). This includes the implementation of change management at a school level (Beycioglu & Kondakci, 2020; Cummings et al., 2016; van der Bij et al., 2016) and considerations on the technical infrastructure of a school. Rolff recommends the creation of steering groups or digital committees as facilitators of Organisation Development. These groups, consisting of different stakeholders and including parents or training companies, pool

specific requirements, expertise and strategies for continuous change. The responsibility for school development in the context of digitalisation can therefore be shared between agents of change, and the stakeholders can take control of the development processes. Although the stakeholders of school development are not as clearly stated as in the IDI school model, they can be found in the different dimensions. Students are most present in Education Development, together with the teachers. In addition, the teachers can be located in Personnel Development, and they also play a role in Organisation Development. The greatest influence of school leaders can be ascribed to Organisation Development and Personnel Development.

An important strength of the three-way model is displayed in Figure 2-2. In contrast to Ilomäki and Lakkala, Rolff's model is arranged circularly. Consequently, the first impression of the model is less hierarchical. Rolff consistently highlights the equal importance of the three development dimensions throughout his remarks on the model (Rolff, 1998, 2019; Rolff & Thünken, 2020). The relationship is visualised by the arrows connecting the dimensions.

Figure 2-2

The Three-Way Model of School Development (Thünken & Rolff, 2020)



Although the model considers school development to refer to the development of a single school, the influence of the context of the school is integrated into the model. The impossibility to remove the contextual factors, as identified at the beginning of this section, is underlined. Through the outer circle, the single school gets embedded into the context. Consequently, the two-point arrows illustrate influences and interactions between the context and the single school

level, as well as the development dimensions.

The third strength of the model is its relative simplicity. Focusing on three central dimensions creates a clear first idea of what Rolff deems as important factors for school development in contrast to the six elements of the IDI model. In addition, methods, tool and approaches are added as examples into the model, simplifying and supporting a transition into practice.

Rolff and Thünken clearly reject the idea of further expanding the model, as has been done by other researchers (Eickelmann & Gerick, 2018; Zylka, 2018), stating that "cooperation is a centrepiece of organisation development; technical infrastructure etc. are added" (Rolff & Thünken, 2020, p. 13). However, reasons for those additions to the Three-Way Model can be critically discussed. The revision of the Three-Way Model with its new focus on digital supported learning might not fully cover the influence and the consequences of digitalisation on school development, especially with regard to vocational schools. The increasing complexity of the digital systems that can be utilised at schools require special administration and support, tasks which can hardly be fulfilled as part of school leaders' or teachers' day-to-day business. If stakeholders want to profit from the educational data that is being created in a school's digital infrastructure, they need the help of educational data specialists from within and outside the school (Papamitsiou et al., 2021; Sánchez-Cruzado et al., 2021).

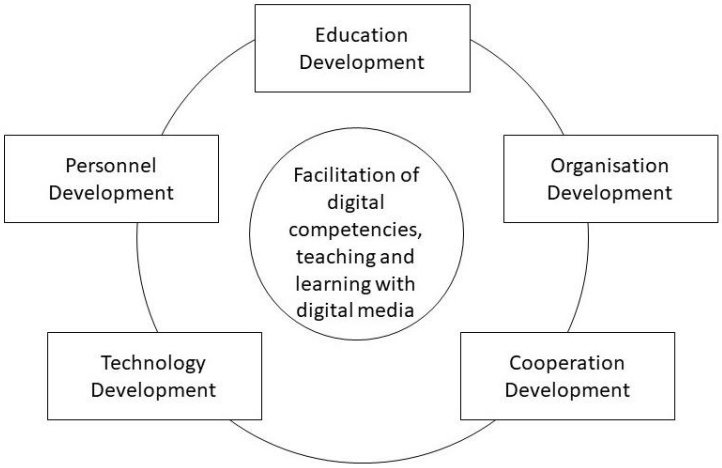
The cooperation between vocational schools and trainings companies is a major aspect of the dual vocational training system in Germany. This fact by itself could be used as an argument for the integration of Cooperation Development as a development dimension in the model as an extension for vocational schools. In consideration of digitalisation, the role of cooperation in vocational schools has the opportunity to chance drastically. Digitalisation is more than a tool that can be "integrated into the three Ways" (Rolff & Thünken, 2020, p. 13); it might also change fundamental beliefs regarding the social, temporal and content concepts of cooperation from the perspective of the stakeholders in vocational schools. This statement can be transferred to the model of Eickelmann and Gericke (2018), which is presented below.

2.3.3 The Five Dimensions of Digital School Development

The five dimensions of digital school development identified by Eickelmann and Gerick (Eickelmann & Gerick, 2018; Labusch et al., 2020) are based on Rolff's three-way model, adopting the basic circular structure and the three development dimensions of education, personnel and organisation. These three development dimensions stay relatively unchanged from the Three-Way Model in terms of their content and in terms of the interpretation of Education, Personnel or Organisation Development in schools. The model is shown in Figure 2-3.

Figure 2-3

The Five Dimensions of Digital School Development (Eickelmann & Gerick, 2018)



Two development dimensions are added to the model, namely Technology Development and Cooperation Development. More precisely, these two dimensions are extracted from the dimension Organisation Development, underlining their importance for digitalisation in school development. Initial arguments for this change in the structure of Rolff's model have been presented in the former paragraph and shall be picked up here.

The classification of technology on the same level as the other development dimensions recognises the influence of technology on those dimensions, as well as the conditional and reciprocal relationship between the dimensions. The model defines Technology Development (TD) as the development of a school's technological infrastructure from various perspectives. Initially, this includes working hardware, such as computers, tablets and printers (Ifenthaler & Schweinbenz, 2013, 2016; Montrieux et al., 2015; Pittman & Gaines, 2015; Villalobos, 2016). The provision of a broadband Internet connection (Underwood et al., 2005) and an efficient

server structure in conjunction with a local network falls under TD as well (Gil-Flores et al., 2017; Jarvis, 2018). Software is the second major component of TD, including learning management systems (De Smet et al., 2012; Lochner et al., 2015; Turnbull et al., 2019), operating systems and administrative tools. Additionally, the hardware also has to be equipped with appropriate software to facilitate teaching, learning and communication between the stakeholders (Bottino, 2020; Lytvyn et al., 2020; Vannucci & Coll, 2010). Specific tools of the vocational school, such as the so-called *Lernfabriken* (learning factories), are part of Technology Development (Abele et al., 2017).

One of the central questions of Technology Development is the method with which students should be provided with the necessary hardware and software. Two general approaches can be identified: Bring Your Own Device (BYOD) allows students to bring their privately owned and purchased digital devices to school (Hung, 2017; Maher & Twining, 2017). In One-To-One (OTO) programmes the school provides the devices, such as smartphones, tablets or laptops. Kay and Schellenberg (2019) identify the major advantages and disadvantages of each approach. BYOD enables students to fully customise their devices in terms of hardware configuration and UI settings, and devices are specifically chosen by the students to their preferences. As a consequence, students are familiar with the devices and can therefore use them more effortlessly. They can also use the same devices in school and at home. The BYOD approach is less costly for the schools, especially with regard to acquisition and maintenance costs. On the other hand, didactical planning and instructional design that takes the various devices into account is a real challenge for teachers. This is not the case if all students work with the same device. In the OTO approach, the school takes on the financial responsibility for the devices. This way, equity issues between students of different socio-economic backgrounds are avoided (A. Delgado et al., 2015). Therefore, the approach for the provision of digital devices that a school chooses carries deep implications for all development dimensions.

The technical and didactical support stakeholders receive within the school is also located in Technology Development. The importance of efficient support systems intensifies with the increasing presence of ICT. Zylka (2018) promotes the introduction of educational support specialists who are able to close the gap between didactical requirements and technical prerequisites. These specialists could be employed teachers who only use a very limited amount of their working hours for actual teaching and rather focus on the technology development within a school, combining the roles of network specialist, hardware technician and instructional designer. The introduction of AI technology in the context of education (U. Schmid et al., 2021), which in return requires educational data competency (Papamitsiou et al.,

2021), is another reason which might lead to the emergence of such new workspaces.

The scope of the different components which fall under under Technology Development highlights the role of the dimension for digitalisation in school development. It seems reasonable to follow the theoretical approach of Eickelmann and Gericke and, in contrast to the statements of Rolff and Thünken, to add Technology Development as a dimension to the model. If the different dimensions (or ways) are supposed to carry equal weight within the theoretical model and the underlying assumption of successful school development is based on a balance between the different parts, the extraction of technology from Organisation Development becomes a necessary step. Otherwise, the increasing significance of ICT for school development would lead to disparity within the model through the expansion of Organisational Development.

This argument can also be made for the demerger of Cooperation Development as a separate dimension within the model. On the one hand, ICT enables improved modes of cooperation, such as school-internal wikis for shared knowledge management (Zylka, 2018), interdisciplinary exchange between teachers (Basu Ray & Maitra, 2017; I. K. R. Hatlevik & Hatlevik, 2018) and collaboration at the school, state or international level (Kelchtermans et al., 2018; Romeu et al., 2016). On the other hand, these methods can be interpreted as digitalised versions of methods which are already "at the heart of Organisation Development" (Rolff & Thünken, 2020, p. 13), implying that Cooperation Development is not required in the model. Two decisive issues are undervalued in their consideration. The first issue is valid for all forms of schools, while the second issue relates specifically to vocational schools. With regard to the technological advancements, the traditional, paper-based forms of cooperation and collaboration are transformed and expanded, which has already briefly been mentioned with the dimension Technology Development. Interconnected systems allow the automated exchange of data to improve learning environments (U. Schmid et al., 2021). The exchange can happen within the different development dimensions and the different stakeholders of a school. As an example, a class-room management system can help teachers and the administration to keep track of the attendance of students. Rather than manually informing the administration about a student who is constantly missing classes, automated processes can directly report critical attendance rates. This might trigger a special intervention team, which can help to get the student back into the classroom.

But the exchange of data and information is not limited to human-to-human interaction. It can also be understood as the collaboration of data sources, such as databases, algorithms and networks, which is a key feature of Learning Analytics systems (Ifenthaler, 2015; Ifenthaler et

al., 2020; Lemay et al., 2021; Seufert et al., 2021). It is important to think about these systems as part of the structure of an educational institution to successfully use their potential in the facilitation of students' self-directed learning competencies (Schumacher, 2019) or intelligent tutoring systems (U. Schmid et al., 2021). These systems will probably play an increasingly important role in the future of school development on all levels and in all forms of schools. Categorising the collaboration of data sources into the dimension of Organisation Development seems to push the boundaries of the Three-Way Model.

The second issue which speaks in favour of the creation of the Cooperation Development dimension is specific to the vocational schools in Germany. As an integral part of the dual system, the cooperation with training companies is extremely significant for the facilitation of students' competencies (Aprea et al., 2020; S. Weber & Achtenhagen, 2017). Digitalisation paves the way for new forms of cooperation between these stakeholders (Freiling & Mozer, 2020): teachers can use simulations to teach aspects of machines which are available at training companies, but not at the vocational schools. Another possibility is the design of project-based learning scenarios, where students solve real-world workplace-related tasks like programming guided by their teachers. Especially smaller and medium-sized companies can profit from a school's infrastructure with regard to the development of interdisciplinary competencies of their apprentices, such as data security, problem-solving and self-directed learning. Learning factories can play an important role in the facilitation of these interdisciplinary competencies when students with different occupational backgrounds work closely together on group projects (Faßhauer et al., 2021; Roll & Ifenthaler, 2020a). The strengths and weaknesses of the different places of learning have to be evaluated thoroughly to identify possible synergies between them (Freiling & Mozer, 2020). Consequently, the stakeholders in the vocational educational training system are required to improve their collaboration and cooperation strategies to take advantage of the described potentials of digitalisation (Berisha-Gawlowski et al., 2020; Freiling & Mozer, 2020; Harteis, 2018).

The Five Dimensions of Digital School Development emphasise the interdependency of the different development dimensions: the digital competencies of students can only be facilitated if a school can provide the necessary technological infrastructure (TD). Including this technology into the classroom (ED) requires competent teachers who take part in further training programmes to expand their own digital competencies (PD). Instructional design at vocational schools is meaningless unless it is connected to workplace-related scenarios (CD). All processes are sustained by shared beliefs and regulations regarding digitalisation processes within the school as an institution (OD). If one of the five dimensions is removed from the

system, the facilitation of students' digital competencies as well as teaching and learning with digital media at vocational schools can most likely not be achieved.

While all three of the presented models have their specific advantages and disadvantages as a theoretical basis for an empirical research approach of digitalisation in the context of education, the Five Dimensions model seems to be the one that is most suited for the vocational schools in the German dual system. Although the model was not specially designed for the vocational education training system, the specific characteristics of vocational schools can be outlined with the five dimensions. The model highlights the cooperation between the different stakeholders and the learning places within and outside of the school. Additionally, technology as an integral part of digitalisation in the context of workplace-related competencies is prioritised at the same level as the other dimensions of school development. Therefore, in this thesis, the model proposed by Eickelmann and Gerick (2018) is used as the main conceptual foundation for the further research process.

2.4 Summary

The outlined considerations towards digitalisation (Euler & Wilbers, 2018; Freiling & Mozer, 2020; Guggemos & Seufert, 2021), school quality (Ditton & Müller, 2011; Harvey & Askling, 2003) and school development (Eickelmann & Gerick, 2018; Ilomäki & Lakkala, 2018; Rolff & Thünken, 2020) emphasise the need for a multi-perspective research approach. The individual schools are characterised as an important facilitator for improvement and change within the educational system. Therefore, the empirical investigation integrates the context of the vocational education and training system, the individual schools as well as the stakeholders of the vocational schools. Quantitative methods are being used to identify shared structures and characteristics on the school level, while qualitative methods are applied to shed a light on the perceived implications of digitalisation in vocational schools on the stakeholder level. The results of the quantitative and qualitative research processes are being triangulated and combined into a concluding interpretation. On that basis, practical implications for the further transformation of vocational schools and the integration of digital tools and methods into daily practice are being derived.

2.5 References

Abele, E., Chryssolouris, G., Sihn, W., Metternich, J., ElMaraghy, H., Seliger, G., Sivard, G., ElMaraghy, W., Hummel, V., Tisch, M., & Seifermann, S. (2017). Learning factories for future oriented research and education in manufacturing. *CIRP Annals*, *66*(2), 803–826. https://doi.org/10.1016/j.cirp.2017.05.005

Adolfsson, C.-H., & Håkansson, J. (2019). Evaluating teacher and school development by learning capital: A conceptual contribution to a fundamental problem. *Improving Schools*, *22*(2), 130–143. https://doi.org/10.1177/1365480218784039

Aguado, T., Ballesteros, B., & Malik, B. (2003). Cultural Diversity and School Equity. A Model to Evaluate and Develop Educational Practices in Multicultural Education Contexts. *Equity & Excellence in Education*, *36*(1), 50–63. https://doi.org/10.1080/10665680303500

Almarri, K., & Boussabaine, H. (2017). The Influence of Critical Success Factors on Value for Money Viability Analysis in Public–Private Partnership Projects. *Project Management Journal*, *48*(4), 93–106. https://doi.org/10.1177/875697281704800408

Almerino, P. M., Ocampo, L. A., Abellana, D. P. M., Almerino, J. G. F., Mamites, I. O., Pinili, L. C., Tenerife, J. J. L., Sitoy, R. E., Abelgas, L. J., & Peteros, E. D. (2020). Evaluating the Academic Performance of K-12 Students in the Philippines: A Standardized Evaluation Approach. *Education Research International*, *2020*, 1–8. https://doi.org/10.1155/2020/8877712

Anderson, G., Boud, D., & Sampson, J. (2014). *Learning Contracts*. Routledge. https://doi.org/10.4324/9781315041766

Aprea, C., Sappa, V., & Tenberg, R. (2020). *Konnektivität und lernortintegrierte Kompetenzentwicklung in der beruflichen Bildung / Connectivity and Integrative Competence Development in Vocational and Professional Education and Training (VET/PET)*. Franz Steiner Verlag.

Arends, H. (2017). Equal Living Conditions vs. Cultural Sovereignty? Federalism Reform, Educational Poverty and Spatial Inequalities in Germany. *Publius: The Journal of Federalism*, *47*(4), 673–706. https://doi.org/10.1093/publius/pjw042

Barblett, L., & Kirk, G. (2018). National Quality Standard in Schools: Leadership Enabling Power and Agency. *Australasian Journal of Early Childhood*, *43*(3), 43–51. https://doi.org/10.23965/AJEC.43.3.05

Barnes, J., & Kennewell, S. (2017). Investigating teacher perceptions of teaching ICT in Wales. *Education and Information Technologies*, *22*(5), 2485–2497. https://doi.org/10.1007/s10639-016-9549-y

Basu Ray, J., & Maitra, S. (2017). Collaborative Interdisciplinary Teaching and Learning Across Borders, Using Mobile Technologies and Smart Devices. *2017 5th IEEE International Conference on MOOCs, Innovation and Technology in Education (MITE)*, 77–82. https://doi.org/10.1109/MITE.2017.00020

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-Service Teachers' Perceptions of School Development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Berisha-Gawlowski, A., Caruso, C., Goller, G., & Harteis, C. (2020). Auswirkungen der Digitalisierung industrieller Arbeit auf die berufliche und allgemeine Bildung. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56). wbv Media GmbH & Co. KG.

Beycioglu, K., & Kondakci, Y. (2020). Organizational Change in Schools. *ECNU Review of Education*, 209653112093217. https://doi.org/10.1177/2096531120932177

BIBB. (2020). *Datenreport zum Berufsbildungsbericht 2020. Informationen und Analysen zur Entwicklung der beruflichen Bildung*. Bundesinstitut für Berufsbildung. https://www.bibb.de/dokumente/pdf/bibb_datenreport_2020.pdf

BIBB. (2021). *Verzeichniss der anerkannten Ausbildungsberufe 2021*. https://www.bibb.de/dienst/veroeffentlichungen/de/publication/download/17368

Blatchford, P., Bassett, P., & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher–pupil interaction: Differences in relation to pupil prior attainment and primary vs. secondary schools. *Learning and Instruction*, *21*(6), 715–730. https://doi.org/10.1016/j.learninstruc.2011.04.001

Bleiberg, J. (2021). Does the Common Core Have a Common Effect? An Exploration of Effects on Academically Vulnerable Students. *AERA Open*, *7*, 233285842110107. https://doi.org/10.1177/23328584211010727

Boekaerts, M., & Corno, L. (2005). Self-Regulation in the Classroom: A Perspective on Assessment and Intervention. *Applied Psychology*, *54*(2), 199–231. https://doi.org/10.1111/j.1464-0597.2005.00205.x

Böhm-Kasper, O., Dizinger, V., & Gausling, P. (2016). Multiprofessional Collaboration Between Teachers and Other Educational Staff at German All-day Schools as a Characteristic of Today's Professionalism. *International Journal for Research on Extended Education*, *4*(1), 29–51. https://doi.org/10.3224/ijree.v4i1.24774

Borman, G. D., Hewes, G. M., Overman, L. T., & Brown, S. (2003). Comprehensive School Reform and Achievement: A Meta-Analysis. *Review of Educational Research*, *73*(2), 125–230. https://doi.org/10.3102/00346543073002125

Bottino, R. (2020). Schools and the digital challenge: Evolution and perspectives. *Education and Information Technologies*, *25*(3), 2241–2259. https://doi.org/10.1007/s10639-019-10061-x

Boyle, P., & Bowden, J. A. (1997). Educational Quality Assurance in Universities: an enhanced model. *Assessment & Evaluation in Higher Education*, *22*(2), 111–121. https://doi.org/10.1080/0260293970220202

Brandon, J., Hollweck, T., Donlevy, J. K., & Whalen, C. (2018). Teacher supervision and evaluation challenges: Canadian perspectives on overall instructional leadership. *Teachers and Teaching*, *24*(3), 263–280. https://doi.org/10.1080/13540602.2018.1425678

Brečka, P., Valentová, M., & Lančarič, D. (2022). The implementation of critical thinking development strategies into technology education: The evidence from Slovakia. *Teaching and Teacher Education*, *109*, 103555. https://doi.org/10.1016/j.tate.2021.103555

Brewer, D. J., Krop, C., Gill, B. P., & Reichardt, R. (1999). Estimating the Cost of National Class Size Reductions Under Different Policy Alternatives. *Educational Evaluation and Policy Analysis*, *21*(2), 179–192. https://doi.org/10.3102/01623737021002179

Brzinsky-Fay, C., & Solga, H. (2016). Compressed, postponed, or disadvantaged? School-to-work-transition patterns and early occupational attainment in West Germany. *Research in Social Stratification and Mobility*, *46*, 21–36. https://doi.org/10.1016/j.rssm.2016.01.004

Buhren, C. G., & Rolff, H.-G. (2011). *Personalmanagement für die Schule: ein Handbuch für Schulleitung und Kollegium*. Beltz.

Cáceres, M., Nussbaum, M., & Ortiz, J. (2020). Integrating critical thinking into the classroom: A teacher's perspective. *Thinking Skills and Creativity*, *37*, 100674. https://doi.org/10.1016/j.tsc.2020.100674

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369.

https://doi.org/10.1111/ejed.12345
Çakır, M. P., Acartürk, C., Alaşehir, O., & Çilingir, C. (2015). A comparative analysis of global and national university ranking systems. *Scientometrics*, *103*(3), 813–848. https://doi.org/10.1007/s11192-015-1586-6
Caputo, A., & Rastelli, V. (2014). School improvement plans and student achievement: Preliminary evidence from the Quality and Merit Project in Italy. *Improving Schools*, *17*(1), 72–98. https://doi.org/10.1177/1365480213515800
Carrington, S., & Robinson, R. (2004). A case study of inclusive school development: a journey of learning. *International Journal of Inclusive Education*, *8*(2), 141–153. https://doi.org/10.1080/1360311032000158024
Chen, C.-M. (2009). Personalized E-learning system with self-regulated learning assisted mechanisms for promoting learning performance. *Expert Systems with Applications*, *36*(5), 8816–8829. https://doi.org/10.1016/j.eswa.2008.11.026
Church, C. H. (1988). The qualities of validation. *Studies in Higher Education*, *13*(1), 27–43. https://doi.org/10.1080/03075078812331377945
Clayson, D. E., & Haley, D. A. (2011). Are Students Telling Us the Truth? A Critical Look at the Student Evaluation of Teaching. *Marketing Education Review*, *21*(2), 101–112. https://doi.org/10.2753/MER1052-8008210201
Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: a critical review of the literature. *Learning Environments Research*, *17*(1), 1–28. https://doi.org/10.1007/s10984-013-9149-3
Colby, J., & Witt, M. (2000). *Defining Quality in Education*. UNICEF. https://www.right-to-education.org/sites/right-to-education.org/files/resource-attachments/UNICEF_Defining_Quality_Education_2000.PDF
Cornelissen, F., McLellan, R. W., & Schofield, J. (2017). Fostering research engagement in partnership schools: networking and value creation. *Oxford Review of Education*, *43*(6), 695–717. https://doi.org/10.1080/03054985.2017.1316251
Cortina, K. S., & Thames, M. H. (2013). Teacher Education in Germany. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers: Results from the COACTIV Project* (pp. 49–62). Springer US. https://doi.org/10.1007/978-1-4614-5149-5_3
Creemers, B., Kyriakides, L., & Antoniou, P. (2013). Establishing the Field of Teacher Effectiveness Research: Moving from Investigating Personal Characteristics of Teachers to Understanding Effective Teaching Practices. In *Teacher Professional Development for Improving Quality of Teaching* (pp. 65–79). Springer Netherlands. https://doi.org/10.1007/978-94-007-5207-8_5
Crissien-Borrero, T.-J., Velásquez-Rodriguez, J., Neira-Rodado, D., & Turizo-Martínez, L.-G. (2020). Measuring the quality of management in education. Review article. *El Profesional de La Información*, *28*(6). https://doi.org/10.3145/epi.2019.nov.04
Croft, M., & Beard, J. J. (2021). Development and Evolution of the SAT and ACT. In B. E. Clauser & M. B. Bunch (Eds.), *The History of Educational Measurement* (1st ed., p. 20). Routledge. https://doi.org/https://doi.org/10.4324/9780367815318
Cummings, S., Bridgman, T., & Brown, K. G. (2016). Unfreezing change as three steps: Rethinking Kurt Lewin's legacy for change management. *Human Relations*, *69*(1), 33–60. https://doi.org/10.1177/0018726715577707
Dadds, M. (2020). *Passionate Enquiry and School Development*. Routledge. https://doi.org/10.4324/9781003059073
De Paola, M., Ponzo, M., & Scoppa, V. (2013). Class size effects on student achievement: heterogeneity across abilities and fields. *Education Economics*, *21*(2), 135–153. https://doi.org/10.1080/09645292.2010.511811

De Smet, C., Bourgonjon, J., De Wever, B., Schellens, T., & Valcke, M. (2012). Researching instructional use and the technology acceptation of learning management systems by secondary school teachers. *Computers & Education*, *58*(2), 688–696. https://doi.org/10.1016/j.compedu.2011.09.013

Deissinger, T. (2015). The German dual vocational education and training system as 'good practice'? *Local Economy: The Journal of the Local Economy Policy Unit*, *30*(5), 557–567. https://doi.org/10.1177/0269094215589311

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826

Delgado, A., Wardlow, L., O'malley, K. J., & Mcknight, K. M. (2015). *Educational Technology: A Review of the Integration, Resources, and Effectiveness of Technology in K-12 Classrooms.*

Delgado, J. M. P. Q. (2016). Indoor Environmental Quality of School Buildings. *Defect and Diffusion Forum*, *369*, 24–29. https://doi.org/10.4028/www.scientific.net/DDF.369.24

Dib, C. Z. (1988). Formal, non-formal and informal education: concepts/applicability. *AIP Conference Proceedings*, *173*, 300–315. https://doi.org/10.1063/1.37526

Ditton, H., & Müller, A. (2011). Schulqualität. In H. Reinders, H. Ditton, C. Gräsel, & B. Gniewosz (Eds.), *Empirische Bildungsforschung: Gegenstandsbereiche* (pp. 99–111). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93021-3_9

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, *57*(2), 1469–1483. https://doi.org/10.1016/j.compedu.2011.02.014

Drachsler, H., & Kirschner, P. A. (2012). Learner Characteristics. In *Encyclopedia of the Sciences of Learning* (pp. 1743–1745). Springer US. https://doi.org/10.1007/978-1-4419-1428-6_347

Drossel, K., & Eickelmann, B. (2017). Teachers' participation in professional development concerning the implementation of new technologies in class: a latent class analysis of teachers and the relationship with the use of computers, ICT self-efficacy and emphasis on teaching ICT skills. *Large-Scale Assessments in Education*, *5*(1), 19. https://doi.org/10.1186/s40536-017-0053-7

DuFour, R., & Mattos, M. (2013). How do principals really improve schools? *Educational Leadership*, *70*, 34–40.

Duvekot, R. (2015). *Netherlands country report - How informal and non-formal learning is recognised in Europe: Bertelsmann Stiftung*. https://www.bertelsmann-stiftung.de/en/publications/publication/did/how-informal-and-non-formal-learning-is-recognised-in-europe-3

Edgerly, H., Wilcox, J., & Easter, J. (2018). Creating a Positive Feedback Culture: Eight Practical Principles to Improve Students' Learning. *Science Scope*, *041*(05). https://doi.org/10.2505/4/ss18_041_05_43

Eickelmann, B., Drossel, K., & Heldt, M. (2020). Vorteile digital fortgeschrittener Schulen in der Pandemie-Zeit. Ergebnisse einer repräsentativen Lehrkräftebefragung. *Schulmanagement. Fachzeitschrift Für Schul- Und Unterrichtsentwicklung*, *51*(3), 28–31.

Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen*, *29*(4), 111–115.

Erdener, M. A., & Knoeppel, R. C. (2018). Parents' Perceptions of Their Involvement in Schooling. *International Journal of Research in Education and Science*, 1–13. https://doi.org/10.21890/ijres.369197

ET2020 Working Group on Schools. (2018). *Quality assurance for school development - Guiding principles for policy development on quality assurance in school education*. European Commision. https://www.schooleducationgateway.eu/downloads/Governance/2018-wgs2-quality-assurance-school_en.pdf

Euler, D. (2013). *Germany´s dual vocational training system - a model for other countries?* Bertelsmann Stiftung. https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Bibliothek/Doi_Publikationen/GP_Germanys_dual_vocational_training_system.pdf

Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1

Faßhauer, U., Windelband, L., Mutzke, B., & Harm, S. (2021). Lernfabriken an beruflichen Schulen als Gegenstand fachdidaktischer Professionalisierung – Entwicklung von standortübergreifenden Medienpaketen im beruflichen Lehramtsstudium. *Berufs- Und Wirtschaftspädagogik Online, 40*. https://www.bwpat.de/ausgabe40/fasshauer_etal_bwpat40.pdf

Fennes, H., & Otten, H. (2008). *Quality in non-formal education and training in the field of European youth work*.

Fox, C., & Jones, R. (2019). *State K-12 Broadband Leadership 2019: Driving Connectivity, Access and Student Success*. https://files.eric.ed.gov/fulltext/ED594505.pdf

Frank, T. E., & Scharff, L. F. V. (2013). Learning Contracts in Undergraduate Courses: Impacts on Student Behaviors and Academic Performance. *Journal of the Scholarship of Teaching and Learning*, *13*, 36–53.

Freiling, T., & Mozer, P. (2020). Digitale Lernformen unterstützen die Lernortkooperation in der beruflichen Bildung! In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf: Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 139–152). wbv Media GmbH & Co. KG.

Fu, Y. C., Quetzal, A. S., & Teo, E. J. (2021). The Development of Institutional Research and Its Implications for University Governance in Taiwan. In A. Y.-C. Hou, T. Chiang, & S.-J. Chan (Eds.), *Higher Education in Taiwan: Global, Political and Social Challenges and Future Trends* (pp. 233–248). Springer Singapore. https://doi.org/10.1007/978-981-15-4554-2_13

Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of Instructional Design*. Thomson/Wadsworth.

Gerecht, M. (2006). *Schulqualität und Schulevaluation. Schulspezifische Rückmeldung auf der Basis der pädagogischen Entwicklungsbilanzen.* DIPF. https://nbn-resolving.org/urn:nbn:de:0111-opus-31203

Gessler, M. (2017). The Lack of Collaboration Between Companies and Schools in the German Dual Apprenticeship System: Historical Background and Recent Data. *International Journal for Research in Vocational Education and Training*, *4*(2), 164–195. https://doi.org/10.13152/IJRVET.4.2.4

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Glossary of Statistical Terms. (2006). *Quality - ISO*. https://stats.oecd.org/glossary/detail.asp?ID=5150

Goos, M., & Salomons, A. (2017). Measuring teaching quality in higher education: assessing selection bias in course evaluations. *Research in Higher Education*, *58*(4), 341–364. https://doi.org/10.1007/s11162-016-9429-8

Gorlewski, J. (2013). Research for the Classroom: Standards, Standardization, and Student Learning. *The English Journal*, *102*(5), 84–88.

Graham, C., Borup, J., Short, C., & Archambault, L. (2019). *K-12 Blended Teaching: A Guide to Personalized Learning and Online Integration*.

Grothus, I., Renz, M., Rzejak, D., Schlamp, K., Daschner, P., Imschweiler, V., Lipowsky, F., Schoof-Wetzig, D., & Steffens, U. (2018). *Recherchen für eine Bestandsaufnahme der Lehrkräftefortbildung in Deutschland DVLfB*. Deutscher Verein zur Förderung der Lehrerinnen und Lehrerfortbildung e.V. (DVLfB). http://www.lehrerinnenfortbildung.de

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: implications for teacher education. *European Journal of Teacher Education*, *41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*, 1–11. https://doi.org/10.1016/j.chb.2020.106613

Hana, G. M., Hansen, R., Johnsen-Høines, M., Lilland, I. E., & Rangnes, T. E. (2013). *Learning Conversation in Mathematics Practice School–Industry Partnerships as Arena for Teacher Education* (pp. 147–155). https://doi.org/10.1007/978-3-319-02270-3_13

Harris, A. (2010). Leading system transformation. *School Leadership & Management*, *30*(3), 197–207. https://doi.org/10.1080/13632434.2010.494080

Harteis, C. (2018). *Machines, Change and Work: An Educational View on the Digitalization of Work* (pp. 1–10). https://doi.org/10.1007/978-3-319-63257-5_1

Harvey, L., & Askling, B. (2003). Quality in Higher Education. In *The Dialogue between Higher Education Research and Practice* (pp. 69–83). Springer Netherlands. https://doi.org/10.1007/978-0-306-48368-4_6

Harvey, L., & Green, D. (1993). Defining Quality. *Assessment & Evaluation in Higher Education*, *18*(1), 9–34. https://doi.org/10.1080/0260293930180102

Harvey, L., & Green, D. (2000). Qualität definieren. Fünf unterschiedliche Ansätze. In E. Terhart (Ed.), *Qualität und Qualitätssicherung im Bildungsbereich; Schule, Sozialpädagogik, Hochschule.* (pp. 17–39). Beltz.

Hatlevik, I. K. R., & Hatlevik, O. E. (2018). Examining the Relationship Between Teachers' ICT Self-Efficacy for Educational Purposes, Collegial Collaboration, Lack of Facilitation and the Use of ICT in Teaching Practice. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00935

Hattie, J. (2005). The paradox of reducing class size and improving learning outcomes. *International Journal of Educational Research*, *43*(6), 387–425. https://doi.org/10.1016/j.ijer.2006.07.002

Hattie, J. (2012). *Visible Learning for Teachers*. Routledge. https://doi.org/10.4324/9780203181522

Heck, R. H., & Hallinger, P. (2010). Testing a longitudinal model of distributed leadership effects on school improvement. *The Leadership Quarterly*, *21*(5), 867–885. https://doi.org/10.1016/j.leaqua.2010.07.013

Hernández-Lara, A. B., Serradell-López, E., & Fitó-Bertran, À. (2019). Students' perception of the impact of competences on learning: An analysis with business simulations. *Computers in Human Behavior*, *101*, 311–319. https://doi.org/https://doi.org/10.1016/j.chb.2019.07.023

Hopmann, S. T. (2003). On the evaluation of curriculum reforms. *Journal of Curriculum Studies*, *35*(4), 459–478. https://doi.org/10.1080/00220270305520

Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2020). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 1–18. https://doi.org/10.1080/1475939X.2020.1839543

Hung, H.-T. (2017). Clickers in the flipped classroom: bring your own device (BYOD) to

promote student learning. *Interactive Learning Environments*, *25*(8), 983–995. https://doi.org/10.1080/10494820.2016.1240090

Ifenthaler, D. (2015). Learning Analytics. In *The SAGE Encyclopedia of Educational Technology* (pp. 447–451). SAGE Publications, Inc. https://doi.org/10.4135/9781483346397.n187

Ifenthaler, D., Gibson, D., Prasse, D., Shimada, A., & Yamada, M. (2020). Putting learning back into learning analytics: actions for policy makers, researchers, and practitioners. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-020-09909-8

Ifenthaler, D., & Schweinbenz, V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behavior*, *29*(3), 525–534. https://doi.org/10.1016/j.chb.2012.11.004

Ifenthaler, D., & Schweinbenz, V. (2016). Students' Acceptance of Tablet PCs in the Classroom. *Journal of Research on Technology in Education*, *48*(4), 306–321. https://doi.org/10.1080/15391523.2016.1215172

IHK Stuttgart. (2021). *Hinweise zum Berufsschulbesuch*. https://www.stuttgart.ihk24.de/fuer-unternehmen/fachkraefte-und-ausbildung/ausbildung/waehrend-der-ausbildung/hinweise-zum-berufsschulbesuch-2989002

Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8

Imboden, D., Lütjen-Drecoll, E., Bargmann, S., Casper, G., Gächter, S., Kratky, C., Nahrstedt, K., Besch Nosch, M.-L., Pauss, F., & Scheidegger, D. (2016). *Internationale Expertenkommission zur Evaluation der Exzellenzinitiative - Endbericht*. Interationale Expertenkmission Exzellenzinitative. https://www.gwk-bonn.de/fileadmin/Redaktion/Dokumente/Papers/Imboden-Bericht-2016.pdf

International Organization for Standardization. (2015). *ISO 9000:2015(en) Quality management systems — Fundamentals and vocabulary*. https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en

Ismail, N., & Yusof, M. A. M. (2012). Using Language Learning Contracts as a Strategy to Promote Learner Autonomy among ESL Learners. *Procedia - Social and Behavioral Sciences*, *66*, 472–480. https://doi.org/10.1016/j.sbspro.2012.11.291

Jacob, B. A., & Wilder, T. (2010). *Educational Expectations and Attainment* (Working Paper Series, Issue 15683). https://doi.org/10.3386/w15683

Jarvis, M. C. (2018). *DSpace Startseite ETDs: Virginia Tech Electronic Theses and Dissertations Doctoral Dissertations Dokumentanzeige Facilities Infrastructure Needs and Practices to Support Technology Implementation in Two Rural School Divisions in Virginia* [Virginia Polytechnic Institute and State University]. http://hdl.handle.net/10919/93595

Jensvoll, M. H., & Lekang, T. (2018). Strengthening professionalism through cooperative learning. *Professional Development in Education*, *44*(4), 466–475. https://doi.org/10.1080/19415257.2017.1376223

Johansson, S., & Myrberg, E. (2019). Teacher specialization and student perceived instructional quality: what are the relationships to student reading achievement? *Educational Assessment, Evaluation and Accountability*, *31*(2), 177–200. https://doi.org/10.1007/s11092-019-09297-5

Jossberger, H., Brand-Gruwel, S., Boshuizen, H., & van de Wiel, M. (2010). The challenge of self-directed and self-regulated learning in vocational education: a theoretical analysis and synthesis of requirements. *Journal of Vocational Education & Training*, *62*(4), 415–440. https://doi.org/10.1080/13636820.2010.523479

Jurkowski, S., & Müller, B. (2018). Co-teaching in inclusive classes: The development of

multi-professional cooperation in teaching dyads. *Teaching and Teacher Education, 75*, 224–231. https://doi.org/10.1016/j.tate.2018.06.017

Kasper, B. (2017). *Implementation von Schulqualität*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-17311-1

Katsenou, C., Flogaitis, E., & Liarakou, G. (2015). Action Research to Encourage Pupils' Active Participation in the Sustainable School. *Applied Environmental Education & Communication*, *14*(1), 14–22. https://doi.org/10.1080/1533015X.2014.994820

Kay, R., & Schellenberg, D. (2019). Comparing BYOD and One-to-One Laptop Programs in Secondary School Classrooms: A Review of the Literature. In K. Graziano (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 1862–1866). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/207900/

Keeley, P. (2020). Student Voice and Leadership: Creating a Feedback Model for Improving School Culture and Climate and Creating Inspired Engaged Students [San Diego State University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/student-voice-leadership-creating-feedback-model/docview/2478103025/se-2?accountid=14570

Kelchtermans, G., Smith, K., & Vanderlinde, R. (2018). Towards an 'international forum for teacher educator development': an agenda for research and action. *European Journal of Teacher Education*, *41*(1), 120–134. https://doi.org/10.1080/02619768.2017.1372743

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J. M. Spector, M. D. Merill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology: Fourth Edition* (4th ed., pp. 101–111). Springer Science+Business Media. https://doi.org/10.1007/978-1-4614-3185-5

Kuijpers, J. M., Houtveen, A. A. M., & Wubbels, T. (2010). An integrated professional development model for effective teaching. *Teaching and Teacher Education*, *26*(8), 1687–1694. https://doi.org/10.1016/j.tate.2010.06.021

Kulgemeyer, C., & Schecker, H. (2014). Research on Educational Standards in German Science Education – Towards a model of student competences. *EURASIA Journal of Mathematics, Science and Technology Education*, *10*(4). https://doi.org/10.12973/eurasia.2014.1081a

Kunter, M., & Baumert, J. (2007). Who is the expert? Construct and criteria validity of student and teacher ratings of instruction. *Learning Environments Research*, *9*(3), 231–251. https://doi.org/10.1007/s10984-006-9015-7

Kyriakides, L., Christoforou, C., & Charalambous, C. Y. (2013). What matters for student learning outcomes: A meta-analysis of studies exploring factors of effective teaching. *Teaching and Teacher Education*, *36*, 143–152. https://doi.org/10.1016/j.tate.2013.07.010

Labusch, A., Eickelmann, B., & Conze, D. (2020). ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland. In *ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland*. Waxmann Verlag GmbH. https://doi.org/10.31244/9783830993087

Leclerc, M., Moreau, A. C., Dumouchel, C., & Sallafranque-St-Louis, F. (2012). Factors that promote Progression in Schools Functioning as a Professional Learning Community. *International Journal of Education Policy and Leadership*, *7*(7). https://doi.org/10.22230/ijepl.2012v7n7a417

Lee, E., & Hannafin, M. J. (2016). A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it. *Educational Technology Research and Development*, *64*(4), 707–734. https://doi.org/10.1007/s11423-015-9422-5

Leithwood, K., & Mascall, B. (2008). Collective Leadership Effects on Student Achievement.

Educational Administration Quarterly, *44*(4), 529–561. https://doi.org/10.1177/0013161X08321221

Lemay, D. J., Baek, C., & Doleck, T. (2021). Comparison of learning analytics and educational data mining: A topic modeling approach. *Computers and Education: Artificial Intelligence*, *2*, 100016. https://doi.org/https://doi.org/10.1016/j.caeai.2021.100016

Lichtenberg, P. (2015). *Zuordnung nationaler Bildungsprogramme zur ISCED 2011*. OECD. https://www.oecd.org/berlin/publikationen/Zuordnung nationaler Bildungsprogramme zur ISCED 2011.pdf

Liebowitz, D. D., & Porter, L. (2019). The Effect of Principal Behaviors on Student, Teacher, and School Outcomes: A Systematic Review and Meta-Analysis of the Empirical Literature. *Review of Educational Research*, *89*(5), 785–827. https://doi.org/10.3102/0034654319866133

Linn, R. L. (2001). A Century of Standardized Testing: Controversies and Pendulum Swings. *Educational Assessment*, *7*(1), 29–38. https://doi.org/10.1207/S15326977EA0701_4

Lobo, A., & Gurney, L. (2014). What did they expect? Exploring a link between students' expectations, attendance and attrition on English language enhancement courses. *Journal of Further and Higher Education*, *38*(5), 730–754. https://doi.org/10.1080/0309877X.2013.817002

Lochner, B., Conrad, R.-M., & Graham, E. (2015). Secondary Teachers' Concerns in Adopting Learning Management Systems: A U.S. Perspective. *TechTrends*, *59*(5), 62–70. https://doi.org/10.1007/s11528-015-0892-4

Lucey, T. A. (2003). Economic Influenced Perceptions and Their Implications for Early 21st Century Education. *Educational Foundations*, *17*(1), 41–54.

Lundahl, C., Hultén, M., & Tveit, S. (2017). The power of teacher-assigned grades in outcome-based education. *Nordic Journal of Studies in Educational Policy*, *3*(1), 56–66. https://doi.org/10.1080/20020317.2017.1317229

Lytvyn, A., Lytvyn, V., Rudenko, L., Pelekh, Y., Didenko, O., Muszkieta, R., & Żukow, W. (2020). Informatization of technical vocational schools: Theoretical foundations and practical approaches. *Education and Information Technologies*, *25*(1), 583–609. https://doi.org/10.1007/s10639-019-09966-4

Mahat, M. (2007). The impact of ranking systems on Higher Education and its stakeholders. *Journal of Institutional Research*, *13*, 83–96.

Maher, D., & Twining, P. (2017). Bring your own device – a snapshot of two Australian primary schools. *Educational Research*, *59*(1), 73–88. https://doi.org/10.1080/00131881.2016.1239509

McNay, I. (2015). Debate: Does research quality assessment increase output and give value for money? *Public Money & Management*, *35*(1), 67–68. https://doi.org/10.1080/09540962.2015.986888

McPartland, J., Balfanz, R., Jordan, W., & Legters, N. (1998). Improving Climate and Achievement in a Troubled Urban High School Through the Talent Development Model. *Journal of Education for Students Placed at Risk (JESPAR)*, *3*(4), 337–361. https://doi.org/10.1207/s15327671espr0304_4

Menon, D., Bp, S., Romero, M., & Viéville, T. (2019). Going beyond digital literacy to develop computational thinking in K-12 education,. In L. Daniela (Ed.), *Smart Pedagogy of Digital Learning*. Taylor\\&Francis (Routledge). https://hal.inria.fr/hal-02281037

Metcalfe, J. (2017). Learning from Errors. *Annual Review of Psychology*, *68*(1), 465–489. https://doi.org/10.1146/annurev-psych-010416-044022

Mishnick, N. (2017). *An Analysis of the Relationship between Professional Development, School Leadership, Technology Infrastructure, and Technology Use*. ProQuest Dissertations Publishing.

Mishra, P., & Koehler, M. (2008). Introducing Technological Pedagogical Content Knowledge. *Teachers College Record*, *9*.

Mitchell, R., Sun, J., Zhang, S., Mendiola, B., & Tarter, J. (2015). *School Effectiveness: A Meta-Analytic Review of Published Research*.

Mitter, W. (1987). Expectations of schools and teachers in the context of social and economic changes. *International Review of Education*, *33*(3), 263–276. https://doi.org/10.1007/BF00615298

Molnar, A. (2003). School Commercialism Hurts All Children, Ethnic Minority Group Children Most of All. *The Journal of Negro Education*, *72*(4), 371. https://doi.org/10.2307/3211189

Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and Learning with Mobile Technology: A Qualitative Explorative Study about the Introduction of Tablet Devices in Secondary Education. *PLOS ONE*, *10*(12), e0144008. https://doi.org/10.1371/journal.pone.0144008

Moreira, M. A., Rivero, V. M. H., & Sosa Alonso, J. J. (2019). Leadership and school integration of ICT. Teachers perceptions in Spain. *Education and Information Technologies*, *24*(1), 549–565. https://doi.org/10.1007/s10639-018-9789-0

Mori, Y., & Stracke, E. (2021). Student teachers' expectations and their sense of fulfillment in a TESOL program. *Australian Review of Applied Linguistics*. https://doi.org/10.1075/aral.19054.mor

Muftić, A. (2012). *Schulentwicklung : Begriff - Theorie - Definition*.

Mulford, B. (2003). *School Leaders: Challenging Roles and Impact on Teaching and School Effectiveness*. OECD. https://www.oecd.org/education/school/37133393.pdf

Mylonakou Keke, I., & Kekes, I. (2007). School, family and the community in cooperation: the model of syneducation. *International Journal about Parents in Education*, *1*, 73–82.

Nettles, M. T. (2019). History of Testing in the United States: Higher Education. *The ANNALS of the American Academy of Political and Social Science*, *683*(1), 38–55. https://doi.org/10.1177/0002716219847139

Nguyen, H. T. M. (2017). *Models of Mentoring in Language Teacher Education*. Springer International Publishing. https://doi.org/10.1007/978-3-319-44151-1

OECD. (2007). Indicator A4 What are students' expectations for education?. In *Education at a Glance 2007: OECD Indicators* (pp. 74–88). OECD Publishing. https://doi.org/10.1787/eag-2007-6-en

Oelkers, J. (2007). *Schule und Wettbewerb: Neue Perspektiven für Leistung und Qualität* (p. 20). https://www.ife.uzh.ch/dam/jcr:00000000-4a53-efb2-ffff-ffff8761d4e8/271b_Biblis.pdf

Page, L. (2016). The impact of lesson observation on practice, professionalism and teacher identity. In M. O'Leary (Ed.), *Reclaiming Lesson Observation - Supporting excellence in teacher learning* (1st ed., pp. 62–74). Routledge.

Panayiotou, A., Kyriakides, L., Creemers, B. P. M., McMahon, L., Vanlaar, G., Pfeifer, M., Rekalidou, G., & Bren, M. (2014). Teacher behavior and student outcomes: Results of a European study. *Educational Assessment, Evaluation and Accountability*, *26*(1), 73–93. https://doi.org/10.1007/s11092-013-9182-x

Papamitsiou, Z., Filippakis, M. E., Poulou, M., Sampson, D., Ifenthaler, D., & Giannakos, M. (2021). Towards an educational data literacy framework: enhancing the profiles of instructional designers and e-tutors of online and blended courses with new competences. *Smart Learning Environments*, *8*(1), 18. https://doi.org/10.1186/s40561-021-00163-w

Persson, R. S. (2010). Experiences of Intellectually Gifted Students in an Egalitarian and Inclusive Educational System: A Survey Study. *Journal for the Education of the Gifted*, *33*(4), 536–569. https://doi.org/10.1177/016235321003300405

Pietsch, M., Lücken, M., Thonke, F., Klitsche, S., & Musekamp, F. (2016). Der Zusammenhang von Schulleitungshandeln, Unterrichtsgestaltung und Lernerfolg. *Zeitschrift Für Erziehungswissenschaft*, *19*(3), 527–555. https://doi.org/10.1007/s11618-016-0692-4

Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth grade classrooms in a Florida school district. *Educational Technology Research and Development*, *63*(4), 539–554. https://doi.org/10.1007/s11423-015-9391-8

Pleshakova, A. Y. (2019). Germany's dual education system: The assessment by its subjects. *The Education and Science Journal*, *21*(5), 130–156. https://doi.org/10.17853/1994-5639-2019-5-131-157

Poedjiastutie, D., & Oliver, R. (2017). Exploring Students' Learning Needs: Expectation and Challenges. *English Language Teaching*, *10*(10), 124. https://doi.org/10.5539/elt.v10n10p124

Praetorius, A.-K., Lauermann, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education*, *65*, 241–254. https://doi.org/10.1016/j.tate.2017.03.023

Protsch, P., & Solga, H. (2016). The social stratification of the German VET system. *Journal of Education and Work*, *29*(6), 637–661. https://doi.org/10.1080/13639080.2015.1024643

Ramírez-Rueda, M. del C., Cózar-Gutiérrez, R., Roblizo Colmenero, M. J., & González-Calero, J. A. (2021). Towards a coordinated vision of ICT in education: A comparative analysis of Preschool and Primary Education teachers' and parents' perceptions. *Teaching and Teacher Education*, *100*, 103300. https://doi.org/10.1016/j.tate.2021.103300

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu* (Y. Punie (Ed.)). Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107466/pdf_digcomedu_a4_final.pdf

Reezigt, G. J., & Creemers, B. P. M. (2005). A comprehensive framework for effective school improvement. *School Effectiveness and School Improvement*, *16*(4), 407–424. https://doi.org/10.1080/09243450500235200

Reichardt, R. (2000). *The Cost of Class Size Reduction: Advice for Policy Makers*. RAND Corporation. https://doi.org/10.7249/RGSD156

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. (1998). Entwicklung von Einzelschulen. Viel Praxis, wenig Theorie und kaum Forschung - Ein Versuch, Schulentwicklung zu systematisieren. *Jahrbuch Der Schulentwicklung*, *10*, 295–326.

Rolff, H.-G. (2019). Wandel durch Schulentwicklung: Essays zu Bildungsreform und Schulpraxis. In *Wandel durch Schulentwicklung*. Beltz Verlagsgruppe.

Rolff, H.-G., & Thünken, U. (2020). Digital gestütztes Lernen: Praxisbeispiele für eine zeitgemäße Schulentwicklung. In *Digital gestütztes Lernen*. Beltz Verlagsgruppe.

Roll, M., & Ifenthaler, D. (2020). Lernort-übergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.

Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4

Romeu, T., Guitert, M., & Sangrà, A. (2016). Teacher collaboration network in Higher Education: reflective visions from praxis. *Innovations in Education and Teaching International*, *53*(6), 592–604. https://doi.org/10.1080/14703297.2015.1025807

Rudasill, K. M., Snyder, K. E., Levinson, H., & L. Adelson, J. (2018). Systems View of School Climate: a Theoretical Framework for Research. *Educational Psychology Review*, *30*(1), 35–60. https://doi.org/10.1007/s10648-017-9401-y

Sabry, N. S., & Bruna, K. R. (2007). Learning from the Experience of Muslim Students in American Schools: Towards a Proactive Model of School-Community Cooperation. *Multicultural Perspectives*, *9*(3), 44–50. https://doi.org/10.1080/15210960701443730

Sahney, S., Banwet, D. K., & Karunes, S. (2008). An integrated framework of indices for quality management in education: a faculty perspective. *The TQM Journal*, *20*(5), 502–519. https://doi.org/10.1108/17542730810898467

Salle, T. P. La, Meyers, J., Varjas, K., & Roach, A. (2015). A Cultural-Ecological Model of School Climate. *International Journal of School & Educational Psychology*, *3*(3), 157–166. https://doi.org/10.1080/21683603.2015.1047550

Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher Digital Literacy: The Indisputable Challenge after COVID-19. *Sustainability*, *13*(4), 1858. https://doi.org/10.3390/su13041858

Sanders, M. G., & Epstein, J. L. (2005). School-Family-Community Partnerships and Educational Change: International Perspectives. In A. Hargreaves (Ed.), *Extending Educational Change* (pp. 202–222). Springer Netherlands. https://doi.org/10.1007/1-4020-4453-4_10

Santi;, S., Dumitru, P., Marc;, D., Gilleran, A., Alexa, J., & Vuorikari, R. (2009). European Schoolnet: Enabling School Networking. *European Journal of Education Research, Development and Policies ; the Official Journal of the European Institute of Education and Social Policy*, *44*(4), 475.

Scantlebury, K., Gallo-Fox, J., & Wassell, B. (2008). Coteaching as a model for preservice secondary science teacher education. *Teaching and Teacher Education*, *24*(4), 967–981. https://doi.org/10.1016/j.tate.2007.10.008

Scheerens, J. (2012). Summary and Conclusion: Instructional Leadership in Schools as Loosely Coupled Organizations. In J. Scheerens (Ed.), *School Leadership Effects Revisited* (pp. 131–152). Springer. https://doi.org/10.1007/978-94-007-2768-7_5

Scheller, H. (2018). Educational Federalism in Germany. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries.* Information Age Publishing.

Schelten, A. (2009). Berufsschule. In S. Blömeke, T. Bohl, L. Haag, G. Lang-Wojtasik, & W. Sacher (Eds.), *Handbuch Schule : Theorie - Organisation - Entwicklung*.

Schmid, U., Blanc, B., Toepel, M., Pinkwart, N., & Drachsler, H. (2021). *KI@Bildung: Lehren und Lernen in der Schule mit Werkzeugen Künstlicher Intelligenz*. https://www.mmb-institut.de/wp-content/uploads/KI@Bildung_Schlussbericht.pdf

Schneider, S. L. (2021). The classification of education in surveys: a generalized framework for ex-post harmonization. *Quality & Quantity*. https://doi.org/10.1007/s11135-021-01101-1

Schumacher, C. (2019). *Cognitive, metacognitive and motivational perspectives on learning analytics : Synthesizing self-regulated learning, assessment, and feedback with Learning Analytics* [University of Mannheim]. https://madoc.bib.uni-mannheim.de/53712/

Scott, T. M. (2016). *Teaching Behavior : Managing Classrooms Through Effective Instruction*. SAGE Publications. http://ebookcentral.proquest.com/lib/unimannheim-ebooks/detail.action?docID=5165196

Sebastian, J., Allensworth, E., Wiedermann, W., Hochbein, C., & Cunningham, M. (2019). Principal Leadership and School Performance: An Examination of Instructional

Leadership and Organizational Management. *Leadership and Policy in Schools*, *18*(4), 591–613. https://doi.org/10.1080/15700763.2018.1513151

Seleznyov, S., & Czerniawksi, G. (2020). *A Research Approach To Curriculum Development: A British Curriculum Forum Event Report* (S. Seleznyov & G. Czerniawski (Eds.)). British Educational Research Association.

Seufert, S., Guggemos, J., Ifenthaler, D., Ertl, H., & Seifried, J. (2021). *Künstliche Intelligenz in der beruflichen Bildung Zukunft der Arbeit und Bildung mit intelligenten Maschinen?!* Franz Steiner Verlag. https://elibrary.steiner-verlag.de/book/99.105010/9783515130752

Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, *7*(1), 33. https://doi.org/10.1186/s40561-020-00140-9

Siemiatycki, M., & Farooqi, N. (2012). Value for Money and Risk in Public–Private Partnerships. *Journal of the American Planning Association*, *78*(3), 286–299. https://doi.org/10.1080/01944363.2012.715525

Silcox, S., & MacNeill, N. (2021). *Leading School Renewal*. Routledge. https://doi.org/10.4324/9781003139935

Silcox, S., Macneill, N., & Cavanagh, R. (2012). *Paper Code 507 PRINCIPAL LEADERSHIP AND SCHOOL RENEWAL*.

Sinakou, Donche, Boeve-de Pauw, & Van Petegem. (2019). Designing Powerful Learning Environments in Education for Sustainable Development: A Conceptual Framework. *Sustainability*, *11*(21), 5994. https://doi.org/10.3390/su11215994

Sloat, E., Amrein-Beardsley, A., & Holloway, J. (2018). Different teacher-level effectiveness estimates, different results: inter-model concordance across six generalized value-added models (VAMs). *Educational Assessment, Evaluation and Accountability*, *30*(4), 367–397. https://doi.org/10.1007/s11092-018-9283-7

Sonntag, M., & Veber, M. (2014). Die Arbeit in multiprofessionellen Teams als Herausforderung und Chance für eine inklusionsorientierte LehrerInnenbildung - ein Dialog über den Tellerrand. *Erziehung Und Unterricht*, *164*.

Spiteri, M., & Chang Rundgren, S.-N. (2020). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning*, *25*(1), 115–128. https://doi.org/10.1007/s10758-018-9376-x

Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the Validity of Student Evaluation of Teaching. *Review of Educational Research*, *83*(4), 598–642. https://doi.org/10.3102/0034654313496870

statistik-bw. (2020). *Öffentliche berufliche Schulen: Rückgang der Schülerzahlen setzt sich fort*. Pressemitteilung 51/2020. https://www.statistik-bw.de/Presse/Pressemitteilungen/2020051

Stronge, J. H. (2018). *Qualities of Effective Teachers, 3rd Edition*. ASCD.

Sugarman, J., Morris-Lange, S., & McHugh, M. (2016). *Improving Education for Migrant-Background Students: A Transatlantic Comparison of School Funding*. https://www.stiftung-mercator.de/content/uploads/2020/12/Sugarman_et_al_MPI_SVR_Improving_Education_Migrant_Background_Students_NEU.pdf

Teodorović, J. (2011). Classroom and school factors related to student achievement: what works for students? *School Effectiveness and School Improvement*, *22*(2), 215–236. https://doi.org/10.1080/09243453.2011.575650

Terhart, E. (2006). Giving Marks: Constructing Differences; Explorations in the Micro-Politics of Selection in Schools. In H. Drerup & W. Fölling (Eds.), *Gleichheit und Gerechtigkeit: Pädagogische Revisionen*. TUD.

Terhart, E. (2019). Teacher Education in Germany. In *Oxford Research Encyclopedia of Education*. Oxford University Press.

https://doi.org/10.1093/acrefore/9780190264093.013.377
Tuffaha, H. W., Aitken, J., Chambers, S., & Scuffham, P. A. (2019). A Framework to Prioritise Health Research Proposals for Funding: Integrating Value for Money. *Applied Health Economics and Health Policy*, *17*(6), 761–770. https://doi.org/10.1007/s40258-019-00495-2
Tulis, M., Steuer, G., & Dresel, M. (2016). Learning from errors: A model of individual processes. *Frontline Learning Research*, *4*(4), 12–26. https://doi.org/10.14786/flr.v4i2.168
Turnbull, D., Chugh, R., & Luck, J. (2019). Learning Management Systems: An Overview. In *Encyclopedia of Education and Information Technologies* (pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-319-60013-0_248-1
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. https://doi.org/10.1111/jcal.12031
Underwood, J., Ault, A., Banyard, P., Bird, K., Dillon, G., Hayes, M., Selwood, I., Somekh, B., & Twining, P. (2005). *The impact of broadband in schools*. Becta.
Uttl, B., White, C. A., & Gonzalez, D. W. (2017). Meta-analysis of faculty's teaching effectiveness: Student evaluation of teaching ratings and student learning are not related. *Studies in Educational Evaluation*, *54*, 22–42. https://doi.org/10.1016/j.stueduc.2016.08.007
van der Bij, T., Geijsel, F. ., & ten Dam, G. T. . (2016). Improving the quality of education through self-evaluation in Dutch secondary schools. *Studies in Educational Evaluation*, *49*, 42–50. https://doi.org/10.1016/j.stueduc.2016.04.001
Vannucci, M., & Coll, V. (2010). Educational Software as a Learning Tool for Primary School Students. In *New Achievements in Technology Education and Development*. InTech. https://doi.org/10.5772/9227
Vernon, M. M., Balas, E. A., & Momani, S. (2018). Are university rankings useful to improve research? A systematic review. *PLOS ONE*, *13*(3), e0193762. https://doi.org/10.1371/journal.pone.0193762
Vilcea, M. A. (2014). Quality Culture in Universities and Influences on Formal and Non-formal Education. *Procedia - Social and Behavioral Sciences*, *163*, 148–152. https://doi.org/10.1016/j.sbspro.2014.12.300
Villalobos, C. (2016). Google Chromebook pilot evaluation: An evaluation of professional development and incorporation of Google Chromebook hardware and software applications [Azusa Pacific University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/google-chromebook-pilot-evaluation-professional/docview/1876895376/se-2?accountid=14570
Vossenkuhl, A. (2010). (Berufs-)Schulpflicht in Deutschland. *Berufsbildung in Wissenschaft Und Praxis*, *39*(6), 53–54. http://www.bibb.de/veroeffentlichungen/de/publication/download/id/6512
Walbe Ornstein, S., Saraiva Moreira, N., Ono, R., Limongi França, A. J. G., & Nogueira, R. A. M. F. (2009). Improving the quality of school facilities through building performance assessment. *Journal of Educational Administration*, *47*(3), 350–367. https://doi.org/10.1108/09578230910955782
Waldow, F. (2014). Conceptions of Justice in the Examination Systems of England, Germany, and Sweden: A Look at Safeguards of Fair Procedure and Possibilities of Appeal. *Comparative Education Review*, *58*(2), 322–343. https://doi.org/10.1086/674781
Walker, R., & Baets, W. (2009). Instructional Design for Class-Based and Computer-Mediated Learning. In *Applied E-Learning and E-Teaching in Higher Education* (pp. 244–264). IGI Global. https://doi.org/10.4018/978-1-59904-814-7.ch012
Wang, M.-T., & Degol, J. L. (2016). School Climate: A Review of the Construct,

Measurement, and Impact on Student Outcomes. *Educational Psychology Review*, *28*(2), 315–352. https://doi.org/10.1007/s10648-015-9319-1

Wang, M.-T., & Hofkens, T. L. (2020). Beyond Classroom Academics: A School-Wide and Multi-Contextual Perspective on Student Engagement in School. *Adolescent Research Review*, *5*(4), 419–433. https://doi.org/10.1007/s40894-019-00115-z

Weber, S., & Achtenhagen, F. (2017). Competence Domains and Vocational-Professional Education in Germany BT - Competence-based Vocational and Professional Education: Bridging the Worlds of Work and Education. In M. Mulder (Ed.), *Competence-based Vocational and Professional Education* (pp. 337–359). Springer International Publishing. https://doi.org/10.1007/978-3-319-41713-4_16

Whitehead, B. M., Jensen, D. F. N., & Boschee, F. (2013). *Planning for Technology : A Guide for School Administrators, Technology Coordinators, and Curriculum Leaders: Vol. Second edi*. Corwin.

Wong, K. K. (2018). *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries*. Information Age Publishing.

Wong, K. K., Knüpling, F., Kölling, M., & Chebenova, D. (2018). Federalism and Education: Cross-National Lessons on Governance, Standards and Accountability for the 21st Century. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries* (pp. 1–18). Information Age Publishing.

Wong, K. M. (2021). "A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it" by Lee and Hannafin (2016): an international perspective. *Educational Technology Research and Development*, *69*(1), 93–96. https://doi.org/10.1007/s11423-020-09842-w

Zylka, J. (2018). *Digitale Schulentwicklung: Das Praxisbuch für Schulleitung und Steuergruppen*. Beltz

3. Digitalisation in the Curricula of Vocational Schools

3.1 Introduction

School curricula are a fundamental connection between a society's beliefs and its educational system (Pahl, 2014). They are a condensed version of what is deemed as worthy competencies for learners by the society (Ellis, 2004). The value of what is taught and learned at schools and university is especially measured to the degree of how it facilitates the development of emancipated citizens, focusing on professional competences, long-term career development as well as the connection between learning and work (Zhao, 2014). Teacher education is influenced by the content of school curricula to a large extent and in-service teachers develop their classroom teaching in accordance to the requirements of the school curricula (J. K.-S. Chan, 2010).

The influence of digitalisation on the modern society requires students and teachers to develop digital competencies as a prerequisite for participation processes in the society and the workplace (Fraillon et al., 2020; Roll & Ifenthaler, 2020a). Therefore, elements of digitalisation have to be integrated into school development processes (Bellin-Mularski et al., 2016; Eickelmann & Gerick, 2018). School curricula are a strong external influence on school development and must contain digital competencies, especially in the curricula of vocational schools (Balsmeier & Woerter, 2019; Seeber & Seifried, 2019; Wild & Schulze Heuling, 2020; Wuttke et al., 2020).

The objective of this project was the analysis of curricula of vocational schools in the state of Baden-Württemberg, Germany, focusing on the presence of indicators for digitalisation. The different types of vocational schools, the complexity of digital competencies and their characteristics are being prioritized in the research process.

3.2 Theoretical Framework

3.2.1 Vocational Schools in Germany

In Germany, the education system and therefore the curricula of vocational schools are based on the cultural sovereignty of the federated states (Arends, 2017). As a result, the different states have developed very heterogenic systems, comprising of a multitude of school types and educational paths which learners can choose from based on their competencies and interests. Although the states have different approaches to vocational education, three main purposes can be identified, namely the promotion of (1) economic productivity, (2) social integration and (3) individual development (Euler, 2013). The underlying concept is the dual system, the combination of theoretical knowledge, which is taught in vocational schools, and practical knowledge, which is facilitated at training companies (Pleshakova, 2019).

The International Standard Classification of Education (ISCED) framework can be utilized to compare education systems across different countries or states within a country. The comparison is made possible through two cross-classification variables (S. L. Schneider, 2021). The first variable describes the level of education, which ranges from childhood education (level 1) to the doctoral level (level 9). The field of education, such as science, law or health, is indicated by the second variable.

In the state of Baden-Württemberg, 15 different types and subtypes of vocational schools exist (Delcker & Ifenthaler, 2020). These vocational schools can be assigned to the levels 3 and 4 of the ISCED framework, which correspond to upper secondary education and post-secondary non-tertiary education (OECD, 2015). The combination of theoretical and practical knowledge as well as the possibility to advance through the educational system differs between the types of vocational schools, which requires the assignment of a level range, rather than a fixed level. The six main types of vocational schools, the number of students and their corresponding ISCED levels are listed in Table 3-1, including the English translation of the German terms (Batzel & Börgmann, 2017; KMK, 2019a). The number at the second position of the ISCED level describes whether the education program adds more general knowledge to the educational program (34, 44) or if it heavily centres on job specific skills (35, 45) (Lichtenberg, 2015).

Table 3-1

Student Numbers and ISCED Levels of Vocational Schools (Lichtenberg, 2015; statistik-bw, 2020)

School	Students	ISCED Level
Berufsschule (part-time vocational school)	188170	34
Berufsfachschule (full-time vocational school)	39760	35
Berufskolleg (vocational college)	41470	35
Berufsoberschule (upper vocational school)	1190	44
Fachschule (school for intermediate vocational education)	1100	45
Berufliches Gymnasium (vocational grammar school)	54330	34
Total	343350	

The mean age of students is 20 years and they generally graduate between the age of 20 and 22 years (BMBF, 2015). One of the main benefits for the students is the possibility to move through different types of vocational schools and therefore the improvement of competencies related to the goals of the dual system (Euler, 2013; Pleshakova, 2019): The Berufsschule is the most prominent type of vocational school. In general, the combination of theoretical knowledge and workplace related skills leads to a professional qualification.

The Berufsfachschule is structured similarly, but with less emphasis on practical knowledge. As a result, graduates of the Berufsfachschule are considered as less qualified for the work environment than those of the Berufsschule and often work in jobs that pay less wages. Graduates of both of those types of schools qualify for the next level of vocational schools, the Fachschule and the Berufskolleg, as well as the Berufliche Gymnasium.

Entering the Fachschule additionally requires a certain amount of work experience in a specific field, because the graduates of the Fachschule are supposed to work in position of middle management or as self-employed persons. The Berufskolleg has lower entry requirements, but the consecutive undergoing of the program depends on the grades of the single school terms and the sustainment of an employment relationship. Successfully graduating from the Fachschule or the Berufskolleg allows students to apply for the

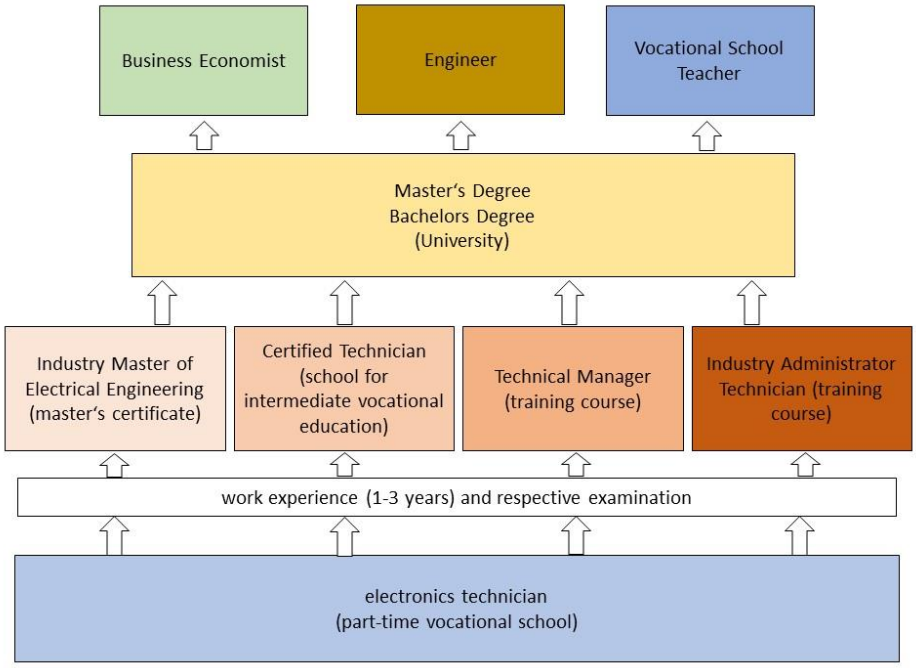
Berufsoberschule. The Berufsoberschule focuses on theoretical knowledge. Graduates can apply for a subject-specific undergraduate program at a university of applied science in connection with their job qualification. Additional qualifications within the Berufsoberschule allow graduates to apply for all undergraduate programs, independent of their job qualification.

The same access path to undergraduate programs can be reached through a degree at the Berufliches Gymnasium. The Berufliches Gymnasium requires good grades in the lower secondary education level. Graduates have to pass sophisticated exams which are comparable to the A levels or a high-school diploma.

The permeability of the vocational school system allows students to adjust their educational careers to their current competencies and ambitions. As an example, an electrician who graduates from the Berufsschule could apply for the bachelor's program of an electrical engineer. An exemplary career path is visualized in Figure 3-1.

Figure 3-1

Exemplary Career Path of an Electronics Technician (Berufskompass Chemie, 2013)



Young people often graduate from one type of vocational school, join the workforce for some time and then join the program of a higher level type of vocational school to gain access to undergraduate programs of the German universities (Virdia & Schindler, 2019).

3.2.2 Digitalisation, School Development and School Curricula

The influence of digitalisation on vocational school development can be shown from three perspectives (Euler & Wilbers, 2018). Firstly, citizens require new competencies to participate in a changing world. Schools are an important facilitator of those competencies (Ilomäki et al., 2016; Janssen et al., 2013). Secondly, digitalisation offers new tools and methods for teaching (Collins & Halverson, 2018), such as computers (Patterson & Patterson, 2017) and interactive whiteboards (Tosuntaş et al., 2015) in flipped classroom (Strelan et al., 2020) or blended learning settings (Hrastinski, 2019). Additionally, digitalisation finds its way into classroom as content, when educators include data privacy or digital ethics into their teaching practices (Luke et al., 2017). Digital competencies, digital tools and digital content can be found within the vocational schools, but also at the workplace of apprentices (Berisha-Gawlowski et al., 2020; Freiling & Mozer, 2020; Harteis, 2018). Within the training companies, new digital processes and tools change the workplace (Euler & Wilbers, 2018), such as 3D-printers (H. K. Chan et al., 2018) smart production systems (Hirsch-Kreinsen, 2016), digital marketing (Nadkarni & Prügl, 2021). As a result, the strong interlocking between practical workplace competencies and theoretical knowledge in vocational schools demands a constant alignment with the requirements of the work environment. The influence of digitalisation on the workplace and the work environment are therefore one of the most pressing issues for vocational schools and their role in the German education system (Roll & Ifenthaler, 2020a, 2021).

The competency of school leaders (Dexter, 2008; Håkansson Lindqvist & Pettersson, 2019; Hauge, 2016) and teachers (Delcker, 2020; Instefjord & Munthe, 2017; Pettersson, 2021) are key success factors for the adaptation of schools to the challenges of the digitalisation processes. Necessary changes in school development will have to be made in the fields of organisation, personnel, teaching, technology and cooperation (Delcker, 2020; Eickelmann et al., 2020; Eickelmann & Gerick, 2018). While these fields play an important role for the digitalisation of school development, they focus on the modifications of aspects within single schools as organisational forms. In addition to internal development perspectives, changes to external realities, requirements and expectations have to be considered.

While publicly expressed opinions of stakeholders such as educational researchers, politicians or journalists might be interpreted as a possible influence, the effect of school curricula on school development from the outside is much more apparent (Matos et al., 2019; Olofsson et al., 2020). Following the prescriptive viewpoint on curricula (Ellis, 2004), students choose their educational paths based on what a program can offer them, information which is laid out in the specific curriculum. Teachers are required to design their classroom education in

accordance to school curricula, so they can help students to achieve the determined educational goals. School leaders have to develop their schools in a way that facilitates a suitable teaching and learning environment for students and teachers. From an experience perspective, training companies and employers can assess the competencies of their apprentices, trainees and future staff by reading the specific curricula (Zhao, 2014).

As a result, the integration of digitalisation in school development has to be based on internal development processes, but also on school curricula as an external requirement. These curricula need to implicate the digital competencies required in vocational education for the modern world (Balsmeier & Woerter, 2019; Seeber & Seifried, 2019; Wild & Schulze Heuling, 2020; Wuttke et al., 2020).

3.2.3 Curriculum Development at Vocational Schools

Basic elements for the curricula of vocational schools in Germany are determined in framework curricula by the conference of ministers of education of the German states (KMK, 2019b). The framework curricula are closely coordinated with the regulations of company training, to balance theoretical and practical competencies in the dual system and to include requirements of the workplace. The German states use the framework curricula as a guideline to implement state-specific curricula, based on the cultural sovereignty of the federated states (Arends, 2017). In the state of Baden-Württemberg, an advisory board consisting of members with a background in society, economics, research, religion and politics monitors the development of the state specific curricula (Pant, 2021). The concrete development is undertaken by specialized departments within the ministry of culture, youth and sport. The development process of the curricula is often criticized because of its complexity and the long duration, which carries the risk of outdated curricula, passing by the requirements of changing societies (Pahl, 2014; Pätzold et al., 2006).

In December 2016, the KMK published a strategy concept called Education in the Digital World for the “future development of education in Germany” (KMK, 2017b). The strategy lays out necessary improvements for teaching and learning processes in order to adapt to digital changes in society. Six areas of action are identified: curricular development (1), teacher education (2), infrastructure (3), educational media (4), school administration programs (5) as well as legal and functional frameworks. All fields of actions focus on the facilitation of students’ “Competencies in a Digital World” (CDW), which are summarized in a competency framework. This framework is based on three competency models, namely the DigComp

(Caena & Redecker, 2019; Vuorikari et al., 2016), the Competency-oriented Concept for Media Education in Schools (Länderkonferenz Medienbildung, 2015) and the model of the International Computer and Information Literacy (ICLIS) (Senkbeil et al., 2014). ICLIS is centered around two competency fields. The first one is called Searching and Researching Information and the second one is called Creating and Sharing Information (Senkbeil et al., 2014). The Competencies in a Digital World are structured in six competency fields.

(1) Searching, Processing and Storing (SPS) includes search strategies, the critical analysis of information and structured storage of data
(2) Communicating and Cooperating (CC) is comprised of digital communication tools and sharing of information. Other parts of CC are skills for collaborative work, knowledge about formal and informal rules of digital communication and participation in the society.
(3) Producing and Presenting (PP) focuses on digital tools for the creation, editing and presentation of digital resources and products with regard to legal restrictions.
(4) Protecting and Securing (PS) means to know about digital risks and challenges of digitalisation for societies and the environment, as well as protection strategies, including personal data, privacy and health.
(5) Problem-solving and Acting (PA) includes the identification of technical problems and consequently choosing necessary tools for appropriate solutions. It also contains the evaluation of personal skills and the knowledge on how to further develop those skills. In addition, the aspects of computational thinking (Wang) are listed in the competency field.
(6) Analysing and Reflecting (AR) focuses on digital media, the spreading of information through digital media and its influence on society, politics and economy.

The authors of the strategy underline the fact that the competency fields are relevant for all subjects, but to a varying degree and with a differing focus on the various competency fields. The strategy implies a holistic perspective on digital competencies, which discards the idea of a single ICT subject in favour of a multi-subject approach (KMK, 2017a). The strategy is developed for all schools of general education. As such, the described digital competency fields are carried over to the dual system and the vocational schools. The CDW are expanded for the vocational school, emphasizing the requirements of the future workplace. This includes tools of the industry 4.0 (Roll & Ifenthaler, 2021), self-management, global thinking, data security and data privacy, project based work processes as well as the critical reflection on the influence of digitalisation on living and work environments. The strategy concept of the KMK represents

a comprising set of requirements for the future development of school curricula for the schools in Germany. Since the publication of the strategy, stakeholders have already reformed parts of the curricula. Regarding the slow speed and the often-criticized misalignment of curricula development with changes in the society (Goller et al., 2020), the following research questions concentrate on the role of digitalisation in the curricula of vocational schools in Baden-Württemberg, Germany.

RQ1: What role does digitalisation play in the curricula of the different types of vocational schools in the federate state of Baden-Württemberg, Germany?
RQ2: To what degree do current curricula at vocational schools already align to the goals of the strategy concept Education in the Digital World?

The role of digitalisation focuses on the presence of digital terms in the curricula of vocational schools. The integration of topic specific terms into curricula can be an indicator for the importance of the topic, in this case digitalisation. The second research question adds a qualitative component to the analysis and examines the connection between the goals of the CDW and the curricula of vocational schools.

3.3 Methods

3.3.1 Data Collection

A text mining approach is being used to answer the research questions. Text mining is a process which examines a big number of documents with the help of computer programs and algorithms. The advantages of text mining are based on increasing computational power and the availability of digital text documents. Archives and databases which had to be searched manually in the past can now be automatically analysed and structured (Feinerer et al., 2008; Moro et al., 2019; Wiedemann, 2016). In text mining, the sum of the collected and organized texts for analysis is called corpus (Kwartler, 2017). The corpus for this research project consists of the curricula of all types of vocational schools in the federate state of Baden-Württemberg, which have been acquired through the process of web scraping (Ignatow, 2019). In total, 831 curricula documents have been scraped from the website. The scraping algorithm has been developed with the RCrawler package (Khalil & Fakir, 2017) using the R-Studio software. The curricula of the vocational schools in Baden-Württemberg were accessed and downloaded from the website of the Federal Institute of School Development (in German: Landesinstitut für Schulentwicklung). The data has recently been moved to a new website, called curricula-bw (in German: bidlungspläne-bw). Web scraping had to be used for a variety of reasons. It is not possible to download a bundled package of a subject, a single grade, a single school type or a combination of those characteristics. The website forces the user to move through four different structural levels by selecting the type of school and then choosing from a division of subjects (e.g. MINT). Under those divisions, single subjects (e.g. math, biology, chemistry) can be found, which are themselves segmented into the curricula of different grades, depending on the school type. Some of the filenames were incomplete or misleading, especially when the same curriculum is being used in different types of schools. The meta data of the pdf files were insufficiently structured, damaged or blank. The web scraping approach allowed for a thorough collection of data, including proper file names and the creation of useable meta data, which resulted in 831 documents. After the removal of stopwords (Rani & Lobiyal, 2020), these 831 documents contained 128731 words.

3.3.2 Analysis

Two analysis approaches were used to examine the data in regard to the research questions. The text mining packages tm (Feinerer et al., 2008), quanteda (Benoit et al., 2018) and stopwords (Benoit et al., 2021) for RStudio. RQ1 is analysed through descriptive methods. The frequency of terms belonging to the construct digitalisation can hint towards the role digitalisation plays in the existing curricula. More importantly, comparisons between the different types of schools can be made (Kerres & Schmidt, 2011). A dictionary was created to label documents which contain terms belonging to digitalisation (Moro et al., 2019). This dictionary consists of 62 different terms (e.g. the German words for digitalisation, digital print, digital photography, analog-digital-transformation, see appendix) which have been identified within the corpus. It is unnecessary to include features which exists outside of the corpus (e.g. the term digital currency, in German Digitalwährung), because the curricula are compared between each other and not with other texts or corpora. It is important to create a dictionary in which the specifics of a language are considered. In the German language, substantives are generally formed by combining two words into a single word (Dürscheid & Elspaß, 2018), whereas the two words build a single term, but not a single word, in the English language (e.g. digital art in English, Digitalkunst in German). This might increase or decrease the extent of a dictionary used in text mining considerably. The dictionary has been used to analyse the frequency of digital terms within the corpus as well as the distribution within and between different types of schools.

RQ2 has been examined through the analysis of keywords in context (Benoit et al., 2018; Kronberger & Wagner, 2000).While the descriptive analysis can help stakeholders to explore curricula and gather fundamental information about their composition, a Keywords in Context (KWIC) analysis allows to examine how certain words are used in the document (Maramba et al., 2015). The keywords as well as the words preceding and following these keywords are extracted from the corpus. In addition, the exact source (e.g. document name, page, row) or other meta data can be added for further analysis. One of the risks of KWIC is the loss of context by selecting to few words surrounding the keyword (Leech & Onwuegbuzie, 2007). The KWIC deployed to answer RQ1 used the 20 words before and after the keyword. This way, the sentences that contained the keyword, but also the preceding and following sentence could be analysed, reducing the risk of context loss. After the extraction of keywords in their context, the usage of the keywords was examined by allocating the KWIC elements to the different competency fields of the KMK strategy (KMK, 2017a). As a result, statements about the emphasis of the dimension within the curricula can be made.

3.4 Results

3.4.1 RQ1: The Role of Digitalisation in Vocational School Curricula

Within the 831 documents, 200 documents (24%) contain at least one of the features. The 62 different features appear 1133 times over all documents. Table 3-2 shows the distribution of digital terms in the curricula of the five main types of vocational schools. The number of curricula in the corpus for each of the types of vocational school is shown in the column *Curricula*. The number of documents that contain any of the digital terms is shown in the column *Digital*. The column *Rate* shows how many percent of curricula of a school contain a digital term. The column *Terms* includes the number of times a digital term appears in the curricula and the percentage value in relation to the total number of digital terms in all documents.

Table 3-2

Digital Terms in the Curricula of the Five Main Types of Vocational Schools

School	Curricula	Digital	Rate	Terms
Berufsschule	303 (36.5 %)	89 (44.5 %)	29.4 %	543 (47.9 %)
Berufsfachschule	41 (4.9 %)	5 (2.5 %)	12.2 %	21 (1.9 %)
Berufskolleg	225 (27.1 %)	39 (19.5 %)	17.3 %	248 (21.9 %)
Berufsoberschule	40 (4.8)	6 (3.0 %)	15.0 %	28 (2.5 %)
Fachschule	103 (12.4 %)	23 (11.5 %)	22.3 %	127 (11.2)
Berufliches Gymnasium	132 (15.9 %)	38 (19.0 %)	28.8 %	166 (14 .7 %)
Total	831 (100 %)	200 (100 %)	24.1 %	1133 (100 %)

The curricula of the Berufsschule make up most of the majority (36.5%) of curricula in the corpus. From the 200 curricula that contain a digital term, 44.5% belong to the Berufsschule. Almost half of all the occurrences of a digital term can be found in the curriculum of the Berufsschule. With a rate of 29.5 %, close to a third of the curricula of the Berufsschule contain a digital term. For the Berufliches Gymnasium, the rate of curricula with digital terms is almost the same, followed by the Fachschule. In contrast, only a small amount of the curricula of the

Berufsfachschule (12.2 %), the Berufsoberschule (15 %) and the Berufskolleg (17.3 %) contain digital terms.

The curricula with the most occurrences can be found within the group of subjects and degrees that belong to the media sector. The one with the most occurrences belongs to Berufskolleg. The curriculum for Graphic and Design (Grafik und Design) was implemented in 2019 and contains 89 occurrences. As one of the newer curricula, it does not describe learning goals and competencies for a single school year, but rather the full three years students have to participate in the program to get the subject specific degree. In terms of occurrences, the curriculum is followed by the curricula of Commercial IT (Kaufmännische IT Berufe 2019, 90 occurrences), Media Agent (Medienkaufmann/frau 2014, 84 occurrences) and Digital Print (Mediengestaltung DigiPrint 2004, 55 occurrences), which all belong to the Berufliche Schule. The number of occurrences keeps declining, with the curriculum of Design & Media (Profil Gestaltung und Medien 2016), containing 34 occurrences. The continued ranking then contains more technical subjects and degrees, such as Media Technician (Medientechnik FS), Construction Mechanic (Konstruktionsmechaniker), Assistance for Media Technics (Medientechnischer Assistent) and Industrial Plant Mechanic (Anlagenmechaniker), which all belong to the Berufliche Schule.

3.4.2 RQ2: Digital Competencies in the Curricula of Vocational Schools

The findings of the KWIC analysis (Benoit et al., 2018; Kronberger & Wagner, 2000) and the consequent assignment of citations to the competency fields of the KMK strategy (KMK, 2017a) resulted in the following distribution. Half of the citations have been allocated to Problem-solving and Acting (PA), with a strong focus on the usage of tools for occupation related tasks. The competency field Searching, Processing and Storing (SPS) makes up 25% of the allocations, with most keywords in the context of internet search. The distribution of the competency fields is followed by Producing and Presenting and Analysing (PA) and Reflecting (AR) with 10% each. The competency fields with the least amount of assigned citations are Protecting and Security (PS) and Communicating and Cooperating (CC) (2.5 % each). The distribution is comparable between the different types of schools.

3.5 Conclusion

The findings of the text mining analysis provide information about the role of digitalisation in the curricula of vocational schools in Baden-Württemberg, Germany. At the moment, a small number (24%) of the curricula include terms that can be assigned to digitalisation. With regard to RQ1, the proportion differs between the different types of vocational schools. The mean is skewed by the high number of digitalized curricula of the Berufsschule. On the one hand, the Berufsschule connects a lot of vocational students to digitalisation based on the curricula. On the other hand, the curricula in the other types of vocational schools fall far behind, resulting in potentially much less contact with digitalisation for the students at those schools. One of the goals of the stakeholders involved in curriculum development has to be an increasing proportion of curricula with digital content, especially at the Berufsfachschule, the Berufsoberschule and the Berufskolleg. The permeability of the dual system and students' capability to choose their own educational paths requires an equal representation of digitalisation in the curricula of the different types of vocational schools (Virdia & Schindler, 2019). The challenges of the digitalized workspace (Roll & Ifenthaler, 2020a) and the social expectations towards the dual system (Euler, 2013) can hardly be met with the current vocational school curricula.

The difference between the intended digital competency goals (KMK, 2017b, 2017a) and the current implementation in the curricula of vocational schools can also be found in the findings of RQ2. Although all competency fields can be found in curricula, they are not equally distributed. The fact that a high number of occurrences have assigned to PA is a consequence of the subject- and workplace related focus of vocational schools. This focus includes profession-specific knowledge about specific technical tools. Currently, the view on digital tools is often limit on their capability to find and store information, which can be seen in the high rate of occurrences labelled in SPS. Important competencies for a future in a digital world are inadequately represented (Fraillon et al., 2020). In the time to come, data privacy, data security, cooperative forms of work and digital citizenship have to be placed more broadly in the curricula.

From a methodical perspective, this number of curricula containing digital terms is probably higher, because the dictionary that has been used for the analysis does not contain all features belonging to digitalisation, such as the word internet. The inclusion of additional terms would indubitably increase the proportion of curricula containing digital terms. At the same time, adding terms would decrease the focus of the dictionary. The distributions of the competency fields in the findings of RQ2 would probably change as well. Given the large amount of mentions allocated to PA and SPS, the overall findings would not change and might even

increase the proportion of the two most prominent competency fields.

The process of web crawling and the subsequent text mining analysis provide a superficial, yet comprehensive perspective on the curricula of the vocational schools, given the large number of analysed documents. The conclusive findings in the distributions in both RQ1 and RQ2 would probably only change slightly with a more granular analysis. Such a refined analysis is indicated once more of the curricula have been aligned with the CWD. Especially in regard to RQ2, the presence of the six competency fields could be analysed with a focus on the different sub-competencies of the strategy concept (KMK, 2017b, 2017a). In addition, an approach which includes qualitative differences between the identified terms could overcome the shortcomings of the mainly quantitative approach. While occurrences have been counted and classified, the study does not uncover differences based on the quality and significance of specific terms. Further research could identify wording which is particularly useful to describe the goals of the CWD within the curricula. Such expressions could be used as best-practice examples for the revision of curricula.

A thorough implementation of digitalisation into the curricula is necessary with regard to the requirements of the digitalized workspace and a changing society (Balsmeier & Woerter, 2019; Seeber & Seifried, 2019; Wild & Schulze Heuling, 2020; Wuttke et al., 2020). Many stakeholders at vocational schools will be able to profit from further implementations.

School leaders are enabled to provide necessary infrastructure and tools, because they can make a connection between the financial investments and the requirements of the curricula (Dexter, 2008; Håkansson Lindqvist & Pettersson, 2019; Hauge, 2016). Curricula can be used as guidelines for the selection of incoming teachers as well as the professional development training of teaching and administrative personnel. Organisational decisions, such as the cooperation between schools, businesses or research facilities, can be based on curricula.

Businesses as partners in the dual system can tailor their practical training processes in accordance with the curricula to provide students with the competencies that are of particular importance for the specific businesses. Businesses can also use curricula as a summary of the digital competencies of job applicants with a certain vocational degree.

Teachers interpret curricula as guidelines for meaningful teaching, because they get reassured about the social acceptance and the relevance of the content they teach (Pahl, 2014). They can inform their students about the reasons why they teach certain topics, strengthening the basis for constructive alignment within their classes (Biggs & Tang, 2011). As a result, teachers are enabled to plan and conduct their classes (J. K.-S. Chan, 2010; Ellis, 2004; Matos et al., 2019). Dissolving insecurities about the importance of digital contents in curricula

supports the efforts of teachers to cooperate across subjects, classes, years, vocational programs and the different types of vocational schools.

Students at vocational school will profit the most from the further integration of the digital competency fields into the curricula. In a continuous process, students can reflect on their competencies and the competencies in the curricula, which are necessary to successfully advance in their education. Aligning the competency fields across different types of vocational schools will increase the upwards permeability of the dual system and helps students to find a vocational training program that fits their skills and interests. Most importantly, the combined effects of the integration of competency fields into the curricula of vocational schools will enable all stakeholders to facilitate the development of student's digital competencies over all vocational schools.

3.6 References

Arends, H. (2017). Equal Living Conditions vs. Cultural Sovereignty? Federalism Reform, Educational Poverty and Spatial Inequalities in Germany. *Publius: The Journal of Federalism*, *47*(4), 673–706. https://doi.org/10.1093/publius/pjw042

Balsmeier, B., & Woerter, M. (2019). Is this time different? How digitalization influences job creation and destruction. *Research Policy*, *48*(8), 103765. https://doi.org/10.1016/j.respol.2019.03.010

Batzel, G., & Börgmann, S. (2017). *Berufsbildungsbegriffe Deutsch-Englisch : Terminologiesammlung für Berufsbildungsfachleut*. Bundesinstitut für Berufsbildung.

Bellin-Mularski, N., Mah, D. K., & Ifenthaler, D. (2016). Pre-service teachers' perceptions of school development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age: Papers from CELDA 2014* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Benoit, K., Watanabe, K., & Muhr, D. (2021). *stopwords - Multilingual Stopword Lists in R*. https://github.com/quanteda/stopwords

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., & Matsuo, A. (2018). quanteda: An R package for the quantitative analysis of textual data. *Journal of Open Source Software*, *3*(30), 774. https://doi.org/10.21105/joss.00774

Berisha-Gawlowski, A., Caruso, C., Goller, G., & Harteis, C. (2020). Auswirkungen der Digitalisierung industrieller Arbeit auf die berufliche und allgemeine Bildung. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56). wbv Media GmbH & Co. KG. https://www.ssoar.info/ssoar/bitstream/handle/document/70167/ssoar-2020-heisler_et_al-Digitalisierung_am_Ubergang_Schule_Beruf.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2020-heisler_et_al-Digitalisierung_am_Ubergang_Schule_Beruf.pdf

Berufskompass Chemie. (2013). *Entwicklungswege Elektroberufe*. Berufskompass Chemie. https://www.berufskompass-chemie.de/dokumente/Entwicklungswege_Elektroberufe.pdf

Biggs, J., & Tang, C. (2011). *Teaching For Quality Learning At University*. McGraw-Hill Education.

BMBF. (2015). *Datenreport zum Berufsbildungsbericht 2015. Informationen und Analysen zur Entwicklung der beruflichen Bildung*. Bundesinstitut für Berufsbildung. http://datenreport.bibb.de/media2012/BIBB_Datenreport_2012.pdf

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Chan, H. K., Griffin, J., Lim, J. J., Zeng, F., & Chiu, A. S. F. (2018). The impact of 3D Printing Technology on the supply chain: Manufacturing and legal perspectives. *International Journal of Production Economics*, *205*, 156–162. https://doi.org/10.1016/j.ijpe.2018.09.009

Chan, J. K.-S. (2010). Teachers' responses to curriculum policy implementation: colonial constraints for curriculum reform. *Educational Research for Policy and Practice*, *9*(2), 93–106. https://doi.org/10.1007/s10671-010-9082-5

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology : the digital revolution and schooling in America* (Second edi). Teachers College Press.

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826

Dexter, S. (2008). Leadership for IT in Schools. In *International Handbook of Information Technology in Primary and Secondary Education* (pp. 543–554). Springer US. https://doi.org/10.1007/978-0-387-73315-9_32

Dürscheid, C., & Elspaß, S. (2018). Variantengrammatik des Standarddeutschen. In *Regionale Variation des Deutschen*. DE GRUYTER. https://doi.org/10.1515/9783110363449-024

Eickelmann, B., Drossel, K., & Heldt, M. (2020). Vorteile digital fortgeschrittener Schulen in der Pandemie-Zeit. Ergebnisse einer repräsentativen Lehrkräftebefragung. *Schulmanagement. Fachzeitschrift Für Schul- Und Unterrichtsentwicklung*, *51*(3), 28–31. https://kw.uni-paderborn.de/fileadmin/fakultaet/Institute/erziehungswissenschaft/Schulpaedagogik/2020_Eickelmann_et_al_Vorteile_digitaler_Schulen_in_Pandemiezeiten_Zeitschrift_Schulmanagement.pdf

Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen*, *29*(4), 111–115.

Ellis, A. K. (2004). *Exemplars of Curriculum Theory*. Routledge.

Euler, D. (2013). *Germany´s dual vocational training system - a model for other countries?* Bertelsmann Stiftung. https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Bibliothek/Doi_Publikationen/GP_Germanys_dual_vocational_training_system.pdf

Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1

Feinerer, I., Hornik, K., & Meyer, D. (2008). Text Mining Infrastructure in R. *Journal of Statistical Software*, *25*(5). https://doi.org/10.18637/jss.v025.i05

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

Freiling, T., & Mozer, P. (2020). Digitale Lernformen unterstützen die Lernortkooperation in der beruflichen Bildung! In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf: Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 139–152). wbv Media GmbH & Co. KG.

Goller, M., Caruso, C., Berisha-Gawlowski, A., & Harteis, C. (2020). Digitalisierung in der Landwirtschaft: Gründe, Optionen und Bewertungen aus Perspektive von Milchviehlandwirtinnen und -landwirten. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56, pp. 53–80). wbv Media GmbH & Co. KG. https://doi.org/10.3278/6004725w

Håkansson Lindqvist, M., & Pettersson, F. (2019). Digitalization and school leadership: on the complexity of leading for digitalization in school. *The International Journal of Information and Learning Technology*, *36*(3), 218–230. https://doi.org/10.1108/IJILT-11-2018-0126

Harteis, C. (2018). *Machines, Change and Work: An Educational View on the Digitalization of Work* (pp. 1–10). https://doi.org/10.1007/978-3-319-63257-5_1

Hauge, T. E. (2016). On the Life of ICT and School Leadership in a Large-Scale Reform Movement. In *Digital Expectations and Experiences in Education* (pp. 97–115). SensePublishers. https://doi.org/10.1007/978-94-6300-648-4_6

Hirsch-Kreinsen, H. (2016). Digitization of industrial work: development paths and prospects. *Journal for Labour Market Research*, *49*(1), 1–14. https://doi.org/10.1007/s12651-016-

0200-6
Hrastinski, S. (2019). What Do We Mean by Blended Learning? *TechTrends*, *63*(5), 564–569. https://doi.org/10.1007/s11528-019-00375-5
Ignatow, G. (2019). Text Mining. In *Digital and Media Research*. SAGE Publications Ltd. https://doi.org/10.4135/9781526421036821928
Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. *Education and Information Technologies*, *21*(3), 655–679. https://doi.org/10.1007/s10639-014-9346-4
Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education*, *67*, 37–45. https://doi.org/10.1016/j.tate.2017.05.016
Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., & Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Computers & Education*, *68*, 473–481. https://doi.org/10.1016/j.compedu.2013.06.008
Kerres, M., & Schmidt, A. (2011). Zur Anatomie von Bologna-Studiengängen. Eine empirische Analyse von Modulhandbüchern. *Die Hochschule : Journal Für Wissenschaft Und Bildung*, *20*(2), 173–191. https://nbn-resolving.org/urn:nbn:de:0111-pedocs-163314
Khalil, S., & Fakir, M. (2017). RCrawler: An R package for parallel web crawling and scraping. *SoftwareX*, *6*, 98–106. https://doi.org/10.1016/j.softx.2017.04.004
KMK. (2017a). *Bildung in der digitalen Welt - Strategie der Kultusministerkonferenz*. Sekretariat der Kultusministerkonferenz. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2018/Digitalstrategie_2017_mit_Weiterbildung.pdf
KMK. (2017b). *The Standing Conference's "Education in the Digital World" strategy - Summary*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2017/KMK-Strategie_Bildung_in_der_digitalen_Welt_Zusammenfassung_en.pdf
KMK. (2019a). *Basic Structure of the Education System in the Federal Republic of Germany*. KMK. https://www.kmk.org/fileadmin/Dateien/pdf/Dokumentation/en_2019.pdf
KMK. (2019b). *The Education System in the Federal Republic of Germany 2017/2018 - A description of the responsibilities, s truc tures and development s in education poli cy for the exchange of information in Europe*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany.
Kronberger, N., & Wagner, W. (2000). Keywords in context: Statistical analysis of text features. *Qualitative Researching with Text, Image and Sound: A Practical Handbook*, 299–317.
Kwartler, T. (2017). *Text Mining in Practice with R*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/unimannheim-ebooks/detail.action?docID=4860512
Länderkonferenz Medienbildung. (2015). *Länderkonferenz MedienBildung: Kompetenzorientiertes Konzept für die schulische Medienbildung: LKM-Positionspapier*. https://lkm.lernnetz.de/files/Dateien_lkm/Dokumente/LKM-Positionspapier_2015.pdf
Leech, N. L., & Onwuegbuzie, A. J. (2007). An array of qualitative data analysis tools: A call for data analysis triangulation. *School Psychology Quarterly*, *22*(4), 557–584. https://doi.org/10.1037/1045-3830.22.4.557
Lichtenberg, P. (2015). *Zuordnung nationaler Bildungsprogramme zur ISCED 2011*. OECD. https://www.oecd.org/berlin/publikationen/Zuordnung nationaler Bildungsprogramme zur ISCED 2011.pdf
Luke, A., Sefton-Green, J., GGraham, P., Kellner, D., & Ladwig, J. (2017). Digital ethics, political economy, and the curriculum: This changes everything. In K. A. Mills, A.

Stornaiuolo, A. Smith, & P. Jessica Zacher (Eds.), *Handbook of Writing, Literacies, and Education in Digital Cultures*. Routledge. https://doi.org/10.4324/9781315465258

Maramba, I. D., Davey, A., Elliott, M. N., Roberts, M., Roland, M., Brown, F., Burt, J., Boiko, O., & Campbell, J. (2015). Web-Based Textual Analysis of Free-Text Patient Experience Comments From a Survey in Primary Care. *JMIR Medical Informatics*, *3*(2), e20. https://doi.org/10.2196/medinform.3783

Matos, J., Pedro, A., & Piedade, J. (2019). Integrating Digital Technology in the School Curriculum. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(21), 4. https://doi.org/10.3991/ijet.v14i21.10863

Moro, S., Pires, G., Rita, P., & Cortez, P. (2019). A text mining and topic modelling perspective of ethnic marketing research. *Journal of Business Research*, *103*, 275–285. https://doi.org/10.1016/J.JBUSRES.2019.01.053

Nadkarni, S., & Prügl, R. (2021). Digital transformation: a review, synthesis and opportunities for future research. *Management Review Quarterly*, *71*(2), 233–341. https://doi.org/10.1007/s11301-020-00185-7

Olofsson, A. D., Fransson, G., & Lindberg, J. O. (2020). A study of the use of digital technology and its conditions with a view to understanding what 'adequate digital competence' may mean in a national policy initiative. *Educational Studies*, *46*(6), 727–743. https://doi.org/10.1080/03055698.2019.1651694

Pahl, J.-P. (2014). *Berufsschule: Annäherungen an eine Theorie des Lernortes 3. überarbeitete und erweiterte Auflage*. wbv Media.

Pant, H. A. (2021). *Einführung in den Bildungsplan 2016 - Warum ein »neuer« Bildungsplan? Anlässe und Absichten der Bildungsplanreform*. http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/EINFUEHRUNG

Patterson, R. W., & Patterson, R. M. (2017). Computers and productivity: Evidence from laptop use in the college classroom. *Economics of Education Review*, *57*, 66–79. https://doi.org/10.1016/j.econedurev.2017.02.004

Pätzold, G., Rauner, F., Husinga, R., Buchmann, U., Kirsch, J.-L., Brandsma, J., Bremer, R., Fischer, M., Euler, D., Gomez, J., Keller, M., Walzik, S., Ertl, H., Sloane, P. F. E., Spöttl, G., Windelband, L., Becker, W., Meifort, B., Haasler, B., … Rein, V. (2006). *Qualifikationsforschung und Curriculumentwicklung.* (G. Pätzold & F. Rauner (Eds.)). Steiner.

Pettersson, F. (2021). Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technologies*, *26*(1), 187–204. https://doi.org/10.1007/s10639-020-10239-8

Pleshakova, A. Y. (2019). Germany's dual education system: The assessment by its subjects. *The Education and Science Journal*, *21*(5), 130–156. https://doi.org/10.17853/1994-5639-2019-5-131-157

Rani, R., & Lobiyal, D. K. (2020). Performance evaluation of text-mining models with Hindi stopwords lists. *Journal of King Saud University - Computer and Information Sciences*. https://doi.org/10.1016/j.jksuci.2020.03.003

Roll, M., & Ifenthaler, D. (2020). Lernort-übergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.

Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4

Schneider, S. L. (2021). The classification of education in surveys: a generalized framework for ex-post harmonization. *Quality & Quantity*. https://doi.org/10.1007/s11135-021-01101-1

Seeber, S., & Seifried, J. (2019). Herausforderungen und Entwicklungsperspektiven der beruflichen Bildung unter veränderten Rahmenbedingungen. *Zeitschrift Für Erziehungswissenschaft, 22*(3), 485–508. https://doi.org/10.1007/s11618-019-00876-2

Senkbeil, M., Goldhammer, F., Bos, W., Eickelmann, B., Schwippert, K., & Julia, G. (2014). Das Konstrukt der computer- und informationsbezogenen Kompetenzen in ICILS 2013. In *ICILS 2013. Computer- und informationsbezogene Kompetenzen von Schülerinnen und Schülern in der 8. Jahrgangsstufe im internationalen Vergleich* (pp. 83–112). Waxmann.

Spener, C., Häuber, G., Horlacher, T., & Schumann, S. (2019). Der berufsschulische Einsatz von ERP-Systemen in der Ausbildung von Industriekaufleuten. In K. Wilbers (Ed.), *Digitale Transformation kaufmännischer Bildung. Ausbildung in Industrie und Handel hinterfragt* (Vol. 23, pp. 195–216). epubli GmbH.

statistik-bw. (2020). *Öffentliche berufliche Schulen: Rückgang der Schülerzahlen setzt sich fort*. Pressemitteilung 51/2020. https://www.statistik-bw.de/Presse/Pressemitteilungen/2020051

Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review, 30*, 100314. https://doi.org/10.1016/j.edurev.2020.100314

Tosuntaş, Ş. B., Karadağ, E., & Orhan, S. (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education, 81*, 169–178. https://doi.org/10.1016/j.compedu.2014.10.009

Virdia, S., & Schindler, S. (2019). Educational upgrading, career advancement, and social inequality development from a life-course perspective in Germany. *Research in Social Stratification and Mobility*, *60*(2), 29–38. https://doi.org/10.1016/j.rssm.2019.02.002

Vuorikari, R., Punie, Y., Carretero, S., & Van Den Brande, L. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens* (pp. 1-). Publications Office of the European Union. https://doi.org/10.2791/11517

Wiedemann, G. (2016). *Text Mining for Qualitative Data Analysis in the Social Sciences*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-15309-0

Wild, S., & Schulze Heuling, L. (2020). How do the digital competences of students in vocational schools differ from those of students in cooperative higher education institutions in Germany? *Empirical Research in Vocational Education and Training*, *12*(1), 5. https://doi.org/10.1186/s40461-020-00091-y

Wuttke, E., Seifried, J., & Niegemann, H. M. (2020). Editorial: In *Vocational Education and Training in the Age of Digitization* (pp. 9–14). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.3

Zhao, Z. (2014). Curriculum Research. In Z. Zhao & F. Rauner (Eds.), *Areas of Vocational Education Research* (pp. 189–214). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-54224-4_10

4. Teachers' Perspective on School Development at German Vocational Schools during the COVID-19 Pandemic

4.1 Introduction

The nationwide closing of schools due to the COVID-19 pandemic in the first half of 2020 was a radical recess for the German society. Similar to other European countries, a closing of school facilities had last occurred during World War II. The current closing applied to day-care centres, kindergartens, primary and secondary schools, vocational schools, and institutions of higher education. In March 2020, classroom teaching was ceased in all German federal states to protect students, teachers, and other school personnel from COVID-19 virus infection. Initially, schools were scheduled to reopen April 2020, but the ongoing pandemic forced policy makers to invoke several extensions. In schools, teachers and administration started to implement online teaching. The rapid and extensive shift from offline to online learning and teaching constituted an enormous challenge for all stakeholders in school development, referred to as a conscious and systematic transformation performed by the stakeholders (Rolff, 1995), but especially for teachers.

This paper focuses on the challenges to teachers during the process of digitalisation in school development with a specific emphasis on the COVID-19 pandemic. It examines the intrapersonal prerequisites for teaching with technology as described in the TPACK (Technological Pedagogical Content Knowledge) framework (Mishra & Koehler, 2006), the changes in learning and teaching attitudes related to technology integration (Ifenthaler & Schweinbenz, 2013, 2016), and the preconditions concerning schools as part of a learning organisation (Ilomäki & Lakkala, 2018). These preconditions comprise schools' technological infrastructures and organisational conditions (Fraillon et al., 2019), for example the number of mobile devices (e.g., tablets) available at a school or the presence of a school-wide digital development plan.

The goal of the study was to identify the most common influences of COVID-19 on school development. The coping and solution strategies developed during the pandemic could be useful for other schools and beyond the pandemic.

4.2 Background

4.2.1 German Vocational schools and Teacher Training

For the past years, schools in Germany have not been able to systematically widely integrate Information and Communication Technology (ICT) into teaching, learning, and organisational development. The technological infrastructure to support ICT in schools is less developed than the European mean (Fraillon et al., 2020). A connection to wireless LAN is available to 50% of the students, but only a third of the vocational schools are equipped with the necessary high-speed internet via fibre optic (European Commission, 2019; McCoy et al., 2016). Findings propose that missing technical infrastructure is one reason for students' underdeveloped ICT competencies (Fraillon et ∗al., 2020). German teachers use technology less often than their colleagues in other European countries, and as a result, almost 30% of German students show very low or low ICT competencies (Fraillon et al., 2020). Another reason ICT is not as present in German schools as it is in other European countries is the absence of ICT in teacher education programmes and K-12 curricula (Eickelmann et al., 2020). As a consequence of the lack of formalisation in teacher education programmes and K-12 curricula, stakeholders at schools often do not see the necessity of investing part of their budget into infrastructure or professional development of teachers' ICT competencies. The situation at German schools contrasts strongly with Germany's economic and political position as one of the world's richest countries by GDP.

The education system is the responsibility of the 16 German federal states. The cultural sovereignty of the federal states manifested itself to a high degree in the different school systems, with various types of schools and regulations in each federal state for the different levels of the International Standard Classification of Education (ISCED). The ISCED framework has been developed by UNESCO and can be used to compare education system across different countries through two main cross-classification variables. The first one is the level of education, ranging from early childhood education (level 1) to doctoral level (level 9). The second variable is the field of education, for example science, health or law (OECD, 2015). Within Germany's vocational education system, students are taught relevant subjects and general knowledge at vocational schools while practical knowledge is mediated at training companies and through internships. The vocational schools are assigned to the ISCED levels 3 (upper secondary education) and 4 (post-secondary non-tertiary education/tertiary education) and aim at providing students with the necessary skills for workplace environments not requiring a university degree. In the federal state of Baden-Württemberg, up to 15 different types of vocational schools can be summarized under the ISCED levels 3 and 4. The mean

student age is 20 years. They finish school between the age of 20 and 22 (BMBF, 2015). The different types of schools are mostly combined on one campus, called vocational school centres. The different types of vocational schools concentrate on improving the current education level of students as related to their chosen career. For example, at the so-called 'Berufskolleg' the programmes create a basis for further education by focusing on general skills and knowledge for the workplace. At the 'Berufsschule', classes are strongly connected to students' practical vocational training, emphasising subject specific knowledge in areas such as commerce, electronics, metallurgy and health.

The vast number of different types of school enables students and stakeholders to find the right type of school for their current level of knowledge and the skills they require. In addition, the school system values transition and permeability into the higher ISCED levels. It is relatively common for young people to graduate from a vocational school, join the workforce for some time, and then continue their education by applying for a university degree (Virdia & Schindler, 2019). On the other hand, permeability is often restricted to transition processes in a specific federal state. Moving from one federal state into the school system of another federal state often proves to be difficult. Especially for teachers, moving from one state to another is aggravated by the different and complex school systems (Scheller, 2018). The reduction of teachers' social mobility is seen as one reason for the predicted lack of teachers in Germany (Terhart, 2019). Another downside of education systems based on federalism is the slow speed at which those systems are able to adapt to changing international standards, include findings from educational science, or react to technological innovation (K. K. Wong et al., 2018).

The basic structure of teacher education in Germany is similar in all federal states. Teacher education occurs mainly in universities, where pre-service teachers are taught the theoretical background of two to three school subjects. In the second phase of teacher education, a two-year teacher training combines practical class teaching in schools with a specialized programme at teacher-training institutions. Terhart (2019) describes the system of initial teacher education in Germany as intensive and ambitious, while the in-service teacher education is not well developed because it is mainly conducted through seminars and workshops, which might not meet the requirements for individual teacher development. Although teachers are obliged to participate in in-service teacher education programmes in all 16 federal states, there are no reliable statistics for the amount and quality of seminars and workshops they attend (Grothus et al., 2018).

Teachers and teaching in vocational schools focus on subject specific, workplace-related knowledge (Schelten, 2009). It is relatively common for teachers at vocational schools to have

a practical background in the fields they teach. In many cases, they worked in their specific fields for some time before becoming teachers.

4.2.2 School development and digitalisation

Rolff (1995) defines school development as a continuous, intentional and planned transformation on all levels of a school, involving all stakeholders of the school. The related activities can focus on three dimensions: teaching (e.g., methodical training, student learning, differentiation), staff development (e.g., supervision, team observation, mentoring), and organisational development (e.g., school management, school concepts, cooperation). More recent conceptualisations include the schools' technological infrastructures and organisational conditions (Fraillon et al., 2020), for example the number of mobile devices (e.g., tablets) available for students or the presence of a school-wide digital development plan, as additional drivers for continuous and successful school development (Bellin-Mularski et al., 2016). The development of vocational schools has to consider additional key parameters, such as the cooperation between training companies and vocational schools (Müller, 2011). In addition, education at vocational schools focuses on workplace-related learning rather than on general knowledge, thus requiring different teacher skills (Schelten, 2009).

In the modern workplace environment, digital skills have become increasingly important for all professions (Oberländer et al., 2020; van Laar et al., 2019). Vocational schools have to consider the increasing digitalisation of their students workplaces (Harteis, 2018), such as digitised factories (Roll & Ifenthaler, 2020b; Teichmann et al., 2019). As a result, digitalisation has started to play a major role in in-service teachers' education programmes and processes of school development. Eickelmann and Gerick (2018) proposed a theoretical framework that highlights the importance of digitalisation for school development. In their model, school development can be diversified into five fields of development. (1) Education Development (ED), which focuses on the development of classroom activities. In connection with digitalisation, this contains teaching with tablets or creating new online learning situations. (2) Personnel Development (PD), which concentrates on the training and qualification of teachers and administrative personnel. This training consists of ongoing education that allows stakeholders to use data processing such as digital timetables to organize processes in the school context. (3) Organisational Development (OD), which comprises school rules and agendas as well as organisational mindsets and beliefs which are present in the schools.

Schools in Germany have started to formalise their digitalisation efforts with the help of special media development plans (Ifenthaler, 2019). (4) Technological Development (TD),

which summarises the ongoing maintenance and enhancement of technological infrastructure. It contains the investment into new digital devices, network administration and data security. (5) Cooperation Development (CD), which is especially important for vocational schools because they are in close contact with businesses and companies that take on trainees. In the model, CD should focus on stakeholders both outside and within the school. The school should be embedded in a strong network with other schools, the community it is located in, and relevant policy decisionmakers.

The five fields have to be understood as overlapping and dependent facets of school development. A TD investment into new tablets is a waste of money if teachers are untrained to use them (PD). Teachers can only implement new digital teaching methods (ED) if the school infrastructure allows access to the internet (TD). A similar holistic model is proposed by Ilomäki and Lakkala (2018). It contains almost the same elements as the aforementioned model, but it emphasizes the practices of teachers and students. Especially the skills of students might fade into the background of ED in the Eickelmann and Gerick (2018) model.

The role of the school principal as the leader is also underlined by Ilomäki and Lakkala (Ilomäki & Lakkala, 2018). One of the main tasks of school leadership is to bring the different stakeholders in a school together, to constantly reflect on the ongoing development processes and move toward a common vision. One of the model's weak points is the abundance of clear distinctions at some points. The model strongly differentiates between teachers and school management. However, in Germany, not only do teachers often fulfil tasks that are part of school management but most principals are also actively teaching classes. The roles and tasks can therefore not be defined as clearly as proposed by the model. This is the main reason the model by Eickelmann and Gerick (2018) has been used as the theoretical framework for this study. All five fields of development (Educational, Personnel, Organisational, Technological and Cooperation) are strongly affected by the ongoing digitalisation processes in school development.

4.2.3 Research questions

A rapid and extensive change in schools in the form of a "dramatical digital transformation" (Iivari et al., 2020) has taken place as a result of the COVID-19 pandemic, including a radical change from on-site teaching to online teaching and learning (Krishnamurthy, 2020). Technology can be used to offset some of the pandemic's negative impacts on education, but the limitations of tools and methods have to be thoroughly considered (Hilburg et al., 2020).

For example, Jæger and Blaabæk (2020) postulate an increasing inequality of learning opportunities based on a learner's socioeconomic status. Furthermore, especially younger students are dependent on their parents' support (Bol, 2020). The competence of leadership has been identified as a key factor for the transformation process at educational institutions during the COVID-19 pandemic (Singh & Haynes, 2020). The aforementioned assumptions result in specific research questions regarding the digitalisation of school development in vocational schools:

(1) In which way does the technological infrastructure influence the transformation process at vocational schools (Technological Development)?
(2) How does school leadership influence the transformation process (Organisational Development)?
(3) What are the key success factors and limitations for digital teaching and learning (Educational Development, Personnel Development)?
(4) What will be the long-term effects of the transformation process (Cooperation Development, Sustainability)?

4.3 Method

4.3.1 Participants

Initially, 20 interviews were supposed to be conducted. A participation rate of 50% was assumed based on the COVID-19 pandemic and former experience with qualitative studies at vocational schools. Twenty schools were randomly selected from a list of the 307 public vocational schools in the German federal state Baden-Württemberg. At each school, two people were randomly selected from the list of teachers on the school's website (one male, one female) and contacted by email. In total, 18 teachers agreed to participate and the interviews were conducted with 10 male and 8 female participants. The average age of the participants was 34.8 years, with the oldest participant being 58 and the youngest 29.

4.3.2 Instruments and Procedure

The interviews were conducted as semi-structured interviews (Adams, 2015). In the first part of the interview, participants' demographic data (e.g., gender, age) and data about the schools was collected (e.g., technological infrastructure). In the second part, participants reported on the procedures at the time on-site teaching ended, with a focus on school leadership, teaching and cooperation (e.g., school agenda, methods and tools for online teaching). The questions have been partially adapted from the work of Heinen and Kerres (2015). The goal was to accentuate specific teacher challenges and what measures were taken to overcome those challenges. In the last part, teachers were asked to evaluate the sustainability of the transformation process at their school. The interviews were conducted online (e.g., Zoom, Microsoft Teams) and via telephone. The interviews were recorded and transcribed using the software f4transkript.

4.3.3 Analysis

The transcribed interviews were coded and analysed using the software f4analyse, following the content structuring approach (Mayring, 2015). The participant statements were assigned to the five aforementioned development fields. This way, a cross section could be created for each category. New categories have been created for statements that could not be categorized under the development fields, especially statements regarding sustainability in the last part of the interviews (e.g., conditions for sustainability). Those categories could not be

created a priori, because they are based on the teachers believes. The statements about students and other teachers reflect the beliefs of the participants. Selected statements have been translated by one of the authors to serve as examples throughout the following chapters.

4.4 Results

4.4.1 RQ1: Available Technological Infrastructure

Before COVID-19, most of the surveyed schools had a learning management system (LMS), a cloud system, or both (16 out of 18). The most common LMS at those schools were Moodle, webuntis and Microsoft Teams. Microsoft Office 365 was available at around two thirds of the schools. The available systems were used by a small number of teachers. Only special tablet classes and the teachers who worked with those classes used the systems on a mandatory basis. All except one of the participants reported that they had little knowledge about using the LMS or cloud system at their school. Apart from the students in tablet classes, most of the students had no experience with the schools' LMS or cloud systems. In the most extreme cases, students did not have an account for the LMS/cloud system prior to the end of on-site teaching. All participants possessed a school email address and could be contacted through the school's website, via either email or a special contact formula that redirected to the teachers email address. A small number of schools provided students with their own student email address. The server infrastructure at three quarters of the schools proved to be inadequate for the switch to online teaching. The increasing traffic in the LMS/cloud system, email, and on the website caused numerous crashes. As a result, systems worked very slowly or not at all:

> "[…] and then on Tuesday, nothing worked anymore, not even emails, everything crashed and I couldn't contact anyone. Not my students, not even my colleagues, not even the school's administration." (Interview 3)

In one particular case, the server infrastructure had not been fixed at the time of the interview, which was conducted almost three weeks into the closing of schools. In other schools, major issues had been fixed during the first week, but occasional downtimes were still being reported, especially during times of high traffic in the morning.

All interviewed teachers mentioned numerous students that were unable to access learning material or participate in learning activities because of hardware restrictions on the students' sides. In some cases, students only possessed a mobile phone to access the internet. In other cases, students did not have internet access through a network provider and could only use their

mobile data plan. Students were limited by the underdeveloped German mobile phone network. Additionally, mobile data plans in Germany are expensive, compared to other European countries (Forkel et al., 2018). Students quickly used up their highspeed mobile data plan, especially when teachers started to use band-width heavy methods such as video calls. The comparably small display of the mobile phones made it difficult for students to complete digitalized learning material, decreasing student motivation to work online.

All interviewed teachers used their own computers at home as well as their own internet connection. A few teachers bought additional equipment (webcams and microphones) for video conferences and online teaching.

4.4.2 RQ2: Organisational Development

All schools were officially informed about the end of on-site teaching on Friday, 13th March 2020 by the Ministry of Culture. The directive declared Monday 16th March 2020 as the last day of school. Schools should reopen again after the Easter break (20th April 2020). All participants reported teacher meetings on the last day of school, which were used to inform teachers about the directive and the end of on-site schooling. School leadership and administration reacted differently to the situation. Some schools showed a higher degree of preparedness compared to other schools. At those schools, the last day of school was used to introduce teachers and students to the LMS. The school administration had prepared presentations and short manuals over the weekend to enable teachers and students to use the specific LMS. Although the school administration provided useful information, some participants reported overwhelmed students who could not keep up with the amount of information and the speed it was delivered:

> "[…] Students told me: "it was so much information, it is impossible to remember everything. I'm happy I know my password now!". Many of them were clearly overchallenged." (Interview 12)

In most of the schools, the school administration wanted teachers to provide the students with learning material and exercise sheets that could be processed at home. The distribution of those materials proved to be difficult because not all teachers were scheduled to regularly see specific classes on Mondays (the last day of school). In some of the school programmes, students only come to school on specific days, making them unreachable for their teachers on the last day of school. Additionally, the capacity of the copying machines was too low to enable

all teachers to print all the necessary material. To cope with these situations, some schools decided to provide students with digital learning material by e-mail. At schools that did not provide students with a student e-mail address, the organisation of e-mail distribution lists required teachers to collect the private e-mail addresses from their students. In a few schools, the school administration seemed unable to organize the last day of on-site teaching. Participants reported no or contradictory statements from the school leaders, leading to chaotic scenes at the schools:

> "The school's leadership thought of it as a regular day, with normal teaching and then everything would be closed. Almost as the last day before the holidays. Some teachers tried to provide their classes with learning materials, while other teachers frantically tried to rush each and every student away from the school premises." (Interview 5)

The school administration kept the teachers and students updated on current developments regarding the school's situation during the COVID-19 pandemic, as most participants reported. Getting information from the administration, such as the name of a student's training company, often worked as usual. Many of the administrative tasks which teachers handle during their daily work routine were obsolete because, for example, attendance registers or grading sheets were not in use.

4.4.3 RQ3: Personnel Development and Professional Learning

The participants reported that they mainly used the information given by the school administration and other teachers to prepare their learning material and to cope with the new situation at their schools. In many cases, teachers that were familiar with certain software started to provide small tutorials and workshops for their colleagues. Younger teachers reported that they already had their material digitalized and that they just had to upload their existing files instead of printing them out. After initial problems with the LMS were solved, the teachers quickly began to use the tools that were provided by their schools.

A big majority of participants reported the use of the trial-and-error principle as the initial way of finding adequate online teaching tools and methods. After supplying students with digitalized worksheets, teachers began to introduce voluntary feedback from the students. After this initial phase, teachers started to include small videos and online teaching through video conference tools. The participants mentioned the close attention they paid to the students' reactions during this process. The teachers' main goal was to find methods they themselves felt

comfortable with and which also helped students with their online learning activities. In many cases, teachers asked students which methods they liked or if they wanted to try something else.

> "I started using those small videos that I created with ExplainEverything. I had played around with the app before, but it wasn't very serious. I really like them, especially at the start of a new lecture or topic. The students like that they can watch them multiple times and they seem to really benefit from them." (Interview 3)

The participants reported that often one or two particular tools fitted their own personality and their teaching style best. They mentioned that this was only the case for specific classes and that the tool might not be useful for other students or topics. In addition, they experienced heterogenous feedback from students regarding the most efficient teaching tools. Participants described students in the same class that specifically asked for video conferences that were similar to regular school lessons, while other students want to stick with short videos.

Participants struggled with students who did not respond to their contacting approaches. The teachers described themselves as unsure whether those students were unwilling or unable to participate in online learning. They expressed fears about those students being unable to keep up with the rest of the class, especially in regard to the following school year and the students' professional training in general. Concurrently the participants were unsure about how to handle a future situation in which students might not have been able to comprehensively follow a class for such a long time:

> "And next year, they all have to be brought to an equal level again. It's the same situation in the 12th grade. They are all moving up to 13th grade next year and then the teacher has to see how to catch up." (Interview 13)

Teachers reported a broad variety of tools and methods they included into online teaching. Some teachers stuck to digital versions of the worksheets they had already prepared for regular offline classes. They bundled the worksheets into virtual stacks to limit the amount of e-mails they had to send or files they had to upload. Additionally, they provided students with precise instructions for the stacks and the single worksheets. A couple of teachers talked about small videos and tutorials they had created for their students, in addition to worksheets. Most teachers started to use online video conferencing tools to conduct online classes after the first weeks of uploading material, with a few exceptions, where online teaching was attempted right from the start.

Online classes were met with approval by teachers and students alike. The participants

reported that they felt the urge to be in direct, face-to-face contact with the students. The teachers stated that it was difficult to assess the students' current learning situations and that the online classes turned out to be an eligible method to create a situation in which students were able to express their concerns regarding teaching and learning directly, rather than writing an email. Meanwhile, the main difference teachers identified between online and on-site teaching was the stronger focus the former method put on the teacher; teachers described online teaching as a lot more challenging because it is experienced as a very teacher-centred form of teaching.

> "It's is a lot harder than regular classes. In the end, it often turns out to be completely teacher-centred teaching." (Interview 5)

Students were described as being more passive in online classes and that discussions between the different participants rarely occurred. Often, the students avoided using the camera or the microphone on their devices, which limited the teachers' possibilities to interpret the current situation.

> "You are in full lecturing mode and you get little to no feedback from the students because you cannot see if they grimace because they don't understand or if they nod because they do understand" (Interview 13)

In general, the students used the uploaded material and showed up for online lessons, but there were some students who were unwilling or unable to participate in online teaching. Every teacher reported students with whom they had been out of contact since the end of on-site teaching and who had failed to reply to attempts to get in touch. Those students were described as learners who already struggled in regular classes.

4.4.4 RQ4: Sustainability

The sustainability of the current online teaching methods and tools after the COVID-19 pandemic were valued differently by the participants. The majority of teachers wanted to keep providing digital learning material to their students on LMS and cloud systems. Teachers tended to use the same material or slightly updated material over a longer period of time once it had proven useful for the students. Uploading revised material for a class in the following school year was considered as an effective way of providing the students with learning material. Teachers did not asses the digitalization of material and the upload as a time-consuming process

once they had experienced it. In addition, they wanted their students to be competent in using the LMS and cloud systems as soon as they started learning at their schools. Most participants pled for the mandatory creation of student accounts and the distribution of login credentials in contrast to the existing regulation, in which teachers have to ask the IT administration to start the process of account creation.

With a few exceptions, all participants wanted to keep part of the online teaching methods and tools they used during the COVID-19 epidemic. A prominent example was creating and integrating short videos and tutorials. Videos about key principles and fixed ideas in a specific subject can be repeatedly revisited by students while the production of the video was interpreted as a single effort.

> "In my math class, there are so many principles that don't ever change, for example the Pythagorean theorem. If you make a video about that once, you can use it forever!" (Interview 12)

In the teachers' opinions, on-site teaching could not be fully replaced by online video classes. For successful learning, the teacher's presence and direct communication in the classroom were highly valued.

The teachers believe that the schools' technical infrastructures had to be improved to guarantee access to learning materials and communication tools. They also highlighted the importance of equipping students with adequate hardware while simultaneously pointing out the funding problems created by acquisition costs.

4.4.5 RQ4: Cooperation Development

The importance of cooperation between different stakeholders at the vocational schools was underlined by all participants, with a focus on the cooperation between teachers, students, and the students' training companies. The teachers particularly stressed the need for regular student contact to be able to guide the students through online teaching. In some cases, online teaching enabled teachers to support students on a more individual level.

> "One of them wrote an email to me asking if I could explain something to them again. So, I made a really short video call with them and I think they understood after the additional explanation because they were really very happy and thankful afterwards." (Interview 18)

The students' training companies were a big influence on the students' abilities to

participate in online teaching. When on-site teaching ended, some companies called in all their apprentices and made them work full time, which removed any possibility to take part in online classes. Teachers reported that students had told them they were simply too tired to go through uploaded material after a full day of work. The situation was especially difficult for students working in eCommerce, trading, and retail because those industries experienced a higher demand during COVID-19 while older colleagues who are part of risk groups could not come into work. Teachers and school leaders contacted the training companies to find solutions for the apprentices. This cooperation also helped students who were unable to work from home because they could use company technology to access learning material.

The participants reported an enhanced cooperation between teachers during COVID-19, notably regarding the use of online tools and teaching methods. Teachers experienced in online teaching and digital tools created tutorials and guides for their less experienced colleagues. Teachers who wanted to introduce online video classes often took part in a colleague's online video class to benefit from his or her experience. In the interviews, participants reported receiving and giving help to colleagues.

> "I have a colleague and she always calls me when she has trouble with Teams. She also wanted to do online video classes, so she invited me to a test run to see if everything would work and what she could do." (Interview 12)

Almost all participants mentioned the absent real-life social interactivity with students and teachers, while sometimes simultaneously being overwhelmed by the different digital tools they were using for communicating. They mentioned having to switch between different tools, depending on the stakeholder they were working with in a specific situation. In addition, regular working hours were experienced as being relaxed.

> "For example, I get an email: the administration wants me to fill out a form, but it is not attached to the email; it is uploaded to the intranet and I have to find it there first, which I only knew because they told me when I called them later" (Interview 18)

Chat applications and especially the use of other group chat functions were mentioned by many of the teachers. These functions were experienced as a quick way to send and receive information. The participants emphasized that the chat functions could be used from a smartphone and that chatting is something the students are used to.

4.5 Practical Implications

The COVID-19 pandemic proved to be a major challenge for students, teachers, and other stakeholders at vocational schools in Germany. The findings underline the assumption of interdepending development fields as proposed by the framework of Eickelmann and Gerick (2018), including the concept of a circular process in which changes in one development fields are affected by and have influence on other development fields. While all the different fields of school development were affected, some particular conditions were more prominent, namely an adequately equipped and administered server structure as well as the ability and motivation of teachers to design learning with digital tools. In addition, students must be capable of accessing and working with online material. In many cases, schools were able to overcome related challenges with solutions that possess the potential to be introduced as solutions in other schools, independently of COVID-19.

At the end of on-site schooling, school leadership and the capacity of the technological infrastructure at the schools could be identified as key factors in successfully starting online teaching and learning (Navaridas-Nalda et al., 2020). A fully functioning server structure and a capable IT administration is absolutely essential, with a special focus on the protection and security of educational data (Obermöller, 2019). The results show that the IT infrastructure at many schools had not been thoroughly tested. The technological equipment was unfit for the different tasks at hand, which can be interpreted as insufficient financial investment in the IT infrastructure. Additionally, the IT administration at vocational schools in Germany is a special task of groups of teachers and is not the responsibility of experts outside the schools. It seems that political decision-makers and school leaders underestimate the importance of IT administration and the workload that it creates.

An outsourcing process could prove to be an opportunity to save money while at the same time increasing the performance of IT systems through the upscaling of solutions. In some school districts, the IT administration and especially the maintenance of hardware is to be bundled in competency centres in the near future. In comparison to multiple teacher groups at different schools, a group of specialists can then handle additional students, teachers, or applications much more efficiently. Adding another school into an existing compound is cheaper and faster than training another team of teachers for this schools. At the individual school, teachers could then shift their focus to supporting their colleagues regarding the application of methods and tools for digital teaching and learning. The diverse educational systems in the federal states, the different types of schools within the federal states, and individual schools often compete over available funding. In the last years, this competition for

funding and the heterogeneity of systems and schools have proven to be some of the biggest obstacles for digitalization in school development in Baden-Württemberg and Germany.

All interviews show the great influence school leadership and organisational development had on introducing online teaching at vocational schools in Germany during the COVID-19 pandemic. In schools in which the school leadership presented clear rules, tasks, and requirements, teachers were able to move faster to teaching online than in schools without a distinct leadership. Hence, an explicit agenda provides guidance for teachers and students alike (Chua & Chai, 2019; Supovitz, 2014). It is important to notice that school leaders often chose a target that was easier to achieve, rather than giving out an abstract goal. Digitalisation in school development should start with these achievable goals.

> "The principle told us: 'Okay, during the next week, I want you to upload material for your classes on Moodle. I want the students to be able to work with something. After that is working, we can see what we can do next!" (Interview 7)

The quote above shows another important aspect of organisational development regarding digitalisation. The process of introducing digital tools and methods into school development is circular, and it has to be reflected on constantly (Obermöller, 2019). This reflection includes changing and expanding existing agendas, depending on the challenges a specific school faces.

The situation during COVID-19 covered in the interviews showed up the inadequate ICT training of many teachers. The use of digital methods and tools plays a minor part in the education of pre-service teachers. In the further education of teachers, the importance of digitalisation in school development is increasing (Grothus et al., 2018), but the interviews show that many teachers refrained from broadly using digital tools and methods before the pandemic. The teachers had to adapt to the new situation by finding suitable teaching methods for their own characteristics, subjects, and students in a short amount of time. The process of selecting and reflecting digital teaching methods and tools should be an integral part of pre-service teacher education and teacher education, to support the personnel development of teachers. It is exceptionally important for teachers who are generally more reluctant to use and teach with digital tools and methods.

> "Our students have to use them [digital tools] in their future jobs. They are using them already as apprentices. They have to learn it in schools. Therefore, every teacher has to use it! To some extent at least!" (Interview 15)

The different digital tools and methods the participants chose shows the variety of digital teaching that can be used and the scope of educational development in schools. One of the key findings of this survey is the strong dependence between a teacher's personality, the subject they teach, and the targeted student group. During the interviews, this manifested itself in situations where participants talked about "in this class", "in my subject" and "for me", when referring to the digital methods and tools they preferred. The teachers' self-concept can be interpreted as a real-life representation of the updated TPACK model by Mishra and Koehler (Mishra, 2019; Mishra & Koehler, 2008).

Most of the teachers want to keep using the methods and tools they introduced during the COVID-19 pandemic because they were experienced as ways to create variety in teaching and as an additional channel to make students engage with learning material. Digital methods and tools are an important addition to the classroom because they make lessons more engaging. They give teachers the opportunity to present material in new ways, as well as to create diversified challenges and tasks. Although the idea of different learner types is considered an obsolete theory (Pashler et al., 2008), as are the assumptions about digital natives (Bennett et al., 2008), the teachers identified a group of students who benefit even more from the digital methods and tools.

> "I think it's just their thing. They like to use the computer, the tablet and so on. They grew up with it and they enjoy learning with it more than in the classroom." (Interview 17)

Some participants were troubled by the missing ability to assess students learning activities and the lack of a grading system they could use for digital teaching. While on-site teaching was disrupted, the federal state of Baden-Württemberg mandated that all exams be cancelled and that no graded assessment should be done during online teaching and learning. The missing students, who are not in contact with their teachers, could be affected by the suspension of grading because they see no reason to put effort into school during the pandemic. Grading is considered as an important educational tool by the participants as well as by teachers all over the world (Schinske & Tanner, 2014). Teachers can keep students working by using the threat of failing a class, but they can also reward hardworking students by giving them good grades. It has to be highlighted that only a few of the teachers mentioned the possibility of conducting and grading online assessments as is being done by many universities during the COVID-19 pandemic. This could be caused by the early mandate of the Ministry of Culture to suspend grading or that online assessment was outside the participants' focus. In consideration of the

chronology of the introduced methods, online assessment can be interpreted as a consecutive step after providing digitalized learning material and conducting online video lessons (Ardid et al., 2015; Butler-Henderson & Crawford, 2020).

In general, the teachers pointed out how students communicated with them and each other over the schools messaging and chat functions, which is considered an important aspect of an LMS (Naveh et al., 2012; Schumacher & Ifenthaler, 2017). The main reason is the close relation to their communication behaviour outside the school context (Lauricella & Kay, 2013). The critical teacher reflections on the different tools they had to use for communication are evidence of the need for clear communication guidelines as part of cooperation development, as they would help to determine the correct usage of the different communication channels.

Digitalisation in school development should aim at a cloud-based storage of data following strict data-protection laws and security measures. This process could simplify and streamline the workflow and communication between the different stakeholders in the school (González-Martínez et al., 2015). With a cloud solution, the cooperation between teachers, which was highlighted in the interviews, can be supported as well (Mościcki & Mascetti, 2018). The digital cooperation between training companies and stakeholders in schools can help to integrate workplace-related problems into teaching and learning. Companies should be mandated to financially invest into their apprentices by supporting the funding of digital infrastructures at schools. For example, the acquisition of digital devices could be included into apprenticeship contracts. An ongoing investment into their apprentices' digital competencies is likely to turn into economic profit for the companies.

A conclusion can be drawn for the aforementioned arguments to help stakeholders at schools. Key factors to successfully deal with the COVID-19 pandemic are the creation and communication of a meaningful agenda by the school leadership, reliable technological infrastructure and teachers' competencies to identify and implement digital teaching methods and tools.

The end of on-site teaching and the introduction of digital teaching and learning methods will have a prolonged effect on digitalization processes in schools. The scope of the sustainability of the new digital developments in schools in the federal state of Baden-Württemberg depends on the willingness of stakeholders to increase the quality of the ICT infrastructure in schools based on comprehensive organisational agendas and on the competencies of teachers and students to teach and learn with digital methods and tools (J. König et al., 2020). Socially disadvantaged students with insufficient access to the internet can be identified as an issue that is currently proving to be unsolvable for stakeholders at schools.

The digitalisation of school development has to be embedded into a bigger socio-economic context. Questions regarding citizens' rights to access powerful internet connections, the sustainable use of hardware, and the role of the economy in teaching and learning have to be tackled to successfully develop digitalisation in schools.

4.6 Limitations and Further Research

The average age of teachers at vocational schools was 49 in the year 2009, which makes the young age of the participants one of the main limitations of the study, while the gender distribution matches the distribution at vocational schools (Wolf, 2009). The qualitative nature of the study enables exemplary insight into the situation at schools and the results cannot be generalized over all vocational schools. Although all participants report challenges and problems, no extreme cases could be identified; schools that have had no problems transferring to online teaching due to comprehensive preparation and investment into digitalization are likely to exist, as are schools that offered almost no teaching at all. The results of the study also have to be assessed under the aspect of social desirability because the situation at schools is strongly influenced by the work of the teachers themselves. An emphasis on positive experiences and a neglect of negative situations might be the results.

The long-term effects and the sustainability of the digital transformation processes in school development should be explored in future studies. As a basis for future studies, the qualitative results should be complemented by quantitative assessments on an extensive scale, including the experience of all stakeholders at schools. As of now, most vocational schools are slowly getting back to on-site teaching. A profound evaluation of the last months is needed to provide schools with the chance to make the most out of the difficult situation under COVID-19 for future digitalization in school development.

4.7 References

Adams, W. C. (2015). Conducting Semi-Structured Interviews. In *Handbook of Practical Program Evaluation* (pp. 492–505). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119171386.ch19

Ardid, M., Gómez-Tejedor, J. A., Meseguer-Dueñas, J. M., Riera, J., & Vidaurre, A. (2015). Online exams for blended assessment. Study of different application methodologies. *Computers and Education, 81*, 296–303. https://doi.org/10.1016/j.compedu.2014.10.010

Bellin-Mularski, N., Mah, D. K., & Ifenthaler, D. (2016). Pre-service teachers' perceptions of school development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age: Papers from CELDA 2014* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Bennett, S., Maton, K., & Kervin, L. (2008). The 'Digital Natives' Debate: A Critical Review of the Evidence. *British Journal of Educational Technology, 39*. https://doi.org/10.1111/j.1467-8535.2007.00793.x

Berufsbildung, B. fuer. (2020). *Datenreport zum Berufsbildungsbericht 2020. Informationen und Analysen zur Entwicklung der beruflichen Bildung*. https://www.bibb.de/dokumente/pdf/bibb_datenreport_2020.pdf

Bol, T. (2020). *Inequality in homeschooling during the Corona crisis in the Netherlands. First results from the LISS Panel.* https://doi.org/Inequality in homeschooling during the Corona crisis in the Netherlands. First results from the LISS Panel.

Butler-Henderson, K., & Crawford, J. (2020). A systematic review of online examinations: A pedagogical innovation for scalable authentication and integrity. *Computers & Education, 159*, 104024. https://doi.org/10.1016/j.compedu.2020.104024

Chua, C. S. K., & Chai, C. S. (2019). Information Communication Technology. In B. Wong, S. Hairon, & P. T. Ng (Eds.), *School Leadership and Educational Change in Singapore* (pp. 149–168). Springer International Publishing. https://doi.org/10.1007/978-3-319-74746-0_9

Eickelmann, B., Drossel, K., & Heldt, M. (2020). Vorteile digital fortgeschrittener Schulen in der Pandemie-Zeit. Ergebnisse einer repräsentativen Lehrkräftebefragung. *Schulmanagement. Fachzeitschrift Für Schul- Und Unterrichtsentwicklung, 51*(3), 28–31. https://kw.uni-paderborn.de/fileadmin/fakultaet/Institute/erziehungswissenschaft/Schulpaedagogik/2020_Eickelmann_et_al_Vorteile_digitaler_Schulen_in_Pandemiezeiten_Zeitschrift_Schulmanagement.pdf

Eickelmann, Birgit, & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen, 29*(4), 111–115.

European Commission. (2019). *2nd survey of schools: ICT in education. Objective 1: Benchmarking progress in ICT in schools*. https://doi.org/10.2759/23401

Forkel, I., Seidenberg, P., & Pabst, R. (2018). *5G National Roaming*.

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. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

González-Martínez, J. A., Bote-Lorenzo, M. L., Gómez-Sánchez, E., & Cano-Parra, R. (2015). Cloud computing and education: A state-of-the-art survey. *Computers and Education, 80*, 132–151. https://doi.org/10.1016/j.compedu.2014.08.017

Grothus, I., Renz, M., Rzejak, D., Schlamp, K., Daschner, P., Imschweiler, V., Lipowsky, F., Schoof-Wetzig, D., & Steffens, U. (2018). *Recherchen für eine Bestandsaufnahme der*

Lehrkräftefortbildung in Deutschland DVLfB. http://www.lehrerinnenfortbildung.de

Harteis, C. (2018). *Machines, Change and Work: An Educational View on the Digitalization of Work* (pp. 1–10). https://doi.org/10.1007/978-3-319-63257-5_1

Heinen, R., & Kerres, M. (2015). Individuelle Förderung mit digitalen Medien. Handlungsfelder für die systematische, lernförderliche Integration digitaler Medien in Schule und Unterricht. In *Individuell fördern mit digitalen Medien – Chancen, Risiken, Erfolgsfaktoren* (pp. 96–161). Bertelsmann-Stiftung.

Hilburg, R., Patel, N., Ambruso, S., Biewald, M. A., & Farouk, S. S. (2020). Medical Education During the COVID-19 Pandemic: Learning From A Distance. *Advances in Chronic Kidney Disease*. https://doi.org/https://doi.org/10.1053/j.ackd.2020.05.017

Ifenthaler, D. (2019). *MEPS – Medienentwicklungsplanung für Schulen in Baden-Württemberg. Bericht zum Projekt des Kultusministeriums Baden-Württemberg*.

Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*, 102183. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2020.102183

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

Jæger, M. M., & Blaabæk, E. H. (2020). Inequality in learning opportunities during Covid-19: Evidence from library takeout. *Research in Social Stratification and Mobility*, *68*, 100524. https://doi.org/https://doi.org/10.1016/j.rssm.2020.100524

König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*. https://doi.org/10.1080/02619768.2020.1809650

Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. *Journal of Business Research*, *117*, 1–5. https://doi.org/https://doi.org/10.1016/j.jbusres.2020.05.034

Lauricella, S., & Kay, R. (2013). Exploring the Use of Text and Instant Messaging in Higher Education Classrooms. *Research in Learning Technology*, *21*. https://doi.org/10.3402/rlt.v21i0.19061

Mayring, P. (2015). *Qualitative Inhaltsanalyse : Grundlagen und Techniken* (12., übera).

McCoy, S., Lyons, S., Coyne, B., & Darmody, M. (2016). *Teaching and Learning in Second-Level Schools at the Advent of High Speed Broadband*. www.esri.ie

Mishra, P. (2019). Considering Contextual Knowledge: The TPACK Diagram Gets an Upgrade. *Journal of Digital Learning in Teacher Education*, *35*(2), 76–78. https://doi.org/10.1080/21532974.2019.1588611

Mishra, P., & Koehler, M. (2008). Introducing Technological Pedagogical Content Knowledge. *Teachers College Record*, *9*.

Mościcki, J. T., & Mascetti, L. (2018). Cloud storage services for file synchronization and sharing in science, education and research. In *Future Generation Computer Systems* (Vol. 78, pp. 1052–1054). Elsevier B.V. https://doi.org/10.1016/j.future.2017.09.019

Müller, M. (2011). *Qualitätsorientierte Schulentwicklung an der Berufsschule : Entwicklung von Unterrichtsqualität mit Lehrerklassenteams*.

Navaridas-Nalda, F., Clavel-San Emeterio, M., Fernández-Ortiz, R., & Arias-Oliva, M. (2020). The strategic influence of school principal leadership in the digital transformation of schools. *Computers in Human Behavior*, *112*, 106481. https://doi.org/10.1016/j.chb.2020.106481

Naveh, G., Tubin, D., & Pliskin, N. (2012). Student satisfaction with learning management

systems: a lens of critical success factors. *Technology, Pedagogy and Education*, *21*(3), 337–350. https://doi.org/10.1080/1475939X.2012.720413

Oberländer, M., Beinicke, A., & Bipp, T. (2020). Digital competencies: A review of the literature and applications in the workplace. *Computers & Education*, *146*, 103752. https://doi.org/https://doi.org/10.1016/j.compedu.2019.103752

Obermöller, M. (2019). *Medienentwicklungsplanung in NRW*. https://www.logineo.schulministerium.nrw.de/_Medienberatung-NRW/Publikationen/Broschuere_Medienentwicklungsplanung_NRW_ES_final.pdf

OECD. (2015). *ISCED 2011 Operational Manual*. OECD, European Union, UNESCO Institute for Statistics. https://doi.org/10.1787/9789264228368-en

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest*, *9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

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.

Roll, M., & Ifenthaler, D. (2020). Lernort-übergreifende Kompetenz-entwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungs-kompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschafts-pädagogik*, *29*, 185–209.

Scheller, H. (2018). Educational Federalism in Germany. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries.* Information Age Publishing.

Schelten, A. (2009). Berufsschule. In S. Blömeke, T. Bohl, L. Haag, G. Lang-Wojtasik, & W. Sacher (Eds.), *Handbuch Schule : Theorie - Organisation - Entwicklung*.

Schinske, J., & Tanner, K. (2014). Teaching More by Grading Less (or Differently). *CBE Life Sciences Education*, *13*(2), 159–166. https://doi.org/10.1187/cbe.cbe-14-03-0054

Schumacher, C., & Ifenthaler, D. (2017). Features Students Really Expect from Learning Analytics. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.06.030

Singh, A., & Haynes, M. (2020). The challenges of COVID-19 in nursing education: The time for faculty leadership training is now. *Nurse Education in Practice*, 102831. https://doi.org/https://doi.org/10.1016/j.nepr.2020.102831

Supovitz, J. (2014). *Building a Lattice for School Leadership: The Top-to-Bottom Rethinking of Leadership Development in England and What It Might Mean for American Education*.

Teichmann, M., Ullrich, A., & Gronau, N. (2019). Subject-oriented learning - A new perspective for vocational training in learning factories. *Procedia Manufacturing*, *31*, 72–78. https://doi.org/https://doi.org/10.1016/j.promfg.2019.03.012

Terhart, E. (2019). Critical Overview of Teacher Education in Germany. In *Oxford Research Encyclopedia of Education*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.377

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. *Computers in Human Behavior*, *100*, 93–104. https://doi.org/https://doi.org/10.1016/j.chb.2019.06.017

Virdia, S., & Schindler, S. (2019). Educational upgrading, career advancement, and social inequality development from a life-course perspective in Germany. *Research in Social Stratification and Mobility*, *60*, 29–38. https://doi.org/10.1016/j.rssm.2019.02.002

Wolf, R. (2009). Altersstruktur der Lehrerschaft an öffentlichen Schulen in Baden-Württemberg. *Statistisches Monatsheft Baden-Württemberg*, *8*.

Wong, K. K., Knüpling, F., Kölling, M., & Chebenova, D. (2018). Federalism and Education:

Cross-National Lessons on Governance, Standards and Accountability for the 21st Century. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries*. Information Age Publishing.

5. The Implementation of Distance Learning Practices at Vocational Schools in Germany from a School Development Perspective

5.1 Introduction

In March 2020 state officials declared an end to on-site schooling throughout Germany as a measure to contain the COVID-19 pandemic. As a result, schools were forced to switch to distance learning methods. In schools of secondary education teaching was supposed to be conducted with digital tools, such as learning management systems and live video classes. Most schools did not have the technical and organisational infrastructure to support such a rapid change (Delcker & Ifenthaler, 2020). Further, teachers and students did not possess the necessary competencies to learn and teach online (Howard et al., 2020; Huber & Helm, 2020). The situation changed gradually as stakeholders adapted to the new situation under the ongoing pandemic.

In response to the on-going crises situation at German schools, this project was conducted to examine how school development may facilitate online learning for students and teachers, focusing on the technological, personnel, educational, organisational and cooperative domains of school development (Eickelmann & Gericke, 2018). One of the main issues for school leaders during the COVID-19 pandemic was a decision-making process which could hardly be based on past experiences at the respective school or at similar schools. While school leaders implemented rules for the usage of technology, set up guidelines for communication and tried to provide information for the different stakeholders to enable distance learning at their schools, their options to evaluate their managerial decisions with regard to digitalization in school development were very limited. At that time, school officials in Germany could not provide an appropriate tool yet. The resources of school leaders, especially the time and staff necessary to design, test and implement such a tool, were needed in other domains of the school to keep day-to-day operations running during the COVID-19 pandemic.

One of the main goals pursued by project was to develop and provide a tool for decision makers and school leaders at vocational schools to evaluate the status of continuous school development. The evaluation helps school leaders to use empirical evidence to reflect on managerial decisions which focus on the facilitation of distance learning. As a consequence, changes in already implemented rules, guidelines and processes can be made. In addition, school leaders are enabled to include data-driven considerations into their decision-making

processes (Schildkamp, 2019).

The second objective of the project was to identify factors of school development which facilitate distance learning processes, shifting the perspective from a single school view to the group of vocational schools as a whole. Vocational schools in Germany are one of the two parts of the German dual vocational training system. While training companies provide practical competencies, vocational schools facilitate mostly theoretical knowledge to support students in completing their vocational training. The increasing demands of the workplace towards digital competencies require changes in teachers and students' digital competencies (Roll & Ifenthaler, 2021) and therefore further strategies to implement digitalization into school development (Delcker & Ifenthaler, 2020).

5.2 Theoretical Framework

Brindley et al. (2004) define Distance Learning (DL) as a superior construct, which includes various forms of media-based learning. The main characteristic of DL is the geographical separation between learners and educators, making it a major challenge for the involved stakeholder (Moore & Kearsley, 2011). The requirements for the integration of DL into schools and school development processes are very diverse, which makes a multidimensional perspective on school development necessary (Ames et al., 2021; Bellin-Mularski et al., 2016). This multitude of perspectives is reflected by the different stakeholders involved in school development processes, namely school leaders, teachers, students and parents (Harris, 2010; Ilomäki & Lakkala, 2018). At vocational schools, training companies have to be included as a relevant stakeholder (Delcker & Ifenthaler, 2020). Following the definition by Rolff (1995), the multidimensional composition of school development is represented by the three different domains inside a school. These dimensions can be summarized under teaching (activities in the classroom), personnel (mentoring, teacher training) and organisation (school agendas, school management). With regard to digitalization processes, the technical infrastructure of a school has to be added to the conceptual considerations of school development (Fraillon et al., 2020). Eickelmann & Gericke (2018) expand the model by Rolff (1995) by adding this technological component. Furthermore, cooperation is added as a fifth dimension in their model of school development: Organisational Development (OD) includes a school's agenda, it's mentality and beliefs towards communication and digitalization. The field of Personnel Development (PD) covers teacher training and the onboarding of new teachers. Education Development (ED) subsumes activities in the classroom, such as the usage of learning tools and methods.

Technology Development (TD) consists of requirements regarding technological infrastructure and administration of systems. The final development field is called Cooperation Development (CD) and describes cooperation processes between the internal and external stakeholder of school development.

The centre of the model describes the common goals of the stakeholders and the focus point of the five different dimensions: the ongoing facilitation of students' digital competencies (1), as well as teaching and learning with digital media (2).

A number of studies has shown the influence of the development fields on students learning as well as educators' roles and teaching competencies. The participation of students in the classroom and their ability to reach their educational goals can be increased through the organisational structure of schools (Alinsunurin, 2020; Maxwell et al., 2017; Sebastian et al., 2014). The cooperation between teachers with regard to curricular alignment supports academic improvement (Bryk, 2010). If a school is well-structured and organized, it produces an academic climate that is "conducive to learning and high student performance" (Wang & Degol, 2016), while methods and tools used for teaching influence the learning experience of students (Stefanou et al., 2004).

The way school leaders manage and structure their schools impacts teachers' satisfaction and performance, which in return enhances classroom practices and school effectiveness (Mulford, 2003). Teachers are less likely to leave the schools when they perceive the school administration as effective leaders (Nguyen, 2021). The professional development of teachers is positively influenced by a school's agenda and the creation of learning opportunities within the organisation (L. Huang et al., 2020).

Due to requirements of the modern working world, the integration of digital teaching methods and tools into school development is a necessity. Key digital competencies cannot be facilitated without them (Fraillon et al., 2020; Roll & Ifenthaler, 2020, 2021). The concept of media expansion plans (MEP) has been deployed in the German school system to help schools transitioning towards digitalization in school development. Within the MEP, a school can formulate different digitalization goals, as well as how and when they want to reach those goals. The MEP should include an analysis of the digital status quo at the school (Ifenthaler, 2019; Obermöller, 2019). Most importantly, schools are required to specify the financial resource they need to meet MEP-specific goals to be applicable for the biggest funding program for digitalization in schools in Germany, called "digital pact" (in German Digital Pakt) (km-bw, 2021). The MEP can be an important managerial tool for school leaders to analyse, plan and implement digital tools and methods into their schools. Currently, no published studies about

the effects of the MEP exists, due to the novelty of the MEP and the relative short implementation time. Two research questions emerge from the described problems at vocational schools and theoretical assumptions about school development.

RQ1: Which role do organisational factors play for the perceived learning success of students during distance learning in times of crisis and how does the implementation of a media expansion plan influence these relationships?
RQ2: Which role do organisational factors play for the perceived workload of teachers during distance learning in times of crisis and how does the implementation of a media expansion plan influence these relationships?

5.3 Method

5.3.1 Participants and Data Collection

A convenience sample of 14 vocational schools in the federal state of Baden-Württemberg, Germany took part in the project from November 2020 until March 2021. Each school could choose the starting date of the survey, to avoid conflicts with internal school constraints. In addition, schools could choose which stakeholder groups they wanted to survey, with students, teachers and school leaders being mandatory choices. The schools were provided with hyperlinks to the online questionnaire, which were distributed by the schools through internal email addresses. At each school the data collection was conducted over a period of four weeks. The data collected from the three mandatory stakeholder groups consists of 2,827 students, 444 teachers and 37 school leaders (N = 3,872). After the data collection, each school was provided with an individual report that summarized the results of the schools.

5.3.2 Instrument and Analysis

The online questionnaire “Evaluation of Distance Learning” by (Balzer & Schorn, 2021) has been adapted to collect data from students, teachers, school leaders, parents and training companies at vocational schools. The items can be allocated to five scales, namely organisation (orga), class activity (clac), teaching & learning (tl), social interaction (soci) and personal resources (perr) and are assessed on a Likert scale from 1 to 5 (totally disagree, partially disagree, neither nor, partially agree, completely agree). A small number of items to collect demographic data has been added to the questionnaire. The variable for the MEP (mep) contains

different stages of the MEP. Schools currently either do not have a MEP (stage 0), the MEP is currently worked on (level 1) or the MEP is fully planned and integrated into the school (stage2). Additionally, schools might have already applied for funding (stage 3) or they have been provided funding based on their MEP (stage4). The questionnaires differ between the stakeholders to allow data collection from multiple perspectives. The longest questionnaire (66 items) was provided for the teachers, the shortest one (23 items) for the parents. Only a few of the questions were mandatory to answer to decrease the likelihood of dropouts. The Cronbach's alpha values of the five scales for the three main stakeholder groups are shown in Table 5-1.

Table 5-1

Reliability Scores (Cronbach's alpha) for the Five Main Scales

Group	Orga	Clac	Tl	Soci	Perr
Students	0.83 (11)	0.77 (16)	0.77 (7)	0.56 (2)	0.54 (5)
Teachers	0.83 (9)	0. 66 (17)	0.69 (6)	0.81 (8)	0.74 (6)
School Leaders	0.74 (6)	0.82 (17)	0.74 (10)	0.65 (2)	0.5 (4)

Note. The number in brackets shows the number of items per scale

Hierarchical linear modelling (HLM) was used to examine the relation between the variables stated in the research question. HLM is specifically useful for educational research, because of the nested structure of data from the context of schools (Schildkamp et al., 2017). The nested structure is a consequence of the hierarchical structure of schools, where the selection of a "primary unit (e.g., a school) increases the chances of selection of secondary units (e.g., pupils) from that primary unit" (Snijders & Bosker, 2011, p. 7). Basically, HLM represents a multilevel regression model as a hierarchical system of regression equations (Hox et al., 2017). In the case of this study, two-level data has been collected, with data on the level of the school and the level of the single students.

Student learner success (lsuc) is defined by a set of items which include questions towards their perceived effectiveness and their perceived learning progress while practicing distance learning ($\alpha = .71$). During the first and second lockdown, grading was not allowed except for final-year classes, so learner success could not be measured by grades. The students' perception of their schools' organisational structure (orga_st) was measured with 11 items, which are described in Table 5-2.

Table 5-2

Items for Students' Perception of Schools' Organisational Structure (orga_st), N = 1763

Item	Description	Descriptive
orga1	Teaching Adaptation to Crisis	*M* = 3.20 (*SD* = 1.17)
orga2	Current School Organisation	*M* = 3.17 (*SD* = 1.19)
orga3	Clearness of Procedure Instructions	*M* = 3.54 (*SD* = 1.31)
orga5	Clearness of Tools for Teaching	*M* = 3.56 (*SD* = 1.27)
orga9	Tool Competency of Teachers	*M* = 3.24 (*SD* = 1.11)
orga10	Own Tool Competency	*M* = 4.08 (*SD* = 1.03)
orga12	Provided Technological Infrastructure	*M* = 4.31 (*SD* = 1.09)
orga13	General Information Flow	*M* = 3.59 (*SD* = 1.27)
orga14	Assessment Regulations	*M* = 3.23 (*SD* = 1.26)
orga15	Single Work Assessment	*M* = 3.21 (*SD* = 1.22)
orga18	Fairness of Assessment	*M* = 3.35 (*SD* = 1.26)

In addition, the age of the students is used as a possible predictor variable on level 1. The mep variable was used as a predictor on level 2. Different variables have consequently been added to model to identify the one with the best fit. The conditions for HLM have been met (F. L. Huang, 2018). The following equation represents the initial model:

$$lsuc_{ij} = \gamma_{00} + \gamma_{10} * orga_{ij} + \gamma_{20} * age_{ij} + \gamma_{01} * mep_j + \gamma_{21} * orga_{ij} * mep_j + u_{1j} * orga_{ij} + u_{0j} + e_{ij}$$

lsuc	learner success of student *i* within school *j*
γ_{00}	overall mean intercept
γ_{10}	fixed effect of $orga_{ij}$
γ_{20}	fixed effect of age_{ij}
γ_{01}	fixed effect of mep_j
γ_{01}	fixed effect on interaction between $orga_{ij}$ and mep_j
$orga_{ij}$	orga value of student *i* within school *j*
age_{ij}	age value of student *i* within school *j*
mep_j	mep value of school *j*
u_{1j}	random effects on orga
u_{0j}	intercept
e_{ij}	residual

5.4 Results

Initial analysis on level 1 variables showed a significant medium effect of orga_st on students perceived learning success (d = 0.69). The age of students did not show a significant effect, therefor it was dropped from further analysis. To increase the accuracy of the model, the items of the orga_st scale where subsequently added to the model. In the model with the highest fit, 8 of the 11 items showed a significant effect on lsuc, ranging between 0.1 and 0.15. Mep didn't show a significant effect as a predictor on level 2. Although the low ICC values of the models (< 0.1) across all the models indicates that students' perceived organisation at their schools does not vary between the schools, the regression estimates of the HLM model is presented in Table 5-3, because the approach is more sensible and represents the nested structure of schools within education systems (Alinsunurin, 2020).

Table 5-3

*Regression Estimates for the Model with the Highest Fit (** < 0.01, *** < 0.001), N = 1763*

Item	Description	Estimates (Std. Error)
orga1	Teaching Adaptation to Crisis	0.10309 (0.09986) ***
orga3	Clearness of Procedure Instructions	0.149 (0.01438) ***
orga9	Tool Competency of Teachers	0.06918 (0.01744) ***
orga10	Own Tool Competency	0.10550 (0.01767 ***
orga12	Provided Technological Infrastructure	0.09859 (0.01646) ***
orga13	General Information Flow	-0.05017 (0.01551) **
orga14	Assessment Regulations	0.08707 (0.01630) ***
orga18	Fairness of Assessment	0.14884 (0.01626) ***
Intercept		0.4644 (0.09986) ***

To answer the research question, it can be stated that the perceived organisation has an effect on students' perceived learning success. The parts of the organisation that had the biggest effect were the clearness of procedure instructions and the fairness of the assessment. Secondly, the adaptation of teaching to the crisis, students' tool competency and the provided infrastructure influence student's perceived learning success. These results do not vary significantly between the different schools. The stage of the MEP does not have a significant effect on the learning success. Surprisingly, the item "current school organisation" does not have a significant effect.

5.5 Conclusion

The findings of the study show the importance of the organisational structure of schools for the learning success of students. Most importantly, changes to single parts within the development field of organisation can help students to achieve their educational goals. Students rely on clear procedural instructions, more so when dealing with a crisis like the COVID-19 pandemic, because they create the necessary safety within the learning processes (Sebastian et al., 2014). Fair assessment of students' works encourages students to spend time and effort on submissions and tasks, which increases their chance of succeeding. The teaching processes have to be adapted for the crisis to be feasible and plausible for the students. For the realization of digitalized teaching processes, the students need the competencies to work with the necessary tools such as video conferencing tools and the learning management system of the schools (Olszewski & Crompton, 2020). School leaders can support the students by supplying them with appropriate digital tools (Bond, 2020), which is strongly connected to the development field of technology (Eickelmann & Gericke, 2018). While the effects of the single parts of organisational structure seem to be small, the combination of the diverse perspectives including information flow, communicated rules and the provision of tools that are easy to access shape the characteristic of schools' organisational structures as a facilitator for a successful school environment (Alinsunurin, 2020; Ames et al., 2021; Bryk, 2010; Mulford, 2003; Stefanou et al., 2004; Wang & Degol, 2016).

The analysis of the data suggests that the vocational schools and especially their students' perception of organisation and learner success are not very distinct. The similarity of the challenges school leaders face admits a common crisis and the requirement for digitalization in school development underline the importance of improving the collaboration between school leaders (Ilomäki & Lakkala, 2018). The MEP could be a starting point for ongoing cooperation between vocational schools. The fact that the MEP does not have a significant effect on student learner success might hint towards the MEP currently being a means to an end, namely getting access to much needed funding. Through a joint effort of school leaders, the MEP can develop its full potential as a strategic managerial tool for the digitalization of school development.

The introduced evaluation tool is currently evaluated in cooperation with the involved school leaders, to enhance its capability as a managerial tool. One of the goals of the evaluation process is the optimization of the sample size, especially on the school level. To further examine the integration of the MEP, a refinement of the survey instrument is being conducted. This will improve the collected data and increase the benefit for the stakeholders involved in the digital school development.

5.6 References

Alinsunurin, J. (2020). School learning climate in the lens of parental involvement and school leadership: lessons for inclusiveness among public schools. *Smart Learning Environments, 7*. https://doi.org/10.1186/s40561-020-00139-2

Ames, K., Harris, L. R., Dargusch, J., & Bloomfield, C. (2021). 'So you can make it fast or make it up': K–12 teachers' perspectives on technology's affordances and constraints when supporting distance education learning. *The Australian Educational Researcher, 48*(2), 359–376. https://doi.org/10.1007/s13384-020-00395-8

Bellin-Mularski, N., Mah, D. K., & Ifenthaler, D. (2016). Pre-service teachers' perceptions of school development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age: Papers from CELDA 2014* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education, 151*, 103819. https://doi.org/10.1016/j.compedu.2020.103819

Brindley, J. E., Walti, C., & Zawacki-Richter, O. (2004). The Current Context of Learner Support in Open, Distance and Online Learning: An Introduction. *Learner Support in Open, Distance and Online Learning Environments*.

Bryk, A. S. (2010). Organizing Schools for Improvement. *Phi Delta Kappan, 91*(7), 23–30. https://doi.org/10.1177/003172171009100705

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826

Eickelmann, B., & Gericke, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen, 29*(4), 111–115.

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

Harris, A. (2010). Leading system transformation. *School Leadership & Management, 30*(3), 197–207. https://doi.org/10.1080/13632434.2010.494080

Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2020). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 1–18. https://doi.org/10.1080/1475939X.2020.1839543

Huang, F. L. (2018). Multilevel modeling myths. *School Psychology Quarterly, 33*(3), 492–499. https://doi.org/10.1037/spq0000272

Huang, L., Zhang, T., & Huang, Y. (2020). Effects of school organizational conditions on teacher professional learning in China: The mediating role of teacher self-efficacy. *Studies in Educational Evaluation, 66*, 100893. https://doi.org/10.1016/j.stueduc.2020.100893

Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability, 32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y

Ifenthaler, D. (2019). *MEPS – Medienentwicklungsplanung für Schulen in Baden-Württemberg. Bericht zum Projekt des Kultusministeriums Baden-Württemberg*. Kultusministerium Baden-Württemberg.

Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8

km-bw. (2021). *Digitalpakt von Bund und Ländern*. https://km-bw.de/,Len/startseite/schule/digitalpakt-schule

Maxwell, S., Reynolds, K. J., Lee, E., Subasic, E., & Bromhead, D. (2017). The Impact of School Climate and School Identification on Academic Achievement: Multilevel Modeling with Student and Teacher Data. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.02069

Moore, M. G., & Kearsley, G. (2011). *Distance Education: A Systems View of Online Learning*. Cengage Learning.

Mulford, B. (2003). *School Leaders: Challenging Roles and Impact on Teaching and School Effectiveness*. OECD. https://www.oecd.org/education/school/37133393.pdf

Nguyen, T. D. (2021). Linking school organizational characteristics and teacher retention: Evidence from repeated cross-sectional national data. *Teaching and Teacher Education*, *97*, 103220. https://doi.org/10.1016/j.tate.2020.103220

Obermöller, M. (2019). *Medienentwicklungsplanung in NRW*. Medienberatung NRW.

Olszewski, B., & Crompton, H. (2020). Educational technology conditions to support the development of digital age skills. *Computers & Education*, *150*, 103849. https://doi.org/10.1016/j.compedu.2020.103849

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.

Roll, M., & Ifenthaler, D. (2020). Lernortübergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.

Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4

Schildkamp, K. (2019). Data-based decision-making for school improvement: Research insights and gaps. *Educational Research*, *61*(3), 257–273. https://doi.org/10.1080/00131881.2019.1625716

Sebastian, J., Allensworth, E., & Stevens, D. (2014). The Influence of School Leadership on Classroom Participation: Examining Configurations of Organizational Supports. *Teachers College Record*, *116*(8), 1–36.

Stefanou, C. R., Perencevich, K. C., DiCintio, M., & Turner, J. C. (2004). Supporting Autonomy in the Classroom: Ways Teachers Encourage Student Decision Making and Ownership. *Educational Psychologist*, *39*(2), 97–110. https://doi.org/10.1207/s15326985ep3902_2

Wang, M.-T., & Degol, J. L. (2016). School Climate: A Review of the Construct, Measurement, and Impact on Student Outcomes. *Educational Psychology Review*, *28*(2), 315–352. https://doi.org/10.1007/s10648-015-9319-1

6. Distance Learning and the Transformation of Vocational Schools from a Qualitative Perspective

6.1 Introduction

During the COVID-19 pandemic, distance learning became the primary form of education at vocational schools in Baden-Württemberg. Oftentimes, students nor teachers had the necessary competencies to learn and teach online (Howard et al., 2020; Huber & Helm, 2020). Many schools were not properly equipped with the technical or organisational infrastructure to implement such a rapid change from on-site to online classes (Delcker & Ifenthaler, 2020; Kerres, 2020). The project '*Distance Learning – Schul- und Unterrichtsentwicklung für berufliche Schulen vor Ort'* (Distance Learning at Vocational Schools) was planned and conducted to evaluate the situation of stakeholders in vocational schools in Baden-Württemberg. For this purpose, an online evaluation instrument was designed to help decision makers at the school level to examine the perception of different stakeholder groups. The main goal of the research work was to provide decision makers and school leaders at vocational schools with a tool to evaluate their school, improve the distance learning situation at their schools, and engage in continuous school development.

In Germany, vocational training is traditionally based on the so called dual system (Protsch & Solga, 2016): The first part of the dual system consists of training companies which take in apprentices for the 324 different qualifications programs (BIBB, 2021). The companies provide practical training through qualified instructors. Vocational schools are the second part of the dual system. They focus on the facilitation of theoretical general and subject-specific knowledge (Gessler, 2017). The two parts work closely together, and it is mandatory to attend a vocational school and to meet the requirements of the workplace to acquire the desired professional qualification (Deissinger, 2015). To ensure the close connection between the facilitation of practical and theoretical knowledge, working at the training company and attending a vocational school alternate on a weekly or monthly basis.

One of the most pressing challenges for vocational schools is the influence of digitalisation on the theoretical and practical places of learning (Euler & Wilbers, 2018). On the one hand, digitalisation requires the facilitation of new competencies, on the other hand, new digital educational tools and methods arise (Collins & Halverson, 2018). Amongst others, these competences include the ability to handle various digital technologies (Falloon, 2020), but also data literacy, information retrieval skills and the evaluation of digital data (Henderson & Corry, 2021; Koltay, 2017; Tsai & Wu, 2021). Future citizens are challenged with the protection of

their personal data (Horn & Otto, 2021; Schüller, 2020) and digital collaboration (López-Meneses et al., 2020). The new digital competencies additionally include a sustainable perspective on digitalisation (Chekanushkina et al., 2021; Luthra & Mangla, 2018) and the ability to use digital tools and methods to solve problems of the daily life and the workplace (Godhe, 2019). The competences for the workplace are of special importance for the vocational education trainings system, as digital processes and tools, such as 3D-printers (H. K. Chan et al., 2018), smart production systems (Hirsch-Kreinsen, 2016), digital marketing (Nadkarni & Prügl, 2021) or ERP systems (Spener et al., 2019), continuously change the workplace (Euler & Wilbers, 2018; Roll & Ifenthaler, 2020a).

The tools to facilitate this competences might be computers (Falck et al., 2018; Patterson & Patterson, 2017), tablet PCs (Conrad & Schumann, 2021; Ifenthaler & Schweinbenz, 2016; Montrieux et al., 2015), smartphones (Hochberg et al., 2018; Lindberg et al., 2017) or interactive whiteboards (Hennessy, 2017; Mata et al., 2016; Tosuntaş et al., 2015). Flipped classroom settings (Mohamed & Lamia, 2018; Strelan et al., 2020; Zainuddin et al., 2019) and blended learning approaches (Dziuban et al., 2018; Hrastinski, 2019) are example for new digital teaching methods. Both tools and methods can be used to present new forms of media, such as educational videos (Bateman & Schmidt-Borcherding, 2018; Carmichael et al., 2018), games (Hawlitschek & Joeckel, 2017; Lamb et al., 2018; Platz et al., 2021), apps (Cherner et al., 2014) and podcasts (L. König, 2021; O'Callaghan et al., 2017). Vocational schools can meet the challenge of a changing world through the consequent implementation of digitalisation into school development processes, such as digital tools for the school's administration, modern technological infrastructure or different teaching methods in conjunction with ongoing teacher education. The necessary changes on the school level have not been systematically implemented in the past. In many schools in Germany, the technical infrastructure remains insufficient (Fraillon et al., 2020) and information and communication technology (ICT) is only partially present in teacher education programmes and curricula (Labusch et al., 2020).

During the COVID-19 pandemic, vocational schools were forced to implement distance learning as a new principle for teaching and learning. The school buildings were closed down and on-site teaching was prohibited as a precaution to fight the pandemic. The rapid change from on-site teaching to digital distance learning can be described as a "digitalisation shock" (Harderer et al., 2020, p. 14), which hit many schools unprepared (Freundl et al., 2021; Huber & Helm, 2020; Kerres, 2020; Million, 2021; Zawacki-Richter, 2021). Distance learning is defined as a superior construct which is comprised of different forms of media-based learning with the geographical separation between teachers and learners being one of its main

characteristics (Brindley et al. 2004, Moore & Kearsley, 2011). In regard to the vocational schools in Baden-Württemberg, most teachers used live video-classes, uploaded worksheets or educational videos as methods and tools for digital distance learning with varying perceived success (Delcker & Ifenthaler, 2020). While the schools were closed, stakeholders at the vocational schools, especially school leaders, did not have the tools and opportunities to evaluate the digital distance learning situation within their institutions. The goal of this study is to identify challenges for stakeholders at vocational schools through the analysis of qualitative evaluation data. The following research question emerges:

RQ: How do the stakeholders at vocational schools perceive the digital distance learning situation?

The data is used to discover concrete suggestions and ideas from within the school to overcome the challenges of the implementation of digital distance learning. The study at hand shifts the perspective from a crisis-oriented view towards a future-oriented angle. It uses the experience of ad-hoc distance learning situations to gain insights for sustainable school development.

6.2 Theoretical Framework

6.2.1 School Development

At this point, an important distinction must be made between the terms school development and school reform (Muftić, 2012; Silcox & MacNeill, 2021). School reform should be used for top-approaches which originate from outside of a single school, such as from the federal state administration (Rolff, 2019). External influence factors might be state-wide curricula (Seleznyov & Czerniawksi, 2020), changes in public funding (Sugarman et al., 2016), or broadband Internet access (Fox & Jones, 2019).

Based on the definition by Rolff (1995), school development describes the development of single schools. In contrast to school reforms, school development considers school specific factors, such as organisational, social and infrastructural characteristics at school level from a bottom-up perspective (Rolff, 2019). Examples for these characteristics are school leadership (Barblett & Kirk, 2018; Bellin-Mularski et al., 2016; Mulford, 2003; Whitehead et al., 2013), on-going teacher training (Gudmundsdottir & Hatlevik, 2018; Roll & Ifenthaler, 2021; K. K. Wong, 2018), classroom activities (Dadds, 2020; Eickelmann et al., 2020; Spiteri & Chang

Rundgren, 2020), cooperation (Aprea et al., 2020; Delcker & Ifenthaler, 2020; Jensvoll & Lekang, 2018; Jurkowski & Müller, 2018), and technological infrastructure (Gil-Flores et al., 2017). The goal of the intentional and planned development process is the facilitation of students' inter- and intradisciplinary competencies (Rolff, 1995) and an improvement of students' educational environment (Hanberger et al., 2016). Factors which are beneficial for such an environment include academic rigor (Wang & Degol, 2016), the organisational structure of schools (Sebastian et al., 2014), school identification (Maxwell et al., 2017), and teacher qualification (Podolsky et al., 2019). A meta-analysis of whole-school development programs indicates very small to small effects ($.09 < d < .15$) on students' achievements, with an increasing effect for schools with a financially disadvantaged student population (Borman et al., 2003). In school leadership effect studies, small direct and indirect effects of leadership on students' achievement can be found (Scheerens, 2012). Heck and Hallinger (2010) identify teachers' perception about school improvement capacity as an indicator for the educational achievement of students. Amongst other things, school improvement capacity contains continuous professional learning, open communication, and the implementation of state curricular standards. The perceived ability of teachers to shape their school in the form of collective leadership, teachers' motivation, and the work setting of teachers has a significant effect on students' achievements as well (Leithwood & Mascall, 2008). Teachers' well-being is strongly associated with the administrative skills of principals, as well as principals' time spent on instructional management and internal relations (Liebowitz & Porter, 2019). These findings are related to the research work of Sebastian et. al (2019), who identified a high correlation between the organisational management skills and the instructional leadership skills of principals: Principals who are able to support good classroom interaction are also capable of managing a school as an organisation and vice versa (Sebastian et al., 2019). The quoted results of educational research underline the "interdependence between contextual factors, educational factors and target group factors" (Ditton & Müller, 2011, p. 104) as a major characteristic of school development and school quality.

Although the terms school development' and school reform are differentiated and used to describe different approaches to influence and improve education, they cannot be interpreted as unconnected concepts. School curricula and teacher training programmes are strongly connected to teaching practices and the educational content in the classroom. Vice versa, the desired outcomes of educational processes, such as the qualification of students and the facilitation of competencies, depend on adequate teaching methods and further teacher education.

The distinction between school reform and school development forms the basis for the further considerations of Eickelmann (2017), who identifies five fields for the successful development of schools. Organisational Development (OD) includes a school's agenda, its mentality and beliefs towards communication and digitalization. The field of Personnel Development (PD) covers teacher training and the onboarding of new teachers. Education Development (ED) subsumes activities in the classroom, such as the usage of learning tools and methods. Technology Development (TD) consists of requirements regarding technological infrastructure and administration of systems. The final development field is called Cooperation Development (CD) and describes cooperation processes between the internal and external stakeholders of school development.

Studies show the influence of the different development fields on learner success, academic improvement and staff satisfaction. The structure of a school increases students participation in the classroom and enables them to reach educational goals (Alinsunurin, 2020; Maxwell et al., 2017; Sebastian et al., 2014). If teachers cooperate in instructional processes, they support academic improvement (Bryk, 2010). Wang and Degol (2016) report a well-structured school as an important factor for high student performance. The learning experience of students is influenced by the tools and methods used for teaching (Stefanou et al., 2004), which in turn depends on the skills and competencies of teachers (Ifenthaler & Schweinbenz, 2013, 2016). Mulford (2003) describes effective school leadership as one of the biggest factors for teachers' satisfaction and performance. Teachers leaving a school is less likely, when these teachers perceive the school leaders as effective (T. D. Nguyen, 2021). This includes the creation of learning opportunities for teachers as a major influence on teachers professional development (Huang et al., 2020).

From the development fields, the stakeholders of school development can be derived. They include students, their parents, teachers, school leaders and the school's administration (Harris, 2010; Ilomäki & Lakkala, 2018). In the case of vocational schools, the different training companies have to be added to the list of stakeholders (Delcker & Ifenthaler, 2020). In vocational schools in Baden-Württemberg, school management is placed in the hands of the school principals. In most cases, a single school principal is responsible for most managerial decisions at school level. The school principals are supported by department leaders, whose number depends on the seize of the vocational schools. School leaders as a stakeholder group are therefore defined as the principal and the department leaders.

Furthermore, secondary stakeholders can be identified, such as the school administration on a federate state level and the cities the vocational schools are located in. Although the

secondary level stakeholders influence school development processes at school level, the theoretical model used in this paper focuses on the primary stakeholders and especially possible managerial decisions which can be based on the evaluation of these stakeholders (Eickelmann & Gerick, 2018; Rolff, 2019). The decision to emphasize the primary stakeholders is based on an initial important theoretical assumption presented in this paragraph: the development of schools has to focus on single schools as organisational units and their individual characteristics.

6.2.2 School Evaluation

School evaluation has become an important tool for successful school development (OECD, 2013). Using thorough evaluations, decision makers can make purposeful changes to processes and guidelines within the individual school with regard to the characteristics of this school (Nevo, 2001). Additionally, school evaluation can be an important tool for school leaders to improve students' educational achievements (Blok et al., 2008). The evaluation process can come from within the school itself (internal evaluation) or it can be based on an outside perspective (external evaluation) (Nevo, 2001; Vanhoof & Petegem, 2007). Some external evaluations focus on the performance of students and staff, such as the normative assessment of the PISA or the TIMMS studies (Hanberger, 2014; Hopfenbeck et al., 2018). In contrast, an internal evaluation targets processes inside a school, e. g. the cooperation between teachers, information flow or administrative procedures (Mutch, 2012). External evaluations are often conducted by professional evaluators. As a result, they are deemed to be more objective than internal evaluations. On the other hand, external evaluators are at risk to underestimate the influence of a single school's characteristics on evaluation results (Hopkins et al., 2016). These school characteristics, such as the location of the school, socio-economics of the student population, or staff shortage, are more regularly considered during internal evaluations (Mutch, 2012; O'Brien et al., 2017). At the same time, internal evaluations are often considered as not being critical enough, because the evaluators assess themselves, their own colleagues, employers and workplace (Stoney, 2010).

The program "Distance Learning in Vocational Schools" aims to overcome the shortcomings of external and internal evaluation by combining elements of both approaches. A standardized instrument is used for the data collection, which allows to compare and combine the results of individual schools (Scheerens et al., 2003). The time consuming collection and reporting of data is conducted by external evaluators to adjust for time constraints of school

leaders and teachers (Pont et al., 2008). At the same time, decision makers are able to decide which groups within their school they wanted to evaluate. The school specific data is being provided to each school. These two steps are important to strengthen the sense of ownership and transparency of the evaluation (Mutch, 2012)

6.3 Method

6.3.1 Participants and Data Collection

The evaluation instrument "Evaluation of Distance Learning" by Balzer & Schorn (Balzer & Schorn, 2021) has been adapted for this study in regard to the vocational schools in Baden-Württemberg. It covers different dimensions for the evaluation of distance learning: school organisation, class activity, teaching & learning, social interactions and personal resources. These dimensions can be categorized into the development fields of the 5SD-model (Eickelmann & Gerick, 2018). Likert-scale items from 1 to 5 (totally disagree, partially disagree, neither nor, partially agree, completely agree) have been used for the separate stakeholder groups of students, teachers, school leaders, parents, and training companies. To ensure the correct wording for each stakeholder group, the items' phrasings differ between the stakeholder groups. Additionally, some items were removed if they were not relevant for specific stakeholder groups. A small number of items to collect demographic data has been added to the questionnaire, also depending on the specific stakeholder group. As a result, the instrument varies in length. The longest questionnaire (66 items) was provided to the teachers, the shortest one (23 items) to the parents. Only a few of the questions were mandatory to answer to decrease the likelihood of dropouts.

In addition, a final two-part question has been added to the end of the questionnaire in an open answer format: "Which ideas for the improvement of distance learning in the current situation do you want to share with us? Is there anything else you want to share with us?" This final two-part question is the main data source for the empirical analysis of this survey.

School leaders could decide which stakeholder groups they wanted to provide with a link to the online questionnaire. While this added some individuality to the interests of the individual schools, providing the link to students, teachers, and school leadership was mandatory. School leaders also had the chance to choose single classes or types of vocational schools (in case of vocational school centers) for the data collection. School leaders could also decide at which point in time they wanted the data collection to happen, beginning from November 2020. The individual collection period at each school was planned out in a 2+2 design: after two weeks of

data collection, a reminder was sent to the participating stakeholder groups, resulting in a one-month period of data collection per school. An invitation to the survey was sent to vocational schools in Baden-Württemberg through the ministry of culture in November of 2020. Initially, 19 schools decided to participate in the survey from October 2020 until March 2021. Data had been successfully collected from 15 schools by March 2021. Three schools dropped out as a consequence of the ongoing COVID-19 pandemic. At one school, not enough stakeholders participated in the data collection and the school was not considered for further analysis.

Only two schools decided to limit the data collection by choosing the three mandatory stakeholder groups, while the other schools chose to include all five stakeholder groups.

6.3.2 Analysis

In total, 3,872 persons participated in the survey. A total of 1,493 (38,6 %) participants gave an answer to the open question at the end of the instrument. The answers of 1,172 students, 177 teachers, 57 parents, 56 training companies and 26 school leaders were used for the analysis. The length of the statements varies between single words and long paragraphs. The mean number of words per statement is 49. The analysis method is based on the following five categories: school organisation, class activity, teaching & learning, social interactions and personal resources. In a first step, all stakeholder statements have been organized into these five categories, following the deductive structuring content approach (Mayring, 2004, 2015). In the process, the five dimensions turned out to be too broad for a lot of the statements, especially if multiple aspects of distance learning where mentioned. Consequently, three categories have been added to improve the structuring process.

The following categories emerged:

(1) Organisation: statements regarding organisation processes within the school, such as the flow of information, introduction of schedules, formalized regulations, unified implementation of tools
(2) Technical Infrastructure: statements regarding available software, hardware or internet connection in the school or at home, missing licences, tools or functionalities
(3) Teaching: statements regarding teaching practices, quality of teaching tools and methods
(4) Feedback: statements regarding rules and processes concerning feedback between the different stakeholders
(5) Motivation and learning success: statements regarding stakeholders' motivation to work online
(6) Social interaction and support: statements regarding the relationship between and within stakeholder groups, support systems for the different stakeholder groups
(7) Personal resources and stress factors: statements regarding the impact on day-to-day life, workload, and relevant coping strategies
(8) further education and training: statements regarding the content, organisation and availability of further training programs

The statements were structured into multiple categories, if the statements contained topics for multiple categories, resulting in a total of 1825 assignments after the second categorization. In the third phase of the analysis, the categories were further examined to determine how the stakeholders evaluate the distance learning situation at vocational schools (RQ). Some statements contain practical propositions to enhance the current situation.

6.4 Results

The most prominent statements in the specific categories are summarized to answer the research question. The presentation order of the categories is defined by the number of statements assigned to each category, starting with the category with the most assignments. The evaluation results are further partitioned into the different stakeholder groups, also sorted by seize. Exemplary statements are being used to underline the results at selected passages. These statements have been translated by the authors.

6.4.1 Category 1: Organisation

An insufficient structure and organisation is the most common criticism of participating students (429 of all statements). While some of the statements are very general, specific organisational problems can be identified from the perspective of the students. The first problem is the heterogenous implementation of digital tools and platforms by the teachers. Heterogeneity refers to the type of tool that is being used, but also to the way teachers integrate these tools into their teaching. While some teachers deliver lessons through video conference tools, other teachers limit their teaching to the distribution of worksheets:

> "Teachers should consistently use platforms (max 3. different ones). There should be live teaching in each subject, e.g. on Teams (not just exercises per mail). [sic]" (S, ID 279)

The different teaching techniques are linked to students' fear of not being able to achieve the learning goals for the school year. This fear is further enhanced by the lack of transparency regarding grading formalities and requirements which are perceived as maladjusted. Statements regarding grading and requirements are mentioned 41 times by the students. The third important topic for students is the irregularity of lessons. Out of all student statements, 31 students stated that class schedules should be used to organize distance learning.

The teachers share the students' perception about the structure and organisation within the school as one of the main weaknesses of the current distance learning situation. They advocate clear rules and standards for the use of different programs. The second most mentioned topic is the flow of information from the federal school administration. The information regarding the implementation of specific tools and data privacy is deemed insufficient:

> "[…] The federal state should provide clear recommendations for collaborative tools and supply the schools with these tools (licences). […]" (T, ID 2300)

> "necessary: […] a single tool for video conferences, for the whole school and the whole federal state, e.g. Webex or Zoom" (T, ID 527)

In total, 34 teachers state that they want to keep some form of distance learning. Especially online conferences with colleagues and further implementation of learning management systems are mentioned. School leaders evaluate the organisational situation similar to the teachers. They credit their staff and teachers for the positive developments at their schools, while criticizing the lack of support from state officials. This includes the provision of financial funding as well as clear rules and recommendations.

Only very few of the parents' statements can be categorized into organisation, containing the need for more information about students' tasks and necessary infrastructure. The topic of information and transparency is the biggest part of training company statements. The training companies want to know what their apprentices are doing and how the situation at the school is organized.

> "Information for the training companies about the online classes was completely missing. In general, there was little information for the training companies, this has to be improved." (C, ID 1082)

6.4.2 Category 2: Technical Infrastructure

Almost a third of all statements (29.2 %) refer to the technical infrastructure within the school or at home. While the statements of the different stakeholders in this category are very similar, students express conflicting views towards digital platforms and software. While some state that they have access to the necessary software, almost the same number of students state the opposite. In 31 cases, students mention the lack of necessary hardware, such as tablets, printers and laptops, for the successful participation in distance learning processes at their respective schools. A slightly more prominent problem (43 statements) for students is internet access at home. This includes insufficient stability, speed and data volume, especially when students have to use their mobile data plans to participate in classes as a result of missing computers.

> "I only have an internet connection half of the time. It comes and goes and is not available a lot of the time." (S, ID 3888)

The teachers' statements assess the situation in the same way. In addition to their own infrastructure, they express worries about their students' equipment. They extend the lack of infrastructure to the circumstances in the school, including servers and the internet connection in the school building(s). School leaders, parents and training companies make statements about deficient hardware. In regard to software, data security is a common topic for them, stating the need for tools that are especially built for the educational sector and vocational schools.

6.4.3 Category 3: Teaching

Roughly the same amount of statements as in category 2 can be allocated to category 3 (340 statements). The students emphasise the implementation of live video conferences as a helpful teaching method, with almost 20 % of students' statements in this category. A typical statement is the wish for more live interaction and less autonomous learning in the form of worksheets or exercises. The students stress the importance of explanations and structures when teachers hand out work assignments. Students report an increased workload in comparison to on-site teaching, criticising unrealistic teacher expectations in the form of deadlines and volume of work, which is intensified through the perceived lack of communication between the teachers. The increase of self-regulated learning practices is rated positively in 10 % of students' statements in this category.

> "In my opinion, distance learning is a good opportunity to become more independent and to acquire new competencies. […] the downside is the amount of material teachers want us to go through. In my opinion, that amount of material would not and could not be handled in on-site classes." (S, ID 3809)

The teachers' evaluation of live video conferences as a teaching tool is very mixed. Some teachers made good experiences and want to keep teaching online, while others are opposed to the idea, mainly because of the increased workload and subject-specific barriers. They underline the challenge to implement practical training in an online format. Learning management systems, on the other hand, are rated as a useful asset for digital teaching at vocational schools. Especially the possibility to centrally save files and the ease of distribution of learning material and exercises get mentioned. The statements of the other stakeholders are similar to the ones mentioned above.

6.4.4 Category 4: Feedback

The category ‘Feedback’ has been included as a single category, because it is a very prominent topic within the statements. Around 5 % of all statements mention feedback directly. Students report a lack of feedback from the teachers in regard to tasks and exercises.

> “[…] If tasks have a deadline, students should also receive feedback […]” (S, ID 3904)
> “Tasks which have been uploaded should be assessed with proper feedback” (S, ID 3968)
> “It would be nice to send finished work to the teachers more often and to receive individual feedback” (S, ID 2635)

The criticism goes beyond feedback on tasks and refers to the general communication with teachers. Students state their perception of teachers reacting very late or not at all to questions outside of the class room setting from time to time. Parents and training companies share this evaluation. The teachers on the other hand rarely mention feedback in their statements. In the few cases that can be found in the dataset, teachers express difficulties regarding the time requirements and workload of individual feedback.

6.4.5 Category 5: Motivation and learning success

The statements regarding the motivation to use distance learning are ambivalent. Throughout the 179 students’ statements regarding distance learning, around 60 % can be identified a positive, while the other third prefers on-site teaching practices. This ratio is reversed for the teachers: the teachers prefer on-site teaching and often refer to subject-specific requirements as a reason against distance learning.

> “language teaching with a class of 30 students is not possible online. Language input is much lower than while on-site teaching. […] gymnastic instruction is almost not feasible” (T, ID 1878)
> “practical occupational education is almost impossible in an online format” (T, ID 48)

Many students report problems around their ability to stay motivated during online classes and when working from a distance. Their statements include the lack of digital infrastructure, insufficient space or having to simultaneously work at their respective training companies as reasons for their diminishing motivation. Other students value the opportunity to plan their learning process more independently as well as the safe learning space they can create at home. These students report an increase in motivation when distance learning. Students’ self-assessment corresponds to the evaluation of teachers. Many teachers experience the students as

less motivated during distance learning practices. From the teachers' perspective, the motivation of students is influenced by two factors: students who have been motivated during on-site teaching are still motivated to work from a distance, whereas students who already struggled with motivation before the pandemic had even more motivational problems when taught from a distance. In addition, the type of vocational school influences students' motivation. On the higher ISCED levels, motivation and self-regulated learning skills are reported higher by the teachers, compared to the lower ISCED levels:

> "[…] Even if the technical infrastructure is there, the motivation to participate – depending on the type of school – is generally low." (T, ID 3611)
> "[…] Learning delay and demotivation are very high at the vocational college. Even the majority of students in graduation classes just pretend to register in the morning. In contrast, it works very well in classes in which students generally have a higher level of education (e.g. industrial clerks) […]" (T, ID 2377)

6.4.6 Category 6: Social interaction and social support

Around 100 statements contain information about social interaction and social support. The majority of these statements focuses on missing or insufficient communication between teachers and students. This includes communication in video conferences, but also communication processes outside of the classroom, which have partially been reported in the category 'Feedback'. Many teachers underline the importance of real-life social interaction as an integral part of on-site classes.

> "[…] On-site teaching can't be replaced through online teaching. Teaching lives through direct communication, interaction, and social experience. […]" (T, ID 1720)

Some students mention communication problems in the classroom with their peers, especially during online group projects. A more prominent topic for students is the insufficient communication they attribute to the teacher-teacher relationship. Students perceive their excessive workload as a direct consequence of non-existing agreements between their teachers.

> "[we need] communication between the teachers regarding tasks in the class, big tasks often overlap" [S, ID 3379)

6.4.7 Category 7: Personal resources and stress factors

Almost 15 % of the statements can be filed into this category. A majority of the students' statements refers to the perceived increase of workload when working from a distance. From their perspective, teachers hand out more assignments and those assignments also take more time to complete. Apart from assignment specific workload, students mention a generally higher number of tasks when working online.

> "The hand-in assignments should fit the classes, […] the assignments take much longer than an actual school lesson." (S ID 2873)
> "I think it's just too many assignments. And the teachers can't teach all the competences we need […]" (S ID 3210)

Teachers and other stakeholders share the opinion of students regarding the volume of assignments, time constraints and general workload.

> "The knowledge gap of the apprentices is big and as a consequence they are stressed and are scared that they will graduate with a bad grade" (T, ID 408)
> "The school schedules have to be adapted so that students do not sit in front of the computer the whole day" (T, ID 240)

Only a few of the statements mention personal stress factors, such as problems caused by living conditions or the general situation. Although the number of these statements is low, they show severe problems:

> "Distance classes are very tempting for me. It is easy for me to skip classes. I can simply sleep in and let myself go. I hope I can get back to school soon" (S, ID 1836)
> "We should take more breaks, because we are sitting in front of the PC for such a long time […]. The concentration is gone, your eyes hurt […] (S, ID 2209)
> "[…] During the first lockdown, apprentices had to be in their training companies. It is impossible to stay focused there and we didn't have the time to do all assignments. […]" (S, ID 430)

6.4.8 Category 8: Further education and training

The final category contains around 10 % of all statements. The most important issue for students is the perceived lack of teachers' digital competences. They mainly refer to the usage of digital tools, especially when conducting live video classes or uploading content to a LMS.

> "[…] Teachers should be taught how to use modern media […]" (S, ID 1525)
> "The structure within Moodle differs between the teachers (depending on their knowledge and skills)." (S, ID 1606)

The teachers themselves acknowledge the need for further education and training. They mention specific IT support, but also further training for digital tools and didactical methods.

> "Support from external IT specialists is urgently needed! Many teachers are no computer specialists." (T, ID 1438)
> "It is not just the handling of digital tools that is import, but also the creation of good didactical concepts within the specific subjects." (T, ID 175)

6.5 Practical Implications

The organisation of digital distance learning at school and classroom level is a major concern of students, especially in regard to the heterogeneous implementation of tools and methods, unclear grading processes as well as the lack of classroom schedules. The implementation of tools and methods is problematic in two ways. Firstly, teachers use different didactical methods for digital distance learning. While some stick to more traditional forms, such as live video classes, other teachers prefer problem sets which are being provided over an LMS or distributed via email. It is important to notice that the choice of teaching methods does not generally deviate from an on-site setting. Designing instructions in a way the teachers deem the most effective is one of the most important principles in Germans education system, considering the "constitutional freedom of teachers" (Kerres, 2020). Hence, students at vocational schools should be familiar with different didactical practices. However, they state clear preferences for teacher centred live video classes, most likely because that method does deviate the least from the methods the students are used to. The student-centred learning approach requires much more self-learning competencies on the students' side. The extensive workload that the student perceive might be a result of an imbalance between their

competencies and the requirements.

On the other hand, digital distance learning can make it very difficult for the teachers to notice and recognize how students deal with a specific method, while on-site teaching methods are characterized by the possibility to immediately react to students' needs. Educators at vocational schools have to carefully balance different methods of distance learning to take these two aspects into account. Most importantly, teachers should not rely on the provision of problem sets as the sole teaching method. In accordance with the principle of method diversity, it is recommended to include self-centred learning practices (worksheets, online tests) as well as strategies which focus on the teacher (live video classes) to foster students' competencies (Cidral et al., 2018; Dole et al., 2015; Maass et al., 2019; Tawbush et al., 2020).

A second problem occurs from the heterogenous implementation of tools. In practice, the teachers chose various software solutions for similar tasks. For example, some teachers use a LMS to store learning materials, while other teachers use software like Microsoft Teams or Apple Classroom for the provision of similar learning materials. In many cases, the basic functionality of the tools does not differ significantly. As a result, the teachers' decision for a specific tool seems to be based on personal preference rather than function or didactical value. Therefore, it seems less relevant whether Zoom, WebEx or BigBlueButton is being used for video classes, or if worksheets are provided through a cloud service or via email. While each teacher uses one digital tool for each task, students are required to deal with a multitude of different tools for similar tasks. At worst, students might have to use three or more different video tools throughout video classes in the morning and then get learning materials from other various tools and platforms in the afternoon. This situation has been pointed out as stressful and overwhelming in the students' statements. At school level, stakeholders should come to an agreement on which tools and methods they want to use for specific tasks. Although such an agreement contradicts the freedom of teaching to a certain degree, it seems to be an important step for the introduction of digital distance learning at vocational schools. Once all stakeholders have had the opportunity to acquire competences for the chosen tools, the number of tools can slowly be increased, if stakeholders miss specific functionalities or if new tools prove to be more suited for educational processes.

This argument is additionally backed by teachers' and school leaders' wishes for clearer rules at federal state level. Many of their statements refer to uncertainty regarding the compliance with data protection and privacy laws when working with digital tools. A public whitelist for schools could be an adequate tool to dispel such concerns, because the stakeholders at schools could then make their statements on specific digital tool selection more transparent.

More transparency is also necessary in regard to changing regulations when it comes to grading and assessment. During the switch from on-site to digital online teaching, the federal administration quickly announced that grading was suspended. While teachers perceived that decision as a motivational setback for students, many students were unsure whether and how they could achieve their qualifications. A successful integration of digital learning practices therefore requires thorough regulations on how digital assignments can be designed and how grading is arranged.

Technological infrastructure is one of the most mentioned topics in the stakeholders' statements. In accordance with previous research work (Chua & Chai, 2019; Falloon, 2020; Fraillon et al., 2020; Gil-Flores et al., 2017; Hennessy, 2017), the effective provision of technological infrastructure can be identified as an import pillar of digital distance learning. The results of the data analysis in regard to technological infrastructure can be categorized into different components, namely hardware and software, each on the school and the personal level. From a school level perspective, the server infrastructure within a school has to be capable of supporting digital distance learning. Some of the shortcomings mentioned in the results can be traced back to inadequate hardware, for example when teachers state that they cannot provide hybrid lessons due to the fact that there is no wireless connection in some classrooms. Investments into creating an adequate infrastructure within the school buildings therefore has to be one of the most pressing topics for stakeholders at vocational schools. It is crucial to develop solutions that are specific to individual schools, because the actual structural conditions have a big influence on how wireless networks have to be set up (Gil-Flores et al., 2017; Hernandez et al., 2019). Even with the specific conditions in mind, decision makers at schools can benefit from the experience of comparable schools. To that end, the school administration on the state level has to further support vocational schools through the comprehensive collection of ongoing and finished infrastructural development projects. Accessing such information can help businesses and craftsmen to come up with sustainable on-site solutions.

Even if wireless network coverage is given, some schools cannot provide sufficient internet bandwidth, due to the general condition of the internet grid in Germany (forsa, 2019; Gürtzgen et al., 2018; Stockinger, 2019). Although efforts have been made recently to improve this situation, especially rural areas and schools within these areas have to be described as isolated and underdeveloped in regard to internet access. This includes the internet connection of students and teachers working from their homes. These findings might be located outside of school development in terms of responsibility, but they have to be factored in when planning digital distance learning. One possibility is the provision of digital workplaces within the

school. Although this contradicts the idea of digital distance learning, such digital workplaces allow students to participate in learning processes, rather than leaving those students to themselves. These considerations follow the findings regarding students' access to adequate software and hardware. The question on the provision of devices is still not fully clarified. In comparison to other forms of schools, vocational schools have the advantage of collaborating training companies, which they can include in the provision process. Instead of counting on student-owned devices, schools could use company-owned devices. An additional benefit of this approach is the connection of learning places, meaning that students learn to use the same devices in schools and at their workplaces. The training companies therefore directly benefit from their investment into apprentice devices.

The development and provisioning of educational software should be standardized at federal state level. This way, stakeholders can be certain that they are using software solutions which adhere to data security laws and didactic standards. The tender procedures for the specific software developers have to be based on development processes which include educational researchers and stakeholders at vocational schools. Most importantly, the federal government has to provide sufficient funding to make the production of educational software attractive for software companies.

From the students' perspective, digital distance learning is perceived as more work-intensive than on-site teaching. In addition, students prefer live video classes over problem sets. Both results might be traced back to an argument that has been stated in the context of school organisation in a previous paragraph. Live video classes can focus on the teacher as the main provider of knowledge and information, whereas problem sets require more self-learning competencies. The responsibility for a successful learning process shifts towards the students to a certain degree (McCabe & O'Connor, 2014). This can cause students to feel positively challenged, something that is mentioned in some of the students' statements. Other students might feel overwhelmed or unprepared if the learning process lacks the guidance of a teacher. The potential of challenges can quickly turn into excessive demands in situations where too much at once is required from the learners. Students specifically underline these situations when they report a lack of teacher-teacher communication, resulting in too many or too difficult tasks within a short amount of time. The potentials of self-centred learning strategies can be harnessed through transparent learning goals and close communication with other teachers (Guggemos & Seufert, 2021). Digital tools can support teachers and students to stake out realistic expectations. One example is the implementation of a class schedule which is accessible by all responsible teachers and the students. Here, the educators can present tasks on

a weekly basis, preferably with an envisaged time frame. Such a tool allows the teachers to collaborate and consider students workload more precisely when planning their own tasks. In light of the students' criticism, the lack of experience with digital distance learning has to be emphasized. While teachers can hardly estimate the workload of students beforehand, students can only use their former experience with on-site teaching as a reference point. In digital distance learning situations, students are required to be more self-reliant. Consequently, teachers have to find out which amount of work and which types of problem sets are feasible for their students. The problematic situation for teachers is reflected in their statement regarding difficulties when trying to use digital distance teaching for specific subjects. It seems apparent that some subjects might be less suitable for video classes or other forms of digital teaching methods. This conclusion might be rooted in a possible misconception of digital distance learning. The overall goal should not be the transmission of on-site teaching practices into a digital format, but rather the possibility to expand the existing teaching methods with the help of digital tools. As an example, language classes have been rated as inadequate for digital distance learning, because they "require face to face interaction" (T ID 1337). But language classes are not limited to face to face interaction. Language teachers could design learning scenarios which include online video platforms such as YouTube and task students with providing subtitles for their favourite German songs or movie scenes. Such a scenario enhances more traditional learning settings, rather than trying to force existing practices into digital distance teaching. This argument holds for the facilitation of practical competencies. Simulations might be helpful to support teachers' efforts in regard to practical tasks, but it will not and should not make learning at the workplace obsolete (Jossberger et al., 2018; Lamb et al., 2018).

The challenging teaching situation is further underlined by students' extensive references towards feedback and feedback culture. Students require guidance and feedback from their teachers, especially when learning practices focus on self-centred learning competencies, for example when teachers use problem sets as teaching tools (Hattie & Timperley, 2007; Metcalfe, 2017). Many of the statements describe the didactical process as one dimensional when teachers do not provide solutions or individual feedback for assignments. In those situations, students are unable to complete the learning process, because they do not know whether their solution was right or wrong. Consequently, they are unable to learn from their mistakes (Brookhart, 2017) and reach the planned learning goals. In return, the students get frustrated, which reduces their motivation. The loss of motivation influences their ability to further participate in the learning process, because it affects their sense of competence and self-efficacy (Hattie et al.,

2020). Teachers can break this downward spiral through purposefully implemented feedback. In their statements, the teachers acknowledge the students' need for feedback, but they also mention their workload as a limiting factor on their ability to give feedback. The results show that it is necessary to build an adequate feedback culture which bridges the students' needs and the possibilities of the teachers. Both groups have to agree on specific forms of feedback which meet their requirements. These forms of feedback might be the provision of sample solutions or individual feedback for single students in a rotating process. Additionally, digital tools can help teachers to enhance feedback culture in the classroom with positive implications for their workload. Digital quizzes can be implemented to give direct feedback to the students (George, 2020), as well as automated scoring for longer texts (Ludwig et al., 2021). On the other hand, students have to be aware of the fact that they might not receive individual feedback for each assignment and they have to further develop competencies to evaluate their learning process. Given the high relevance of feedback for the students, the negotiation process between students and teachers has to be embedded in a school-wide feedback culture. In practice, each teacher should be able to provide comparable forms of feedback to their students. Consequently, school leaders have to provide the digital tools to teachers and students alike.

The ability to implement new tools and methods into teaching is linked to the competencies of teachers (Falloon, 2020; Hennessy, 2017; Mishra, 2019; Villalobos, 2016). The results of the analysis show that many students do not perceive their teachers as competent in regard to ICT. More importantly, teachers themselves voice the need for further education and training. Such training programs might focus on specific methods, such as flipped classroom (Strelan et al., 2020) or blended learning approaches (Graham et al., 2019; Hrastinski, 2019). Additionally, specific digital tools might be the content of further teacher education, including the usage of interactive whiteboards (Hennessy, 2017), tablet computers (Ifenthaler & Schweinbenz, 2013; Montrieux et al., 2015; Otterborn et al., 2019) or educational software (George, 2020; Jossberger et al., 2018). In the context of vocational schools, teachers should further enhance their ability to bridge theoretical and practical learning places, by educating themselves about simulations (Jossberger et al., 2018; Rausch et al., 2021) and learning factories (Faßhauer et al., 2021; Roll & Ifenthaler, 2021). The training programs have to be specifically adapted to the abilities of teachers, such as their prior knowledge and preferred style of teaching (Darling-Hammond et al., 2017; Terhart, 2019; van Ackeren et al., 2019). In addition to formal education programs, teachers can benefit from each other's experience in collaborative processes within a single school or within a professional network (García-Martínez et al., 2020; Romeu et al., 2016). Advancements in teacher education should not be limited to in-service teachers. In the

future, digital tools, methods and content has to be further implemented into pre-service teachers training programs at the university level (van Ackeren et al., 2019). Digitally competent young professionals might function as multiplicators at school level, where they can profit from the work experience of expert educators (Scantlebury et al., 2008).

While the majority of statements was made by students and teachers, the other stakeholders share many of their opinions. In the context of vocational schools, some statements of the training companies have to be singled out. The educators at the training companies underline the fact that the schools often do not provide information about the current situation at the schools. An effective flow of information is necessary to foster collaborative processes between the theoretical and practical places of learning (Aprea et al., 2020). Several approaches can help to improve the collaboration between schools and training companies. Firstly, schools could open their LMS to the training companies. With this approach, trainers have the opportunity to coordinate workplace practice with current topics at the school and vice versa. Trainers could inform the teachers about new tools and methods that are currently being implemented on the work floor. Consequently, teachers could use those new tools as real-life examples for specific subjects. Oftentimes, companies have access to machines and software which the vocational schools cannot provide. Through collaborative teaching designs, trainers can showcase these machines, for example by creating explanatory videos together with their apprentices. In this way, all students of a class can learn about new techniques and practices of the workplace. Teachers can also use simulations to connect theory to practice (Rausch et al., 2021). Effective simulations require scenarios which are close to the real tasks on the work floor. Trainers at the training companies can help to create such scenarios.

The analysis of the stakeholder statements helps to identify increasing issues and difficulties of a relatively small number of students. Although their number seems to be small, they require special considerations from decision makers at vocational schools. Firstly, the problems which are described by those students seem to considerably affect their ability to follow the classes, successfully hand in problem sets and reach their learning goals. Digital distance learning must not exclude these students from the vocational educational training system. A solution could be the setup of learning places within the school building, although such rooms are partially opposed to the concept of digital distance learning. If these learning places are accompanied by teachers on-site, struggling students might be able to develop the specific competencies to successfully participate in digital distance learning. Secondly, it is unclear whether the described challenges and the number of the struggling students within the sample accurately represent the situation of all vocational students. This limitation is further presented in the

following chapter.

6.6 Limitations and Further Research

Several limitations influence the interpretation of this study. The online questionnaire resulted in a comprehensive collection of data from the respective vocational schools. The high number of qualitative statements underlines the value of the evaluation process for the stakeholders at vocational schools. Miller and Dumford (2014) as well as Adams (2015) critically reflect on open questions: they state that respondents tend to answer those questions when their experience has been more negative. This might skew the results of the survey. In addition, stakeholders without access to the questionnaire did not have the possibility to state their opinion. Nevertheless, the various participating schools and the high number of responses indicate a good representativeness of the data, especially in regard to students and teachers. In many cases, the different categories are presented from multiple perspectives, allowing for a complex examination. The stakeholders within the training companies have to be better linked to school evaluation in the future. Although their statements contain valuable information, especially in regard to information flow, their attitudes and perceptions have to be further examined. One way could be the definition of contact persons within the companies. Such contact persons might be the instructors at the workspace or relevant management personnel. This way, the response rate from the companies might be increased and new cooperation processes between the vocational schools and the training companies can be initiated.

The interpretative characteristic of the the qualitative research approach should be strengthened through quantitative research, as the numerous considerations regarding the different identified categories require the examination of verifiable relationships. The category feedback can serve as an example for such a research approach. An experimental design can provide the necessary data to identify measurable effects of different feedback methods on the learner success of students and their motivation. Consequently, the success of learners should be assessed as a combination of perceived success and formal assessment, for example graded exams. As a result, the stakeholders at the vocational schools can implement feasible, sustainable and beneficial feedback tools and methods into the daily practice within their institutions.

The success of the data collection and the collaboration between educational researchers and vocational schools has to be enhanced through further cooperative evaluation processes. To that end, a revision of the evaluation instrument is planned. Consequently, school leaders

will have the opportunity for the flexible integration of the evaluation instrument within the systems at their schools. As a result, the initiated evaluation of digital distance learning can be transposed into a continuous evaluation process, in which the consultation of stakeholders and implemented changes on the school level form an iterative process.

6.7 References

Adams, W. C. (2015). Conducting Semi-Structured Interviews. In *Handbook of Practical Program Evaluation* (pp. 492–505). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119171386.ch19

Alinsunurin, J. (2020). School learning climate in the lens of parental involvement and school leadership: lessons for inclusiveness among public schools. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-020-00139-2

Aprea, C., Sappa, V., & Tenberg, R. (2020). *Konnektivität und lernortintegrierte Kompetenzentwicklung in der beruflichen Bildung / Connectivity and Integrative Competence Development in Vocational and Professional Education and Training (VET/PET)*. Franz Steiner Verlag.

Balzer, L., & Schorn, I. (2021). *Check-up Distance Learning für die Sekundarstufe II. Beitrag präsentiert im Webinar "Erfolgreiche digitale Transformation an unseren Berufsfachschulen" der Schweizerischen Direktorinnen- und Direktorenkonferenz der Berufsfachschulen (SDK) und der Schweize*.

Barblett, L., & Kirk, G. (2018). National Quality Standard in Schools: Leadership Enabling Power and Agency. *Australasian Journal of Early Childhood*, *43*(3), 43–51. https://doi.org/10.23965/AJEC.43.3.05

Bateman, J., & Schmidt-Borcherding, F. (2018). The Communicative Effectiveness of Education Videos: Towards an Empirically-Motivated Multimodal Account. *Multimodal Technologies and Interaction*, *2*(3), 59. https://doi.org/10.3390/mti2030059

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-Service Teachers' Perceptions of School Development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

BIBB. (2021). *Verzeichniss der anerkannten Ausbildungsberufe 2021*. https://www.bibb.de/dienst/veroeffentlichungen/de/publication/download/17368

Blok, H., Sleegers, P., & Karsten, S. (2008). Looking for a balance between internal and external evaluation of school quality: evaluation of the SVI model. *Journal of Education Policy*, *23*(4), 379–395. https://doi.org/10.1080/02680930801923773

Borman, G. D., Hewes, G. M., Overman, L. T., & Brown, S. (2003). Comprehensive School Reform and Achievement: A Meta-Analysis. *Review of Educational Research*, *73*(2), 125–230. https://doi.org/10.3102/00346543073002125

Brookhart, S. M. (2017). *How to Give Effective Feedback to Your Students* (2nd ed.). ASCD.

Bryk, A. S. (2010). Organizing Schools for Improvement. *Phi Delta Kappan*, *91*(7), 23–30. https://doi.org/10.1177/003172171009100705

Carmichael, M., Reid, A.-K., & Karpicke, J. D. (2018). *Assessing the Impact of Educational Video on Student Engagement, Critical Thinking and Learning: The Current State of Play*. SAGE Publications. www.sagepublishing.com

Chan, H. K., Griffin, J., Lim, J. J., Zeng, F., & Chiu, A. S. F. (2018). The impact of 3D Printing Technology on the supply chain: Manufacturing and legal perspectives. *International Journal of Production Economics*, *205*, 156–162. https://doi.org/10.1016/j.ijpe.2018.09.009

Chekanushkina, E. N., Timoshchuk, N. A., Kolyvanova, L. A., & Fakhrutdinova, E. V. (2021). *Social and Environmental Competence as a Component of University Graduate's Competitiveness BT - Engineering Economics: Decisions and Solutions from Eurasian Perspective* (S. I. Ashmarina, V. V. Mantulenko, & M. Vochozka (Eds.); pp. 676–681). Springer International Publishing.

Cherner, T., Dix, J., & Lee, C. (2014). Cleaning Up That Mess: A Framework for Classifying Educational Apps. *Contemporary Issues in Technology and Teacher Education*, *14*(2),

158–193.
Chua, C. S. K., & Chai, C. S. (2019). Information Communication Technology. In B. Wong, S. Hairon, & P. T. Ng (Eds.), *School Leadership and Educational Change in Singapore* (pp. 149–168). Springer International Publishing. https://doi.org/10.1007/978-3-319-74746-0_9
Cidral, W. A., Oliveira, T., Di Felice, M., & Aparicio, M. (2018). E-learning success determinants: Brazilian empirical study. *Computers & Education*, *122*, 273–290. https://doi.org/10.1016/j.compedu.2017.12.001
Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: the digital revolution and schooling in America* (2nd ed.). Teachers College Press.
Conrad, M., & Schumann, S. (2021). Emotionales Erleben beim Lernen mit Tablet-PCs im Wirtschaftsunterricht: Berufsbildung. Zeitschrift für Theorie-Praxis-Dialog. *Berufsbildung. Zeitschrift Für Theorie-Praxis-Dialog*, *75*(187), 13–15.
Dadds, M. (2020). *Passionate Enquiry and School Development*. Routledge. https://doi.org/10.4324/9781003059073
Darling-Hammond, L., Hyler, M. E., & Gardener, M. (2017). *Effective Teacher Professional Development*.
Deissinger, T. (2015). The German dual vocational education and training system as 'good practice'? *Local Economy: The Journal of the Local Economy Policy Unit*, *30*(5), 557–567. https://doi.org/10.1177/0269094215589311
Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826
Ditton, H., & Müller, A. (2011). Schulqualität. In H. Reinders, H. Ditton, C. Gräsel, & B. Gniewosz (Eds.), *Empirische Bildungsforschung: Gegenstandsbereiche* (pp. 99–111). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93021-3_9
Dole, S., Bloom, L., & Kowalske, K. (2015). Transforming Pedagogy: Changing Perspectives from Teacher-Centered to Learner-Centered. *Interdisciplinary Journal of Problem-Based Learning*, *10*(1). https://doi.org/10.7771/1541-5015.1538
Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, *15*(1), 3. https://doi.org/10.1186/s41239-017-0087-5
Eickelmann, B., Drossel, K., & Heldt, M. (2020). Vorteile digital fortgeschrittener Schulen in der Pandemie-Zeit. Ergebnisse einer repräsentativen Lehrkräftebefragung. *Schulmanagement. Fachzeitschrift Für Schul- Und Unterrichtsentwicklung*, *51*(3), 28–31.
Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen*, *29*(4), 111–115.
Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1
Falck, O., Mang, C., & Woessmann, L. (2018). Virtually No Effect? Different Uses of Classroom Computers and their Effect on Student Achievement. *Oxford Bulletin of Economics and Statistics*, *80*(1), 1–38. https://doi.org/10.1111/obes.12192
Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4
Faßhauer, U., Windelband, L., Mutzke, B., & Harm, S. (2021). Lernfabriken an beruflichen

Schulen als Gegenstand fachdidaktischer Professionalisierung – Entwicklung von standortübergreifenden Medienpaketen im beruflichen Lehramtsstudium. *Berufs- Und Wirtschaftspädagogik Online, 40*. https://www.bwpat.de/ausgabe40/fasshauer_etal_bwpat40.pdf

forsa. (2019). *Die Schule aus Sicht der Schulleiterinnen und Schulleiter – Digitalisierung und digitale Ausstattung Ergebnisse einer bundesweiten Repräsentativbefragung*. forsa Politik- und Sozialforschung GmbH.

Fox, C., & Jones, R. (2019). *State K-12 Broadband Leadership 2019: Driving Connectivity, Access and Student Success*. https://files.eric.ed.gov/fulltext/ED594505.pdf

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

Freundl, V., Lergetporer, P., & Zierow, L. (2021). Germany's education policy during the COVID-19 crisis. *Zeitschrift Für Politikwissenschaft*, *31*(1), 109–116. https://doi.org/10.1007/s41358-021-00262-7

García-Martínez, I., Tadeu, P., Montenegro-Rueda, M., & Fernández-Batanero, J. M. (2020). Networking for online teacher collaboration. *Interactive Learning Environments*, 1–15. https://doi.org/10.1080/10494820.2020.1764057

George, M. L. (2020). Effective teaching and examination strategies for undergraduate learning during COVID-19 school restrictions. *Journal of Educational Technology Systems*, *49*(1), 23–48.

Gessler, M. (2017). The Lack of Collaboration Between Companies and Schools in the German Dual Apprenticeship System: Historical Background and Recent Data. *International Journal for Research in Vocational Education and Training*, *4*(2), 164–195. https://doi.org/10.13152/IJRVET.4.2.4

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Godhe, A.-L. (2019). Digital Literacies or Digital Competence: Conceptualizations in Nordic Curricula. *Media and Communication*, *7*(2), 25–35. https://doi.org/10.17645/mac.v7i2.1888

Graham, C., Borup, J., Short, C., & Archambault, L. (2019). *K-12 Blended Teaching: A Guide to Personalized Learning and Online Integration*.

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: implications for teacher education. *European Journal of Teacher Education*, *41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*, 1–11. https://doi.org/10.1016/j.chb.2020.106613

Gürtzgen, N., van den Berg, G. J., Nolte, A., & Pohlan, L. (2018). Do Digital Information Technologies Help Unemployed Job Seekers Find a Job? Evidence from the Broadband Internet Expansion in Germany. *IZA Discussion Papers*, *11555*, 1–62.

Hanberger, A. (2014). What PISA Intends to and Can Possibly Achieve: A Critical Programme Theory Analysis. *European Educational Research Journal*, *13*(2), 167–180. https://doi.org/10.2304/eerj.2014.13.2.167

Hanberger, A., Carlbaum, S., Hult, A., Lindgren, L., & Lundström, U. (2016). School evaluation in Sweden in a local perspective: A synthesis. *Education Inquiry*, *7*(3), 30115. https://doi.org/10.3402/edui.v7.30115

Harderer, A., Imboden, S., Glassey-Previdoli, D., & Schumann, S. (2020). Schulleitungshandeln in Zeiten der digitalen Transformation – „Business as usual" oder

„Alles ist neu“? In K. Heinrichs, K. Kögler, & C. Siegfried (Eds.), *Berufliches Lehren und Lernen: Grundlagen, Schwerpunkte und Impulse wirtschaftspädagogischer Forschung. Digitale Festschrift für Eveline Wuttke* (pp. 1–17). https://www.bwpat.de/profil6_wuttke/harder_etal_profil6.pdf

Harris, A. (2010). Leading system transformation. *School Leadership & Management*, *30*(3), 197–207. https://doi.org/10.1080/13632434.2010.494080

Hattie, J., Hodis, F. A., & Kang, S. H. K. (2020). Theories of motivation: Integration and ways forward. *Contemporary Educational Psychology*, *61*, 101865. https://doi.org/10.1016/j.cedpsych.2020.101865

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hawlitschek, A., & Joeckel, S. (2017). Increasing the effectiveness of digital educational games: The effects of a learning instruction on students’ learning, motivation and cognitive load. *Computers in Human Behavior*, *72*, 79–86. https://doi.org/10.1016/j.chb.2017.01.040

Heck, R. H., & Hallinger, P. (2010). Testing a longitudinal model of distributed leadership effects on school improvement. *The Leadership Quarterly*, *21*(5), 867–885. https://doi.org/10.1016/j.leaqua.2010.07.013

Henderson, J., & Corry, M. (2021). Data literacy training and use for educational professionals. *Journal of Research in Innovative Teaching & Learning*, *14*(2), 232–244. https://doi.org/10.1108/JRIT-11-2019-0074

Hennessy, S. (2017). International Experiences with Intergrating Interactive Whiteboards: Policy, Practice, Pedagogy and Professional Development. In R. Maclean (Ed.), *Life in Schools and Classrooms: Past, Present and Future* (pp. 633–650). Springer Singapore. https://doi.org/10.1007/978-981-10-3654-5_38

Hernandez, L., Balmaceda, N., Hernandez, H., Vargas, C., De La Hoz, E., Orellano, N., Vasquez, E., & Uc-Rios, C. E. (2019). *Optimization of a WiFi Wireless Network that Maximizes the Level of Satisfaction of Users and Allows the Use of New Technological Trends in Higher Education Institutions BT - Distributed, Ambient and Pervasive Interactions* (N. Streitz & S. Konomi (Eds.); pp. 144–160). Springer International Publishing.

Hirsch-Kreinsen, H. (2016). Digitization of industrial work: development paths and prospects. *Journal for Labour Market Research*, *49*(1), 1–14. https://doi.org/10.1007/s12651-016-0200-6

Hochberg, K., Kuhn, J., & Müller, A. (2018). Using Smartphones as Experimental Tools—Effects on Interest, Curiosity, and Learning in Physics Education. *Journal of Science Education and Technology*, *27*(5), 385–403. https://doi.org/10.1007/s10956-018-9731-7

Hopfenbeck, T. N., Lenkeit, J., El Masri, Y., Cantrell, K., Ryan, J., & Baird, J.-A. (2018). Lessons Learned from PISA: A Systematic Review of Peer-Reviewed Articles on the Programme for International Student Assessment. *Scandinavian Journal of Educational Research*, *62*(3), 333–353. https://doi.org/10.1080/00313831.2016.1258726

Hopkins, E., Hendry, H., Garrod, F., McClare, S., Pettit, D., Smith, L., Burrell, H., & Temple, J. (2016). Teachers’ views of the impact of school evaluation and external inspection processes. *Improving Schools*, *19*(1), 52–61. https://doi.org/10.1177/1365480215627894

Horn, N., & Otto, P. (2021). *Data protection versus functionality: the dilemma of German schools*. Heinrich Böll Stiftung. https://www.boell.de/en/2021/04/15/Data-protection-versus-functionality-the-dilemma-of-German-schools

Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2020). Ready, set, go! Profiling teachers’ readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 1–18. https://doi.org/10.1080/1475939X.2020.1839543

Hrastinski, S. (2019). What Do We Mean by Blended Learning? *TechTrends*, *63*(5), 564–569.

https://doi.org/10.1007/s11528-019-00375-5
Huang, L., Zhang, T., & Huang, Y. (2020). Effects of school organizational conditions on teacher professional learning in China: The mediating role of teacher self-efficacy. *Studies in Educational Evaluation*, *66*, 100893. https://doi.org/10.1016/j.stueduc.2020.100893
Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability*, *32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y
Ifenthaler, D., & Schweinbenz, V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behavior*, *29*(3), 525–534. https://doi.org/10.1016/j.chb.2012.11.004
Ifenthaler, D., & Schweinbenz, V. (2016). Students' Acceptance of Tablet PCs in the Classroom. *Journal of Research on Technology in Education*, *48*(4), 306–321. https://doi.org/10.1080/15391523.2016.1215172
Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8
Jensvoll, M. H., & Lekang, T. (2018). Strengthening professionalism through cooperative learning. *Professional Development in Education*, *44*(4), 466–475. https://doi.org/10.1080/19415257.2017.1376223
Jossberger, H., Brand-Gruwel, S., van de Wiel, M. W. J., & Boshuizen, H. (2018). Learning in Workplace Simulations in Vocational Education: a Student Perspective. *Vocations and Learning*, *11*(2), 179–204. https://doi.org/10.1007/s12186-017-9186-7
Jurkowski, S., & Müller, B. (2018). Co-teaching in inclusive classes: The development of multi-professional cooperation in teaching dyads. *Teaching and Teacher Education*, *75*, 224–231. https://doi.org/10.1016/j.tate.2018.06.017
Kerres, M. (2020). Against All Odds: Education in Germany Coping with Covid-19. *Postdigital Science and Education*, *2*(3), 690–694. https://doi.org/10.1007/s42438-020-00130-7
Koltay, T. (2017). Data literacy for researchers and data librarians. *Journal of Librarianship and Information Science*, *49*(1), 3–14. https://doi.org/10.1177/0961000615616450
König, L. (2021). Podcasts in higher education: teacher enthusiasm increases students' excitement, interest, enjoyment, and learning motivation. *Educational Studies*, *47*(5), 627–630. https://doi.org/10.1080/03055698.2019.1706040
Labusch, A., Eickelmann, B., & Conze, D. (2020). ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland. In *ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland*. Waxmann Verlag GmbH. https://doi.org/10.31244/9783830993087
Lamb, R. L., Annetta, L., Firestone, J., & Etopio, E. (2018). A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations. *Computers in Human Behavior*, *80*, 158–167. https://doi.org/10.1016/j.chb.2017.10.040
Leithwood, K., & Mascall, B. (2008). Collective Leadership Effects on Student Achievement. *Educational Administration Quarterly*, *44*(4), 529–561. https://doi.org/10.1177/0013161X08321221
Liebowitz, D. D., & Porter, L. (2019). The Effect of Principal Behaviors on Student, Teacher, and School Outcomes: A Systematic Review and Meta-Analysis of the Empirical Literature. *Review of Educational Research*, *89*(5), 785–827. https://doi.org/10.3102/0034654319866133
Lindberg, O. J., Olofsson, A. D., & Fransson, G. (2017). Same but different? An examination

of Swedish upper secondary school teachers' and students' views and use of ICT in education. *The International Journal of Information and Learning Technology*, *34*(2), 122–132. https://doi.org/10.1108/IJILT-09-2016-0043

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology*, 69–88. https://doi.org/10.14742/ajet.5583

Ludwig, S., Mayer, C., Hansen, C., Eilers, K., & Brandt, S. (2021). Automated Essay Scoring Using Transformer Models. *Psych*, *3*(4), 897–915. https://doi.org/10.3390/psych3040056

Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, *117*, 168–179. https://doi.org/10.1016/j.psep.2018.04.018

Maass, K., Cobb, P., Krainer, K., & Potari, D. (2019). Different ways to implement innovative teaching approaches at scale. *Educational Studies in Mathematics*, *102*(3), 303–318. https://doi.org/10.1007/s10649-019-09920-8

Mata, L., Lazar, G., & Lazar, I. (2016). Effects of study levels on students' attitudes towards interactive whiteboards in higher education. *Computers in Human Behavior*, *54*, 278–289. https://doi.org/10.1016/j.chb.2015.07.044

Maxwell, S., Reynolds, K. J., Lee, E., Subasic, E., & Bromhead, D. (2017). The Impact of School Climate and School Identification on Academic Achievement: Multilevel Modeling with Student and Teacher Data. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.02069

Mayring, P. (2004). Qualitative Content Analysis. In U. Flick, E. von Kardoff, I. Steinke, & B. Jenner (Eds.), *A Companion to Qualitative Research*. SAGE Publications.

Mayring, P. (2015). *Qualitative Inhaltsanalyse : Grundlagen und Techniken* (12., übera).

McCabe, A., & O'Connor, U. (2014). Student-centred learning: the role and responsibility of the lecturer. *Teaching in Higher Education*, *19*(4), 350–359. https://doi.org/10.1080/13562517.2013.860111

Metcalfe, J. (2017). Learning from Errors. *Annual Review of Psychology*, *68*(1), 465–489. https://doi.org/10.1146/annurev-psych-010416-044022

Miller, A. L., & Dumford, A. D. (2014). Open-Ended Survey Questions: Item Nonresponse Nightmare or Qualitative Data Dream? *Survey Practice*, *7*(5), 1–11. https://doi.org/10.29115/SP-2014-0024

Million, A. (2021). 'No one listens to us … ' COVID-19 and its socio-spatial impact on children and young people in Germany. *Children's Geographies*, 1–9. https://doi.org/10.1080/14733285.2021.1908520

Mishra, P. (2019). Considering Contextual Knowledge: The TPACK Diagram Gets an Upgrade. *Journal of Digital Learning in Teacher Education*, *35*(2), 76–78. https://doi.org/10.1080/21532974.2019.1588611

Mohamed, H., & Lamia, M. (2018). Implementing flipped classroom that used an intelligent tutoring system into learning process. *Computers & Education*, *124*, 62–76. https://doi.org/10.1016/j.compedu.2018.05.011

Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and Learning with Mobile Technology: A Qualitative Explorative Study about the Introduction of Tablet Devices in Secondary Education. *PLOS ONE*, *10*(12), e0144008. https://doi.org/10.1371/journal.pone.0144008

Muftić, A. (2012). *Schulentwicklung : Begriff - Theorie - Definition*.

Mulford, B. (2003). *School Leaders: Challenging Roles and Impact on Teaching and School Effectiveness*. OECD. https://www.oecd.org/education/school/37133393.pdf

Mutch, C. (2012). Complementary Evaluation: The Development of a Conceptual Framework to Integrate External and Internal Evaluation in the New Zealand School Context. *Policy*

Futures in Education, *10*(5), 569–586. https://doi.org/10.2304/pfie.2012.10.5.569

Nadkarni, S., & Prügl, R. (2021). Digital transformation: a review, synthesis and opportunities for future research. *Management Review Quarterly*, *71*(2), 233–341. https://doi.org/10.1007/s11301-020-00185-7

Nevo, D. (2001). School evaluation: internal or external? *Studies in Educational Evaluation*, *27*(2), 95–106. https://doi.org/10.1016/S0191-491X(01)00016-5

Nguyen, T. D. (2021). Linking school organizational characteristics and teacher retention: Evidence from repeated cross-sectional national data. *Teaching and Teacher Education*, *97*, 103220. https://doi.org/10.1016/j.tate.2020.103220

O'Brien, S., McNamara, G., O'Hara, J., & Brown, M. (2017). External specialist support for school self-evaluation: Testing a model of support in Irish post-primary schools. *Evaluation*, *23*(1), 61–79. https://doi.org/10.1177/1356389016684248

O'Callaghan, F. V., Neumann, D. L., Jones, L., & Creed, P. A. (2017). The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues. *Education and Information Technologies*, *22*(1), 399–415. https://doi.org/10.1007/s10639-015-9451-z

Otterborn, A., Schönborn, K., & Hultén, M. (2019). Surveying preschool teachers' use of digital tablets: general and technology education related findings. *International Journal of Technology and Design Education*, *29*(4), 717–737. https://doi.org/10.1007/s10798-018-9469-9

Patterson, R. W., & Patterson, R. M. (2017). Computers and productivity: Evidence from laptop use in the college classroom. *Economics of Education Review*, *57*, 66–79. https://doi.org/10.1016/j.econedurev.2017.02.004

Platz, L., Jüttler, M., & Schumann, S. (2021). Game-Based Learning in Economics Education at Upper Secondary Level: The Impact of Game Mechanics and Reflection on Students' Financial Literacy. In C. Aprea & D. Ifenthaler (Eds.), *Game-based Learning Across the Disciplines. Advances in Game-Based Learning* (pp. 25–42). Springer. https://doi.org/10.1007/978-3-030-75142-5_2

Pont, B., Nusche, D., & Moorman, H. (2008). *Improving School Leadership - Volume 1: Policy and Practice*. OECD.

Protsch, P., & Solga, H. (2016). The social stratification of the German VET system. *Journal of Education and Work*, *29*(6), 637–661. https://doi.org/10.1080/13639080.2015.1024643

Rausch, A., Deutscher, V., Seifried, J., Brandt, S., & Winther, E. (2021). Die web-basierte Bürosimulation LUCA – Funktionen, Einsatzmöglichkeiten und Forschungsausblick. *Zeitschrift Für Berufsund Wirtschaftspädagogik*, *117*(3), 372. https://doi.org/10.25162/zbw-2021-0017

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. (2019). Wandel durch Schulentwicklung: Essays zu Bildungsreform und Schulpraxis. In *Wandel durch Schulentwicklung*. Beltz Verlagsgruppe.

Roll, M., & Ifenthaler, D. (2020). Lernort-übergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.

Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4

Romeu, T., Guitert, M., & Sangrà, A. (2016). Teacher collaboration network in Higher Education: reflective visions from praxis. *Innovations in Education and Teaching*

International, *53*(6), 592–604. https://doi.org/10.1080/14703297.2015.1025807

Scantlebury, K., Gallo-Fox, J., & Wassell, B. (2008). Coteaching as a model for preservice secondary science teacher education. *Teaching and Teacher Education*, *24*(4), 967–981. https://doi.org/10.1016/j.tate.2007.10.008

Scheerens, J. (2012). Summary and Conclusion: Instructional Leadership in Schools as Loosely Coupled Organizations. In J. Scheerens (Ed.), *School Leadership Effects Revisited* (pp. 131–152). Springer. https://doi.org/10.1007/978-94-007-2768-7_5

Scheerens, J., Glas, C. A. W., & Thomas, S. M. (2003). *Educational Evaluation, Assessment, and Monitoring: A Systemic Approach*. Taylor and Francis Ltd.

Schüller, K. (2020). *Future Skills: a Framework for Data Literacy - Competence Framework and Research Report*. https://doi.org/10.5281/ZENODO.3946067

Sebastian, J., Allensworth, E., & Stevens, D. (2014). The Influence of School Leadership on Classroom Participation: Examining Configurations of Organizational Supports. *Teachers College Record*, *116*(8), 1–36.

Sebastian, J., Allensworth, E., Wiedermann, W., Hochbein, C., & Cunningham, M. (2019). Principal Leadership and School Performance: An Examination of Instructional Leadership and Organizational Management. *Leadership and Policy in Schools*, *18*(4), 591–613. https://doi.org/10.1080/15700763.2018.1513151

Seleznyov, S., & Czerniawksi, G. (2020). *A Research Approach To Curriculum Development: A British Curriculum Forum Event Report* (S. Seleznyov & G. Czerniawski (Eds.)). British Educational Research Association.

Silcox, S., & MacNeill, N. (2021). *Leading School Renewal*. Routledge. https://doi.org/10.4324/9781003139935

Spener, C., Häuber, G., Horlacher, T., & Schumann, S. (2019). Der berufsschulische Einsatz von ERP-Systemen in der Ausbildung von Industriekaufleuten. In K. Wilbers (Ed.), *Digitale Transformation kaufmännischer Bildung. Ausbildung in Industrie und Handel hinterfragt* (Vol. 23, pp. 195–216). epubli GmbH.

Spiteri, M., & Chang Rundgren, S.-N. (2020). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning*, *25*(1), 115–128. https://doi.org/10.1007/s10758-018-9376-x

Stefanou, C. R., Perencevich, K. C., DiCintio, M., & Turner, J. C. (2004). Supporting Autonomy in the Classroom: Ways Teachers Encourage Student Decision Making and Ownership. *Educational Psychologist*, *39*(2), 97–110. https://doi.org/10.1207/s15326985ep3902_2

Stockinger, B. (2019). Broadband internet availability and establishments' employment growth in Germany: evidence from instrumental variables estimations. *Journal for Labour Market Research*, *53*(1), 7. https://doi.org/10.1186/s12651-019-0257-0

Stoney, S. M. (Ed.). (2010). *Beyond Lisbon 2010: perspectives from research and development for education policy in Europe CIDREE Yearbook 2010)*.

Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review*, *30*, 100314. https://doi.org/10.1016/j.edurev.2020.100314

Sugarman, J., Morris-Lange, S., & McHugh, M. (2016). *Improving Education for Migrant-Background Students: A Transatlantic Comparison of School Funding*. https://www.stiftung-mercator.de/content/uploads/2020/12/Sugarman_et_al_MPI_SVR_Improving_Education_Migrant_Background_Students_NEU.pdf

Tawbush, R. L., Stanley, S. D., Campbell, T. G., & Webb, M. A. (2020). International comparison of K-12 STEM teaching practices. *Journal of Research in Innovative Teaching & Learning*, *13*(1), 115–128. https://doi.org/10.1108/JRIT-01-2020-0004

Terhart, E. (2019). Teacher Education in Germany. In *Oxford Research Encyclopedia of*

Education. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.377

Tosuntaş, Ş. B., Karadağ, E., & Orhan, S. (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education*, *81*, 169–178. https://doi.org/10.1016/j.compedu.2014.10.009

Tsai, M.-J., & Wu, A.-H. (2021). Visual search patterns, information selection strategies, and information anxiety for online information problem solving. *Computers & Education*, *172*, 104236. https://doi.org/10.1016/j.compedu.2021.104236

van Ackeren, I., Aufenanger, S., Eickelmann, B., Friedrich, S., Kammerl, R., Knopf, J., Mayrberger, K., Scheika, H., Scheiter, K., & Schiefner-Rohs, M. (2019). Digitalisierung in der Lehrerbildung. Herausforderungen, Entwicklungsfelder und Förderung von Gesamtkonzepten. *DDS – Die Deutsche Schule*, *111*(1), 103–119. https://doi.org/10.31244/dds.2019.01.10

Vanhoof, J., & Petegem, P. Van. (2007). Matching Internal and External Evaluation in an Era of Accountability and School Development: Lessons from a Flemish Perspective. *Studies in Educational Evaluation*, *33*(2), 101–119. https://doi.org/10.1016/j.stueduc.2007.04.001

Villalobos, C. (2016). Google Chromebook pilot evaluation: An evaluation of professional development and incorporation of Google Chromebook hardware and software applications [Azusa Pacific University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/google-chromebook-pilot-evaluation-professional/docview/1876895376/se-2?accountid=14570

Wang, M.-T., & Degol, J. L. (2016). School Climate: A Review of the Construct, Measurement, and Impact on Student Outcomes. *Educational Psychology Review*, *28*(2), 315–352. https://doi.org/10.1007/s10648-015-9319-1

Whitehead, B. M., Jensen, D. F. N., & Boschee, F. (2013). *Planning for Technology : A Guide for School Administrators, Technology Coordinators, and Curriculum Leaders: Vol. Second edi*. Corwin.

Wong, K. K. (2018). *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries*. Information Age Publishing.

Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S. K. W. (2019). A systematic review of flipped classroom empirical evidence from different fields: what are the gaps and future trends? *On the Horizon*, *27*(2), 72–86. https://doi.org/10.1108/OTH-09-2018-0027

Zawacki-Richter, O. (2021). The current state and impact of Covid-19 on digital higher education in Germany. *Human Behavior and Emerging Technologies*, *3*(1), 218–226. https://doi.org/10.1002/hbe2.23

7. Discussion and Further Research

The main findings of the thesis are summarised in this final chapter. In a first step, each of the initial research questions is considered separately. In a second step, practical implications and theoretical considerations are derived from the findings. Then the findings and implications are related to the limitations of the thesis. Future research approaches to overcome these limitations are discussed. The thesis closes with final remarks on the future of digitalisation in the development of vocational schools.

7.1 Findings on the Integration of Digitalisation in the Development of Vocational Schools

7.1.1 Findings on the formal integration of digitalisation into vocational school curricula

The first study examined the presence of digitalisation in the curricula of the vocational schools in Baden-Württemberg using a text mining approach. A so-called dictionary was used to find words related to digitalisation within the 831 curricula documents. The analysis showed that almost a quarter of the curricula of vocational schools contain terms related to digitalisation. However, the occurrences are not distributed equally between the curricula of different types of vocational schools. The rates of occurrence are highest for the *Berufsschule* (part-time vocational school) and the *Berufliches Gymnasium* (vocational grammar school). Around a third of their curricula contain terms related to digitalisation, while the other three main types of vocational schools have rates lower than the mean rate of 24.1%. Almost half of all the terms in the text-mining dictionary stem from the curricula of the *Berufsschule*.

The *Berufsschule* and the *Berufliches Gymnasium* are the two biggest types of vocational schools with regard to student population, with more than half of all vocational students visiting a *Berufsschule* (statistik-bw, 2020). As a result, the higher rate of occurrence of digitalisation-related terms in their curricula could be interpreted as positive, because in theory most vocational students come into contact with digitally influenced curricula. On the other hand, the occurrence rate of digital features is only a weak indicator for the quality of the context in which the terms are used (Kwartler, 2017). Calculating the occurrence of features in relation to the number of curricula shows that, on average, only every second curriculum contains any digital features. With regard to the size of the documents and the fact that a single curriculum contains desired learning goals for at least a single school term, the overall digital content in

curricula has to be interpreted as very low. This applies even more so for the other types of vocational schools, where occurrence ratings are much lower.

The second research question of the first study shed light on the distribution of different digital competency goals within the digital features of the vocational school curricula (KMK, 2017a). All the desired digital competency goals can be identified with the curricula, but they are not equally distributed. The Keywords in Context analysis and the following structuring approach (Maramba et al., 2015; Mayring, 2004) revealed that almost half of all the keywords are used in the context of Problem-solving and Acting, with a strong focus on the usage of occupation-specific tools, such as CAD modelling (Tovey & Owen, 2000). Searching, Processing and Storing is the competency goal with the second-highest number of features. The majority of the features focus on information retrieval through online search engines. The results are related to the subject- and work-place specific focus of vocational schools. At first glance, the two most prominent competence goals are the ones which hold the most practical value for the students, especially with regard to workplace-related tasks and demands of the labour market. Nevertheless, the other competencies required for successful socio-economic participation (Fraillon et al., 2020) have to more thoroughly implemented in the curricula.

7.1.2 Findings on Teachers' Perspectives on School Development at German Vocational Schools

The second study focuses on the perspective of teachers on the implementation of digital distance learning during the first phases of the COVID-19 pandemic at vocational schools in Baden-Württemberg, Germany (Delcker & Ifenthaler, 2020). The initial switch from on-site to online teaching proved to be a major challenge for all stakeholders at vocational schools. The results of the interview study show a strong connection between the different development fields, as proposed in the 5 dimensions model of Eickelmann and Gerick (2018).

Independently of the interconnection of development fields, the interviewed teachers prioritised specific features within school development processes. The technical infrastructure of the school, especially the equipment of the teachers, the server structure and the administrative support for the systems in use proved to be a key feature of a successful transformation from on-site to online practices. The study reveals that some of the infrastructure had not been thoroughly tested prior to the COVID-19 pandemic and that some educational tasks could not be carried out with the equipment at hand, most likely due to insufficient financial investment into IT infrastructure. In some cases, the colleagues who were supposed

to manage the IT infrastructure either had to work overtime or neglect their teaching duties to keep up with the demand of the other stakeholders. These results can be referred back to the importance of technology development as a development dimension and the need to rethink the status of IT support and maintenance practices at vocational schools.

Without a working learning management system, even the most motivated teachers are unable to provide learning material or online classes for their students. These motivational characteristics of teachers (Baier et al., 2019) and their ability to design and carry out digital distance learning is another key feature highlighted by the second study (Caena & Redecker, 2019; Redecker, 2017; Tondeur et al., 2017). On-going teacher training as well as a focus on pre-service teachers' digital competencies in teacher training programmes are required to address these features of school development (Bellin-Mularski et al., 2016; Pleshakova, 2019; Sánchez-Cruzado et al., 2021; Valtonen et al., 2021).

The interviewed teachers also underline the ability of their students to access material online, directly referring to the digital competences of students (KMK, 2019a; J. König et al., 2020). The teachers express their worries about struggling students and fear that students from difficult socio-economic backgrounds will fail to keep up with classes and the learning process during online teaching. Students' lack of technical equipment and an inappropriate learning environment are mentioned in this context. Although many challenges and difficulties are pointed out by the interview partners, clear guidance and effective communication from the school leaders is described as a supportive factor during the transition from on-site teaching to digital distance learning. A shared schedule which shows the relevant tasks for a class is mentioned as a useful tool to help stakeholders keep track of the progress during the week. Many teachers identified their favourite digital tools and methods in the early weeks of online teaching and integrated their strongest competences into teaching practice. The relevance of teacher characteristics can be transferred from traditional classroom settings and emphasises the importance of the "constitutional freedom of teaching" (Kerres, 2020, p. 1) for digitalisation in the development of vocational schools (Baier et al., 2019).

7.1.3 Findings on the Influence of Schools' Organizational Characteristics on Students' Perceived Learning Success

In Study 3, a quantitative research approach was used to analyse the influence of organisational characteristics within a vocational school on the perceived learning success of students. The data was collected as part of the project Check-up Distance Learning. A total of N = 3,872 stakeholders from 15 different vocational schools in Baden-Württemberg participated in the survey. Overall, the quantitative data gathered in the project shows a very small difference between the different vocational schools in Baden-Württemberg with regard to the different school development dimensions, and no school can be identified as over- or underperforming in terms of delivering digital distance learning as measured on the sub-scales organisation, class activity, teaching & learning, social interaction and personal resources.

Hierarchical linear modelling shows small effects for eight items that can be used to characterise parts of a school's organisational structure. Of these items, Clearness of Procedure Instructions has the highest correlation with students' perceived learning success. This result falls in line with established models of instructional theory (Merrill, 2002) and with similar findings in Study 2, where teachers underlined the importance of clear instructions from school leaders and the federal school administration. The second most influential item, Fairness of Assessment, is another aspect of transparent regulations. Similarly to the Clearness of Procedure Instructions, this item has also been identified as a positive influence on students' learning processes in other studies (Gerritsen-van Leeuwenkamp et al., 2019; Rasooli et al., 2018). The small effects of single items correspond to the initial theoretical assumptions of school quality and students' learning success as the goal of school development processes (Ditton & Müller, 2011; Eickelmann & Gerick, 2018; Harvey & Green, 1993): the wide variety of influential and interdependent factors in organisational development and beyond makes the identification of high correlations from single items unlikely.

The second research question of Study 3 analyses the effect of a media development plan (MEP) as an explanatory variable with regard to the hierarchical linear model of Research Question 1 (Ifenthaler, 2019). The stage of the MEP (no MEP, MEP in development, MEP submitted, MEP submitted and funding received) does not improve the explanatory strength of the HLM. Therefore, the stage of the MEP can currently not be used to predict the learners' perceived success.

7.1.4 Stakeholders' qualitative perspective on the introduction of digital distance learning

The findings of the fourth study complement the preceding research studies of this thesis through a qualitative research approach. The data used for the analysis stems from the same participants as the data of Study 3 and is also from the Check-Up Distance Learning project. The statements of $N = 1{,}493$ stakeholders regarding possible improvements and their evaluation of digital distance learning at vocational schools in Baden-Württemberg were examined. In a first step, the development dimensions of the 5 Dimensions Model (Eickelmann & Gerick, 2018) were used as possible categories to structure the stakeholder statements. The initial analysis showed that many statements could not effectively be categorised into one of the development dimensions. The lack of selectivity suggested the need to expand the dimensions through the introduction of three additional categories, resulting in a structuring process with eight different categories.

Organisation is the most prominent of the categories. In this category the heterogeneity of tools and methods is criticised by the stakeholders. Overall, they prefer clear instructions and regulations to choose from a smaller number of digital tools. Students and teachers demand transparency regarding assessment processes and grading. The state school administration is required to provide additional guidance, which school leaders can communicate at the school level.

The Technical Infrastructure at the schools is mentioned in almost one third of the statements. The statements of the students show contradictory views on the accessibility of required tools. Some students state that they have trouble connecting to the Internet, including insufficient stability, speed and data volume. They also state that they do not possess the required hardware, such as tablets or printers. Other students on the other hand seem to be well equipped. From the teachers' perspective, the schools lack sufficient infrastructure within the premises of the school. The stakeholders also mention data security as a big concern and propose the development of educational software under the governance of the state.

Students clearly state a preference for live video classes in the category Teaching. They perceive an increase in workload compared to on-site teaching, especially when teachers hand out work assignments rather than teaching in a traditional face-to-face format. At the same time, the switch to digital distance learning is recognised as a chance to improve self-regulated learning competences. Teachers noticed an increase in workload as well. The implementation of practical training is portrayed as a challenge and teachers bring up the difficulty of online teaching for specific subjects, such as language classes or sports. Learning management

systems are perceived as helpful tools to store and distribute learning material and are evaluated as a valuable tool that should be kept and extended in the future.

Feedback is one of the categories that were added in the analysis. Students request more feedback from their teachers, especially when handing in worksheets and written assignments. This falls in line with students' perception of teachers' reachability via digital forms of communications, such as emails or LMS chat function. The students describe many situations in which teachers didn't answer them or reacted very late. The teachers mention the difficulty of providing students with individual feedback due to time constraints and workloads.

In the category Motivation, the statements are ambivalent, with a small majority of students reporting feeling motivated to work online. Their motivation is influenced by the available technical infrastructure and the ability to simultaneously work in their training companies and in the school setting. Other students underline the importance of self-regulated learning in a safe environment as a facilitator of their motivation. Teachers are more critical about digital distance learning and show increased concern about students' motivation and learner success. They report that students who were motivated before the switch to online teaching are still motivated, while students who were already struggling in on-site teaching struggle even more.

Students underline that the communication between the them and the teachers, between the teachers and the communication with their peers should be better. The importance of direct communication for an effective learning process is also emphasised by the teachers in the category Social Interaction.

While questions regarding bullying are raised in the quantitative part of the instrument, neither students nor teachers report any forms of inadequate social behaviour in the qualitative data. Parents and training companies perceive the communication with the school, and especially the provision of information, as difficult. Training companies refer to their needs of being informed about regulations and practices of digital distance learning to support their trainees during the learning process.

The workload of students is the major topic in the category Personal Resources and Stress Factors. The workload is criticised in terms of volume and time. Students perceive the workload during online learning as much higher than in on-site classes. The higher workload is confirmed by other stakeholders as well, especially the teachers.

Further Education and Training is the final category that was added to the analysis, because it plays in important role for the perception of students and teachers. Students feel that the teachers' digital competencies are insufficient for digital distance learning, especially with regard to tool usage and technical skills. The teachers report similar experiences and underline

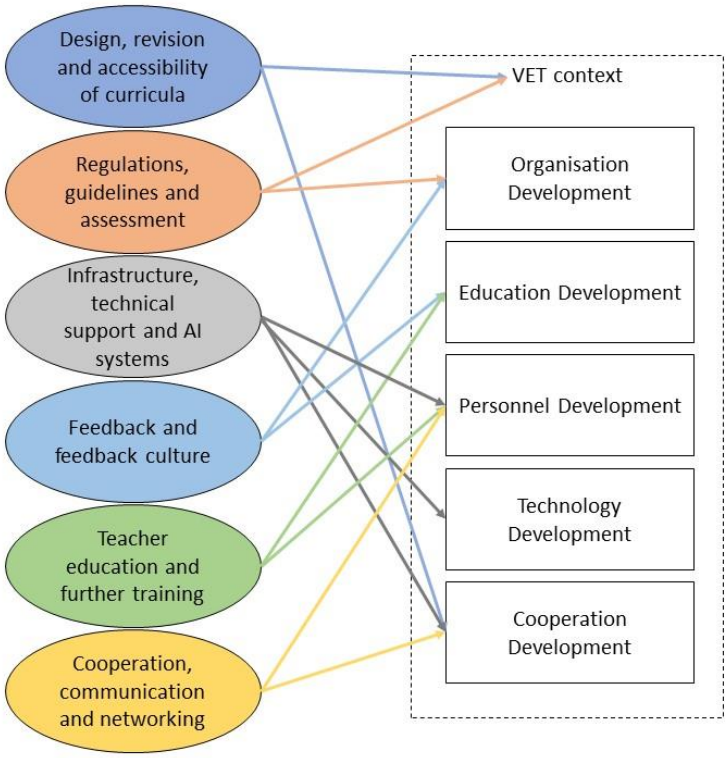
the importance of further teacher training. In many cases, teacher training is mentioned in the form the of topic specific content, which allows teachers to independently strengthen their competences based on their existing skills and knowledge base.

7.2 Practical Implications

Various practical implications can be derived from the results of the fours studies presented in this thesis. Several implications which are specific to the individual studies were already stated in the respective chapters. Therefore, the goal of this chapter is to provide practical implications from the combined findings of the empirical research. The implications are relevant to the various stakeholders of the vocational educational system and the different levels of the German vocational educational training system. An allocation to the five dimensions of the underlying theoretical model of school development (Eickelmann & Gerick, 2018), which takes the context of the educational system into account, is presented

Figure 7-1

Practical Implications on the Dimensions of School Development



7.2.1 Design, Revision and Accessibility of Curricula

The results of the first study show that teachers can hardly use the existing curricula as guidance for their classes with regard to digitalisation. Initial steps have already been undertaken to improve the relevant curricula, for example in the framework curricula for specific training programmes in the metal and electro professions (Alsdorf et al., 2020). From the teacher perspective, the contributors to the framework curricula at the national level and the curricula of vocational schools at the state level have to increase and speed up their efforts to integrate digitalisation into the respective curricula (Harteis et al., 2019). The further formalisation of digital competencies into curricula simultaneously constitutes as justification for the decisions of school leaders, for example when linking specific development goals in the media development plans to interdisciplinary competencies within the curricula of vocational schools. At the school level, teachers should continuously support each other's efforts to link teaching with the digitalisation features of the curricula, by designing teaching scenarios in cooperative subject-specific or interdisciplinary groups (Handelzalts, 2019).

The data collection process presented in Study 1 can serve as a negative example for the current accessibility status of curricula. Documents are stored in heterogeneous file formats of varying quality, while the internal structure of the documents depends on their latest revision. Some curricula are used for several types of vocational schools. As a result, documents and links sometimes apply to several types of school, but not always, making it difficult for the users to find the right information. In the case of the curricula, national and state school administrations have to consider restructuring and reorganising the various curricula documents. This involves unifying document design to increase the comparability of curricula, especially with regard to documents which already contain digitisation features and those documents that have not been updated yet. As a result, synergies between different school subjects can be harnessed in the curriculum design process. Secondly, accessibility to the curricula should be increased through the introduction of a nation-wide archive. This doesn't shift the responsibility for the content of the curricula to the federal level, but it creates a central point of contact for teachers, school leaders, training companies and educational researchers. Although this seems like a complex process against the background of the federal education system in Germany (Markowitsch & Hefler, 2018; Scheller, 2018; K. K. Wong, 2018), all stakeholders in the field of education could benefit from such efforts. On a daily-practice level, an easy to use and clearly structured archive saves time and increases the chance of finding the needed information. In addition, such a centralised archive also allows the stakeholders to collaboratively work with and on the curricula much more effectively.

7.2.2 Regulations, Guidelines and Assessment

Regulations, rules and guidelines have been identified as important factors which can support the different stakeholders in implementing digitalisation into the processes within vocational schools. Although school development processes target the development of individual schools (Eickelmann & Gerick, 2018; Ilomäki & Lakkala, 2018; Muftić, 2012; Rolff, 2019), vocational schools in Germany are deeply embedded in the hierarchical structure of the school system and the vocational education training system. The top-down approach and the dependency of schools on higher-level decision-makers have been rightfully criticised by various researchers, especially with regard to the heterogenic dynamics at the school level (Kyriakides et al., 2019; Morgan, 1992; Straub & Vilsmaier, 2020; Wells, 2017). On the other hand, regulations can serve as meaningful and necessary guidelines for the stakeholders of school development (Hopmann, 2003), as the results of Studies 2, 3 and 4 show. Regulations can be symbols of stability and security, especially in times of change, such as the switch from on-site to digital distance learning. These regulations have to be clearly communicated between all stakeholders of the vocational education training system.

With regard to digitalisation, the school administration at the state level has to provide formal regulations about the use of specific tools which are deemed appropriate for educational contexts. One possibility is the introduction of a so-called whitelist for software applications (Sedgewick et al., 2015). An expert team consisting of educators and ICT specialists could curate such a list and keep it up to date, focusing on didactical and security suitability of the applications. Quality labels or certificates could be another solution to provide guidance for teachers and school leaders with regulations for educational software. Such regulations also protect decision makers at the school level from the overwhelming abundance of ICT tools and can help them to choose appropriate solutions based on informed decisions. Teachers can utilise guides from the state level to transparently justify the implementation of specific tools to their students.

State-wide regulations should start with a very limited amount of accepted ICT tools, followed by a steady expansion. At the beginning of the process, this would be a clear restriction of teachers' "constitutional freedom of teaching" (Kerres, 2020, p. 1). On the other hand, it seems reasonable to limit the amounts of tools that are implemented in a school in order to allow different stakeholders to develop basic competencies by teaching and learning with those tools. The results of Study 4 show that especially students struggle with the various tools that

teachers are using and prefer a limited number of tools. The persons responsible for the IT support within schools would also benefit from initial restrictions on tools, because they can focus on scalable solutions, such as in-house training for teachers, instead of constantly dealing with different applications. In Baden-Württemberg, the first steps of this process are already underway. At the beginning of the COVID-19 pandemic, the Ministry of Culture, Youth and Sports advocated for the usage of a single learning management system (Moodle) and later created a second option (itslearning) in June 2021 (km-bw, 2021).

ICT expands the traditional methods of assessment through online exams, digital project work or virtual submissions (Amhag et al., 2019; Collins & Halverson, 2018; Hall & Jones, 2021; J. König et al., 2020; L. König, 2021). The insecurities of teachers and students in these areas were shown to be an influencing factor on students' perceived learning success and overall motivation (Antony et al., 2019; Praetorius et al., 2017; R. Schneider et al., 2021; Tondeur et al., 2017). As a consequence, digitalisation in the development of vocational schools also requires the federal school administration to formalise rules towards assessment tools and grading (Holden et al., 2021; Raaheim et al., 2019). In the case of assessment tools, the assumptions of the previous paragraph can be utilised. Additionally, ICT itself can be used to support teachers' grading processes, for example by using automated assessment methods (Ludwig et al., 2021; Qian & Lehman, 2019) or software to detect plagiarism (Shang, 2019; Wijaya & Gruber, 2018). At the same time, digital formats enable teachers to make the grading process much more transparent. Teachers can publish grading standards as a guidance for their students (Brookhart, 2018). They can also use annotations within documents in the form of related links, which show students further information, refer to classroom material or show the correct steps to solve a problem (Krouska et al., 2018; Wakefield et al., 2018). This way, the assessment is embedded into the learning process, rather than symbolising the end of a learning unit.

7.2.3 Infrastructure, Technical Support and AI Systems

An efficient digital infrastructure is the backbone of digitalisation at the school level and one of the requirements to put regulations, digital teaching processes and collaboration into practice (Fraillon et al., 2020; Gil-Flores et al., 2017; Mishnick, 2017; Zylka, 2018). From a technical perspective, the development of digital infrastructure at vocational schools is increasingly taking shape. The process is fostered by political commitment, funding programmes and implementation strategies, such as the media development plan (Ifenthaler, 2019; KMK, 2017a, 2019c). In the context of vocational schools, special forms of digital infrastructure have to be considered, such as learning factories (Faßhauer et al., 2021), games (Platz et al., 2021) and office simulations (Ludwig et al., 2021; Rausch et al., 2021; Seifried et al., 2020), as these tools are valuable assets to facilitate interdisciplinary and job-specific digital competencies of vocational school students (Spener et al., 2019). On the one hand, more funding has to be invested into the purchase of such tools, especially considering the high costs of learning factories (Abele et al., 2017). On the other hand, the stakeholders in vocational schools and educational researchers have to collaboratively develop didactical concepts for the sustainable integration of the tools into effective learning processes (Adamowicz & Pyra, 2019; Roll & Ifenthaler, 2021).

Apart from support for decision-making processes, innovative systems for the continuous administration and maintenance of a school's digital infrastructure have to be designed, because the traditional system of teacher-admins is increasingly reaching its limits. New positions for the intersection of IT administration and didactical support have to be established at all levels of the VET system. These educational data administrators maintain a school's digital infrastructure, expand its digital portfolio, function as didactical mediators and are capable of interacting with educational data systems (Ifenthaler et al., 2020; Papamitsiou et al., 2021) in cooperation with the other stakeholders of vocational school development. Depending on the size of the school, the position can cover a single school centre or a network of schools. Comparable training programmes for these positions are already under construction (KI-Campus, 2021) and should be further developed at the university level.

So far, AI systems play a subordinate role in the digital infrastructure of vocational schools, although their potentials for all stakeholders of school development have been recognised by several researchers (Attwell et al., 2020; Papamitsiou et al., 2021; U. Schmid et al., 2021). Intelligent Tutoring Systems should be implemented for the adaptive guidance, instruction and evaluation of students (Mousavinasab et al., 2018; Paladines & Ramirez, 2020). Learning Analytics can help teachers to identify at-risk students and initiate interventions (Du et al.,

2019; Kärner et al., 2021; Queiroga et al., 2020) and should be introduced to foster students' self-centred learning through individual learning paths (Govindarajan et al., 2016; Schumacher, 2019). Decision-makers at schools should enrich their LMS with recommender systems, to provide additional learning material to students (Deschênes, 2020; Rivera et al., 2018), but also to suggest possible further training possibilities or career paths for all stakeholders in vocational schools (Dahdouh et al., 2018; Lin et al., 2018; Ma et al., 2021).

7.2.4 Feedback and Feedback Culture

The lack of feedback and a so-called feedback culture (Rolff & Thünken, 2020) is a reoccurring topic in the thesis, but especially in Studies 2 and 4. The following section provides practical implications from the perspective of different stakeholders, beginning with the student-teacher relation. Especially in digital distance settings, teachers need to implement specific forms of feedback to support students' self-directed learning competencies, motivation and perceived learner success (Hattie & Timperley, 2007). As mentioned in the previous section, virtual assignments are an important tool during digital distance practices, even more so when teachers choose them over live video classes. By doing so, teachers move away from a teacher-centred form of learning towards a more student-centred approach, giving students more responsibility for their own learning progress (McCabe & O'Connor, 2014).

But students can only profit from such assignments if they receive the necessary feedback to evaluate whether or not they reached the desired learning goal (Brookhart, 2017; Gudjons, 2011). Giving individual, productive feedback has been identified as a time-consuming task for the teachers. Teachers should implement ICT into the teaching process to support their feedback efforts and reduce workload. Automated feedback within learning tools can help to uncover students' misconceptions (Gusukuma et al., 2018; Qian & Lehman, 2019). LMS can be used to present best practice examples or solutions to problem sets (Gorshenin, 2018). Teachers can create learning videos to visualise problem-solving scenarios for specific tasks (Borba et al., 2018; L.-T. Chen et al., 2021; Kabooha & Elyas, 2018). Students can then use these videos to evaluate their solutions step by step. While the initial workload for such feedback scenarios is high, teachers can use ICT to create scalable solutions which can be re-used over different school years.

Most importantly, the feedback relation between teachers and students has to be revised in the context of digitalisation. The stakeholders at the vocational schools have to negotiate which feedback practices are appropriate within the educational environment. Neither should teachers

prepare individual feedback after every task, nor should students expect to receive individual feedback for every assignment. Agreements and rules help to balance the demands of teachers and learners. As an example, teachers could implement rotating individual feedback, giving a fixed percentage of the class individual feedback and also providing all students with a detailed solution for a problem set through the LMS of a school. For the next task, new students are chosen to receive individual feedback. Online forums can be used to establish a system of peer2peer2teacher feedback (Ortoleva & Bétrancourt, 2016; Peters et al., 2018; Sampson, 2019). A student posts his solution online and another student is tasked with giving feedback to this solution. In a third step, the teacher complements the feedback of the student. Through this process, multiple competencies of students are facilitated and individual feedback is provided, while simultaneously lowering the workload of the teachers.

Increasing students' responsibility through self-centred learning practices is based on the students' ability to evaluate their own learning process, either by individual feedback or by having to work with less personalised solutions (Gudjons, 2011). This relationship is less apparent in the traditional on-site classroom, while it plays a major role for learning in digital distance learning scenarios. Teachers and students have to be aware of the decisive role of feedback (Edgerly et al., 2018; Hattie & Timperley, 2007; Metcalfe, 2017). Therefore, feedback and feedback culture have to be actively included and discussed in the teaching process. Additionally, all stakeholders within a school have to develop ideas of how an effective feedback culture can be created inside and outside of the classroom (Rolff & Thünken, 2020).

Feedback is not limited to classroom assignments and can also include stakeholders' ideas for change within school development (Drago-Severson & Blum-DeStefano, 2018; Markowitsch & Hefler, 2018). The introduction of new tools, systems and regulations should also be tied to a process of feedback and evaluation (Drago-Severson & Blum-DeStefano, 2018; Ramani et al., 2018). Continuous feedback helps school leaders to identify which of their decisions increase student motivation or improve the working conditions of the teachers (Heck & Hallinger, 2010; Leithwood et al., 2020; Leithwood & Mascall, 2008; Mulford, 2003). Introducing feedback programmes between teachers is especially helpful for novice teachers (Jin et al., 2021). ICT can be used to help pre-service teachers to reflect on their professional competency, for example through video-based reflection in cooperation with experienced teachers (K. E. Weber et al., 2018). Experienced teachers need the possibility to foster their digital teaching competencies through such loops as a form of life-long learning in the context of further teacher training (Cropley & Dave, 2014; Day, 2002; Redecker, 2017).

7.2.5 Teacher Education and Further Training

Teachers' digital competencies are one of the biggest factors for the successful implementation of ICT in the classroom (Antony et al., 2019; Koehler et al., 2014; Kreijns et al., 2013; Willis et al., 2019) and the integration of digitalisation into the development of vocational schools (Caena & Redecker, 2019; Redecker, 2017). This includes the already established digital competencies, but also an expanded understanding of future competencies, such as educational data literacy (Ifenthaler et al., 2020; Papamitsiou et al., 2021) and the implementation of AI systems (U. Schmid et al., 2021; Schumacher, 2019). Initially, teachers have to be able to identify and measure their digital competencies. Critical reflection on one's skill can be supported through digital tools. Existing instruments to measure the competencies of teachers (I. K. R. Hatlevik & Hatlevik, 2018; O. E. Hatlevik, 2017; Howard et al., 2020; Rubach & Lazarides, 2021) should therefore be made available to all schools. This process should be supported by further education specialist who can help the teachers to examine which parts of their competencies they want to develop, for example their capability to use technology in the classroom or subject-specific digital knowledge (Koehler et al., 2014).

Consequently, teachers need access to various forms of further education programmes that are adapted to their learning goals and their learning preferences (Hana et al., 2013; H. T. M. Nguyen, 2017; Scantlebury et al., 2008). Such further education programmes could take the form of a structured educational course in a traditional on-site setting, but could also be provided in a blended-learning environment (Barnová et al., 2020).

The need to scale the development of teachers' competencies while simultaneously supporting self-centred learning processes of teachers makes Massive Open Online Courses a valuable tool for teacher education (Castaño-Muñoz et al., 2018; Misra, 2018). Professional networks can be fostered in virtual environments to help teachers connect and develop their competences in a collaborative process (Butter et al., 2014; García-Martínez et al., 2020). Knowledge management practices, such as wikis and mediator programmes, can be used to curate ICT competencies within a school (Zylka, 2018).

The statements regarding the further education of teachers can be transferred to pre-service teacher education (Tondeur et al., 2018; K. E. Weber et al., 2018). More importantly, the approaches to competency development stated in the prior paragraph have to be expanded to the teacher training programmes in universities (Bellin-Mularski et al., 2016; Roll & Ifenthaler, 2021; M. Schmid et al., 2021; Tondeur et al., 2017). At the university level, teacher educators need to further implement digital content, digital tools and digital teaching methods, so students can continuously learn with and about ICT (Kabooha & Elyas, 2018; López-Meneses et al.,

2020; Schumacher, 2019). This way, students' digital competencies, but also their digital education competencies, can be facilitated. The implementation of digital teaching methods at the university level includes online and blended-learning classes (Castro, 2019; Serrano et al., 2019). Students' learning processes have to be enhanced through digital media, such as learning videos and podcasts (Norton & Hathaway, 2010; Pan, 2018). Teacher educators have to envision new forms of assessment, such as video productions, online tests or digital submissions (Hawley & Allen, 2018; Kemp et al., 2012). As a result, pre-service teachers are enabled to reflect on those methods and tools (Snelson, 2018). Learning with these tools is an important step for pre-service teachers to evaluate these tools for their own teaching career (Nixon, 2021; Watt, 2019). In addition to learning with digital media and how to teach with the new tools and methods, the content of pre-service teachers programmes must include theoretical approaches to the changes in the information society, such as socio-economic relationships, computational thinking (Menon et al., 2019; P. S. Wang, 2017; Wing, 2008), data security (Falloon, 2020; Rahman et al., 2020), AI systems (Seonghun Kim et al., 2021) or data ethics (García-Peñalvo, 2021; Luke et al., 2017).

Pre-service teacher training can further be enhanced through the aforementioned AI technology. The transparent implementation of automated tutoring systems (U. Schmid et al., 2021) and learning analytics (García-Peñalvo, 2021; Ifenthaler, 2015; Lemay et al., 2021) can increase self-directed learning competencies under the premise of students' understanding and acceptance of such systems (Schumacher & Ifenthaler, 2017).

As digitalisation in schools has to be considered as the responsibility of all stakeholders, school development itself has to be more thoroughly implemented as a topic in (further) education and training programmes (Bellin-Mularski et al., 2016; Straub & Vilsmaier, 2020). In this way, teachers, school leaders and instructors in training companies are enabled to develop an understanding of roles in changing institutions. The self-conception of all stakeholders is a key starting point to harness synergies in collaborative school development (Cornelissen et al., 2017; García-Martínez et al., 2020; Santi; et al., 2009).

7.2.6 Cooperation, Communication and Networking

The mutual interdependence of stakeholders and development fields is a reoccurring characteristic of digitalisation in the development of vocational schools. On the one hand, these relationships complicate the theoretical modelling and the empirical research on the topic. A sustainable integration of digital tools and methods into vocational schools relies on the collaborative efforts of all stakeholders (Eickelmann & Gerick, 2018; Haasler, 2020; Ilomäki & Lakkala, 2018; Matos et al., 2019; Pettersson, 2021; Rolff & Thünken, 2020). On the other hand, the potential synergies within the dual system are one of its biggest strengths (Deissinger, 2015; Gessler, 2017; Haasler, 2020). Against this backdrop, digital tools are means and end of collaborative processes at the classroom, institution and school system level (Castaño Muñoz et al., 2021; Hammond, 2017; O. E. Hatlevik, 2017).

In on-site and online classroom settings, students can acquire digital competencies through collaborative work with their peers (Genlott & Grönlund, 2016; Schulz-Zander et al., 2002), such as the LMS-based peer2peer2teacher feedback presented in the Feedback section above (Ortoleva & Bétrancourt, 2016; Peters et al., 2018; Sampson, 2019). Email and a chat tool function as reliable communication tools for all stakeholders at the school level (Aguilar et al., 2020; Delcker & Ifenthaler, 2020; Ndlovu & Mostert, 2018). Interdisciplinary expert groups can further facilitate the digital competencies of teachers, especially if technical, pedagogical and content knowledge can be combined and shared (Bueno-Alastuey et al., 2018; Yeh et al., 2021). In addition, the various stakeholder groups within a school should implement tools such as wikis, cloud services, online forums and video conferences for the shared design of school-internal agreements and agendas (Zylka, 2018). Each school should collaboratively develop and formulate an individual digital vision containing the beliefs, goals and strategies for the digitalisation of the specific vocational school. This digital vision can be a co-production with or an expansion of the media development plan (Ifenthaler, 2019; Obermöller, 2019).

Digital cooperation with training companies has to be a major focus for vocational schools. The emphasis of the cooperation should lie on the connection and interlocking of theoretical and practical learning places through digital tools (Markowitsch & Hefler, 2018). One important first step is the increased accessibility to LMS to improve the contact to the training companies. Automated reporting and exchange systems need to be implemented to improve the communication between the schools and the training companies, especially between educators in the classroom and in the workplace (Aprea et al., 2020; Rausch et al., 2021; Roll & Ifenthaler, 2020a).

The potentials of digital networks have to be harnessed across the educational system. In

addition to bottom-up or top-down approaches at the single school level, school networks have to be further implemented (Rolff & Thünken, 2020), as professional networks are an important digital tool of further education of all stakeholders (García-Martínez et al., 2020; Gurr & Drysdale, 2018; Lantz-Andersson et al., 2018; Romeu et al., 2016). Stakeholders in the context of vocational school development need digital platforms to exchange subject-specific and interdisciplinary instructional designs (teachers), implementations strategies (school leaders) and task-specific teaching concepts (training companies). On these platforms, the various stakeholders can share experiences and ideas to further facilitate the digital competences of all stakeholders, with the goal to continuously support students and their learning processes. The streams of educational data have to be brought together from all sources of the VET systems to create valuable input for AI systems (Ifenthaler et al., 2020). As a consequence, scalable solutions for the VET systems and its stakeholders can be designed, implemented and evaluated.

7.3 Limitations and Further Research

The research presented in this thesis is limited and influenced by various factors, which have to be considered when interpreting, generalising and discussing the findings of the thesis. These limitations and emerging further research questions are summarised in this chapter. Although the consequences of the COVID-19 pandemic for the development of vocational schools (and especially the persons working, teaching and studying in those institutions) was not the focus of the research, the existence of the pandemic during the process has to be acknowledged. The integration of the thesis into existing and future research work without this recognition would skew the transferability and validity of its results. Throughout the research process, the influence of the global pandemic manifested visibly in the data, the access to the research field and as a precondition for the research itself: the abrupt switch to distance learning at the vocational schools in Baden-Württemberg was a political decision as a result of the spread of COVID-19 in Germany. The research situation presented in Chapters 4, 5 and 6 would not have existed without COVID-19. In addition, the research work of Chapters 5 and 6 emerged in cooperation with the Ministry of Culture, which acknowledged the proposal to scientifically evaluate the situation during the COVID-19 pandemic. Undoubtedly, the cooperation between the vocational schools, the Ministry of Culture and the research team would not have happened in this particular way under different circumstances, or without the "digitalisation shock" of the pandemic situation (Harderer et al., 2020).

It seems paradoxical that the COVID-19 pandemic created an unequalled opportunity for the digitalisation of vocational schools and for educational research. On the other hand, the immense pressure and challenges faced by the vocational schools during the pandemic limited the access to the field as well as the willingness of school leaders to participate in the survey of Chapters 5 and 6. It is plausible to assume that fewer participants would have answered the open question in the school evaluation survey of Chapter 6, based on research findings on questionnaire design (Miller & Dumford, 2014; Vitale et al., 2008). Selected answers of students support this assumption. Students specifically emphasised the possibility of voicing their opinion during the COVID-19 pandemic through the questionnaire. Especially the statements of students in the qualitative study presented in Chapter 6 pick up the pandemic as a subject, for example when students report their fear of using public transportation or infections in the classroom as an argument for the implementation of distance learning at vocational schools.

Researchers around the world have examined the impact of the COVID-19 pandemic on the field of education. Despite differences at a national and local level, the stakeholders in school

development are facing similar challenges, such as insufficient technological infrastructure or the need for further teacher training (Ewing & Cooper, 2021; Hilburg et al., 2020; Huber & Helm, 2020; Jæger & Blaabæk, 2020; J. König et al., 2020; Krishnamurthy, 2020; Palau et al., 2021; Sánchez-Cruzado et al., 2021; R. Schneider et al., 2021; Sokal et al., 2020; Zawacki-Richter, 2021). These research results have to be turned into sustainable problem-solving approaches. As a result, the experiences of the COVID-19 pandemic can serve as guidance for future crises. The publication of Study 2 in a special issue on the role of technology and pedagogy on school education during a pandemic (Starkey et al., 2021) supports the idea of international collaboration and sustainable school development from a German perspective.

7.3.1 Vocational School Curricula

The first study examines the appearance of digital terms in the curricula of vocational schools. The analysis was conducted based on the publicly available data in the federal state of Baden-Württemberg, Germany. The results are therefore limited to the vocational schools in the German education system, more specifically in Baden-Württemberg. The federal system in Germany and the specifics of the dual system can make it difficult to transfer the results to other federal states or national education systems (K. K. Wong, 2018). Furthermore, the keyword in context analysis (Benoit et al., 2018; Kronberger & Wagner, 2000) provides a superficial view of the data. Although a categorisation into the various aspired digital competencies of students is possible with this method (KMK, 2017b), the derivation of concrete teaching assignments from the perspective of educators remains a demanding task.

To overcome this challenge, the applied methods of data collection and analysis should be expanded. On the one hand, a more extensive picture of the appearance of digital terms in the curricula of vocational schools should be drawn at the national level. As a consequence, a comparison of curricula from different federal states would be possible. The results of a comparative analysis have the potential to uncover best-practice examples of well-developed curricula, which can in turn be used as guidance for the future design of curricula. On the other hand, the research process has to include an in-depth analysis of the digital keywords in their context, to reveal individual formulations and details which help stakeholders to derive practical implications from the curricula documents.

The creation of a national database for curricula forms the basis for the aforementioned research processes. Even more so, such a database supports the efforts of stakeholders at all levels of the educational system to collaboratively work with the curricula. This includes the

continuous revision, redesign and expansion of the curricula. The idea of a national curricula database is followed by a central research question on the development of vocational school curricula. Ways in which the lengthy and slow process of curricula development can be adapted through digital collaborative practices, for example through an interaction analysis on a curricula platform, should be examined.

Furthermore, the provision of concrete learning designs based on subject-specific curricular guidelines could be examined as a tool to support teachers in their efforts to connect formulated learning goals and classroom practices. Different approaches to instructional classroom design, such interdisciplinary expert groups at the school level, from a network of schools or at the state level could be compiled (Cornelissen et al., 2017; García-Martínez et al., 2020; Rolff & Thünken, 2020; Santi; et al., 2009). These designs would then be provided to and tested by teachers in the vocational school. Consequently, the participating stakeholders would evaluate the designs and provide feedback to the creators. In a circular process, the initial groups of instructional designers would rework their suggestions, integrating the connection between curriculum and practice in a circular process. The accompanying research can identify best practice examples for further development steps. Most importantly, the circular implementation of curricula requirements into teaching practices picks up the idea of the circular media development plan (Ifenthaler, 2019; Obermöller, 2019). Hence, such a research approach presents a possibility to directly enhance school development processes to complement the document-based, descriptive methods of curriculum research.

7.3.2 Challenges and Opportunities of Teachers

In the second study, challenges and coping strategies of teachers during the switch from on-site teaching to digital distance learning were examined using a qualitative approach. The results show similarities to related research (Ewing & Cooper, 2021; Palau et al., 2021; Scully et al., 2021). The interview partners represent different regions of Baden-Württemberg, as well as different subjects and types of vocational schools. The different genders are equally represented. The age distribution is skewed towards younger teachers. It is possible that older teachers might be less skilled or more critical in terms of their digital skills and might have struggled even more than their younger colleagues. The trusting atmosphere of the interviews diminished the chances of socially desirable answers and allowed the participants to speak honestly about their perceived challenges. Under these circumstances, the qualitative research approach can harness the ideas and suggestions of teachers. The researchers themselves

function as professional mediators between school administration and teachers, circumventing the power gap within the employer-employee relationship while simultaneously gathering relevant research data of high validity (Fletcher, 2019; Gurr & Huerta, 2013; Swaffield & MacBeath, 2005). Consequently, a follow up study to identify persisting challenges, new problems and coping strategies developed by teachers during digital distance learning at vocational schools is a valuable undertaking. Such a study has to incorporate older teachers to become more representative in terms of the age distribution. Ideally, implications for specific (further) teacher education can be gained from the challenges of teachers.

The need for teacher education and further training of teachers in the context of digitalisation has been identified throughout this thesis. Future research should focus on the instructional design of ICT competence training programmes that are adequate for the existing competencies and learner characteristics of individual (pre-service) teachers (Cropley & Dave, 2014; Howard et al., 2020; Misra, 2018; Tondeur et al., 2018; K. E. Weber et al., 2018). An important research question for further teacher education is the feasibility of integrating digital tools into the already developed classroom practices of experienced teachers (Donnelly et al., 2011; Moreira et al., 2019). A possible research approach is the empirical support and analysis of teacher-teacher tandems. In such collaborative tandems, teachers with more pronounced digital competencies review the teaching concepts of less digitally experienced colleagues. Ideally, collaborative tools should already be implemented into the process to further enhance the digital competencies of the participating teachers (Böhm-Kasper et al., 2016; Castaño Muñoz et al., 2021; Romeu et al., 2016). While such tandems already exist in practice, research work on this topic could identify basic prerequisites, valuable collaborative tools and pitfalls. Empirical research could gather best-practice examples of collaboratively designed instruction, while school administrations at the state level would curate them on an open-access platform. Pre-service teachers could profit from such tandems during their internships at schools.

A second research question focuses on the implementation of digital content into teacher education. Educational research has to find feasible ways to incorporate topics such as AI systems (U. Schmid et al., 2021) and Educational Data Literacy (Papamitsiou et al., 2021) into existing teacher education programmes. One research approach to answer the question could be the design of a blended-learning educational data literacy course that allows participating (pre-service) teachers to work with educational data. While video classes convey the theoretical concepts, in-person group projects are used to derive conclusions from actual educational data.

Another future research question should examine how digital tools can be used to address time constraint challenges of teachers when preparing digital content for their classes. A

possible solution could be the implementation of a recommender system, which helps teachers to find valuable additional digital content (Dahdouh et al., 2018; Deschênes, 2020; Rivera et al., 2018). The evaluation of such a system could combine quantitative and qualitative research approaches. Participating teachers could give feedback through focus group interviews and online questionnaires, focusing on their perceived change in workload and the quality of the recommended content. Meanwhile, analysis of the recommender system data could provide information about the actual time spent by teachers preparing classes in the LMS, how often recommended content was used and whether different teachers prefer different formats of recommended content. The triangulation of qualitative and quantitative data could then be used to improve the recommendation algorithms, foster the integration of content recommender systems into the LMS of vocational schools and support teachers in the instructional design of digital education.

One research question arises in the context of (pre-service) teachers' digital competencies and recommender systems, namely how AI systems can be used to support individual teacher education. At the university level, learning analytics might help to reduce drop-out rates of pre-service teachers and help to foster self-regulated learning competencies through course and content recommendation (U. Schmid et al., 2021). In terms of further teacher education, recommender systems could support teachers to find appropriate training programmes that supplement their learning goals but also consider other individual characteristics, such as their preferred learning strategies, time constraints, subject-specific foci and prior knowledge.

7.3.3 School Development and Learner Success

The importance of organisational development on learner success was examined in Study 3. The research methodology is based on an external online evaluation instrument. While the reliabilities of the different subscales meet the statistical requirements for an empirical analysis of the data, specific characteristics of the instrument and the data collection limit its explanatory power. Firstly, leaner success was not measured based on grades or comparable data sources (Croft & Beard, 2021; Hanberger, 2014), due to the fact that grading was officially suspended during the survey period. Secondly, the number of participating schools diminishes the usability of the hierarchical linear model. The limitation of self-reported learner success (Deslauriers et al., 2019) could be circumvented by including direct measurements in future research. However, this would contradict a basic principle of the initial research approach. One of the goals of the research project was to establish an evaluation process based on trust and the

willingness of participants to provide valid answers, which are not skewed by social desirability. Data privacy is a key principle of the research project, including the waiver of as much personal data as possible. In particular, the number and quality of the open question at the end of the instrument show that these initial ideals are a positive influence on the data collection process (Miller & Dumford, 2014; Vitale et al., 2008).

A subsequent study is already being planned to collect additional data from a higher number of schools to increase the explanatory power of the hierarchical linear model (Alinsunurin, 2020; Hox et al., 2017; Snijders & Bosker, 2011). To that end, the instrument is being revised with a focus on greater flexibility and modularity. Consequently, decision-makers at the schools will be able to decide which development fields they want to evaluate. An automated progress is planned to allow schools to independently implement the tool into their LMS. These steps will increase the likelihood of a higher number of participating schools and result in a stronger explanatory power of the hierarchical linear model. Despite its limitations, the instrument proved to be a valuable tool for students to give feedback to the decision-makers at the school level.

Additionally, future educational research needs to analyse tools and methods which can be used to foster feedback processes inside and outside of the classroom (Edgerly et al., 2018; Hattie & Timperley, 2007; Markowitsch & Hefler, 2018; Metcalfe, 2017; K. E. Weber et al., 2018). In a first step, different feedback methods have to be identified, such as individual feedback, the provision of sample solutions, learning group feedback or peer2peer2teacher feedback, as presented in the practical implications. In an experimental setting, the effectiveness, the acceptance, the appropriateness and the feasibility of the different concepts could be examined and compared. The results can help teachers to identify feedback tools which they can implement into their instructional designs, based on their own preferences, the interests of students and empirically verified relationships.

The question of learner support through AI systems can be transferred to the students at vocational schools (Baker & Siemens, 2015; Lemay et al., 2021; Ludwig et al., 2021; Rivera et al., 2018; Zawacki-Richter et al., 2019). More specifically, the proposed research approach for a content recommender system for teachers can be conducted in conjunction with the evaluation of the students' experiences, combining the perspective of both stakeholder groups. By doing so, the major goal of school development, the facilitation of students' competencies, comes to the fore. The empirical analysis of the recommender system could examine the relationship between students' learner success and the engagement with the system. Learner success could be measured as a combination of motivational factors, assessment results and learning goal

achievements, while engagement with the system is a compound of how often recommended content is chosen, how much time is spent on the content and how the students rate the recommended content.

Apart from content recommendation systems, AI systems could play a major role in tackling the increasing dropout rates of vocational students and apprentices in the dual system (Fries et al., 2013; Kärner et al., 2021; Neuber-Pohl, 2021; Patzina & Wydra-Somaggio, 2020). This includes the possibility to identify at-risk students, but also the recommendation of alternative career paths, much like the recommendation of training programmes for teachers presented above. Although the VET system is supposed to be highly permeable, choosing the right training programme can be very difficult for young people (Virdia & Schindler, 2019). An AI-enhanced system could constitute a fist low-threshold offer for students. One could examine how such a system can find appropriate career choices for young people, based on inputs such as certificates, former training and students' interests. In a second step, a career consultant could discuss the results of the recommendation process with the student, using the recommender system as an easy way to connect students and specialised career consultants (Cardoso & Sales, 2019; Cohen-Scali et al., 2018). Vacant positions and the associated training companies should be implemented within the system, to effectively connect interested apprentices and possible employers. A subsequent evaluation throughout the process and at multiple points with temporal distance can be used to examine the effectiveness of this approach.

7.3.4 Stakeholder Collaboration in School Development

The fourth study uses a qualitative approach to examine the perspectives of the different stakeholder groups of school development. The open question format proved to be a valuable tool to collect numerous statements from students, teachers, school leaders, parents and training companies. Research on open questions in online instruments suggests that the results might be skewed, based on the assumption that negatively inclined respondents tend to provide answers more often than positively inclined respondents (Adams, 2015; Miller & Dumford, 2014). It is possible that the statements to the open question draw a more negative picture on the situation within the vocational schools. In addition, the classification of statements into predefined categories is an interpretative process (Mayring, 2004, 2015). The classification can be ambiguous, for example when a statement includes aspects of multiple categories or when the content of a statement is not directly evident. Two student research projects have successfully

been utilised to validate the interpretation process. As a result, the analysis of the qualitative data provides valuable results for improvement processes of vocational school development in the context of digitalisation.

Originating from the research process described in Studies 3 and 4, the development of evaluation tools for vocational school development emerges as a future research question (Gougas & Malinova, 2021). Which functionalities are required by vocational schools and how can such tools be implemented into existing systems and processes? Studies 3 and 4 show that a collaborative design approach with educational researchers, vocational school stakeholders and school administration is needed to foster evaluation development. Hence, the input from the stakeholders and school administration will be utilised to revise the existing instrument and to transform it into a more flexible tool. Automated processes will allow schools to gather and analyse their specific data autonomously. Meanwhile, the data of all schools is stored according to the German data protection laws. Educational researchers can use the resulting educational data and analyse it with approaches that are specifically designed for such databases, such as the proposed hierarchical linear modelling or learning analytics algorithms.

The research process is not limited to the quantitative data. Natural language processing can be deployed to automatically create a descriptive overview of the gathered qualitative evaluation data (Rafail & Freitas, 2020; Zhang & Teng, 2021). Consequently, educational researchers and the stakeholders at schools can work together to derive practical implications for research and school development from a thorough analysis of the qualitative data.

Furthermore, educational research has to examine solutions to interconnect the different digital systems within a single school and within the VET system. The collaboration of systems is a cornerstone of digitalisation in school development, because it creates the base for effective AI system implementation and data-driven decision-making processes (U. Schmid et al., 2021). The protection of personal data and the transparent communication about which and whose specific data is being used, and why, has to be paramount for such a research undertaking. One example for system collaboration could be the introduction of an e-portfolio system within the training companies (Ebil et al., 2020; Kiffer et al., 2021), coupled with a content-based classroom schedule. Trainers and teachers continuously capture the theoretical and practical topics they addressed during educational processes. The connected system visualises matching topics and allows the educators to backward reference on their own teaching as well as the respective parallel learning place.

Apart from collaborative digital systems, educational research has to envisage the cooperation of stakeholders in vocational school development. Most of all, this means the

aforementioned collaboration of learning places (Aprea et al., 2020; Roll & Ifenthaler, 2020a). How can teachers at schools and educators at training companies continuously work together to facilitate the digital competencies of students? How can digital tools and methods enhance this process? A possible research approach could be the opening of a school's LMS for training companies. In this way, trainers would have access to regulations of the school, but most importantly the intended learning path of their trainees. They could see which topics are being discussed and integrate those topics into work floor learning. Additionally, they would have information about upcoming exams and could support their trainees by revising relevant content or by making apprentice working hours more flexible. In return, trainers could use their access to the LMS to inform teachers about new technology they are using in their companies or trending developments from the perspective of practice. When stakeholders such as teachers and trainers start collaborating in the LMS, traditional borders and barriers between the learning places are softened up. Hence, educational research has to provide approaches which minimise the risk of disparity in the relationship between students, teachers and training companies. Most importantly, the collaboration is not supposed to allow one stakeholder group to extract information without enriching the relationship themselves. Additionally, a continuous examination of the process by educational researchers has to ensure that students can profit from a collaboration of learner places.

Throughout this thesis, the dependency and the interrelation of the different stakeholder groups within a school has been emphasised at various points. In the context of digitalisation, a model of school development that focuses on a network of collaborating schools could advance the theoretical foundation of school development at vocational schools. Given the historical progression of school development theory, the increasing transformation of vocational schools and the shifts in traditional development fields, a revision of the existing models is indicated.

7.3.5 Summary of Further Research Questions

In Table 7-1 further research questions for the different development dimensions are visualised.

Table 7-1

Development Dimensions and Further Research Questions

Development dimension	Research question
Organisation Development	How can vocational schools develop a culture of feedback?
	Which components should be elements of a shared digital vision?
	What are requirements for iterative evaluation processes?
Education Development	Which educational competencies are needed to implement digital distance learning?
	How can digital feedback tools be implemented into teaching and learning?
Personnel Development	Which programmes are able to support (pre-service) teacher education?
	How can future digital competences be integrated into teacher education at universities and vocational schools?
Technology Development	Are new structures of IT administration feasible in vocational schools?
	Which new competencies does ICT at schools require for IT support personnel?
Cooperation Development	In which ways can AI systems be used to connect the theoretical and practical places of learning in the VET?
	How can the strengths of the learning places be further harnessed through digital tools and methods?

7.4 Conclusion

The vocational educational training system in Germany is changing constantly. The increasing influence of digitalisation on everyday life and the workplace call for new competencies (Aprea et al., 2020; Caena & Redecker, 2019; Euler & Wilbers, 2018; Falloon, 2020; Guggemos & Seufert, 2021; Vuorikari et al., 2016). The present thesis examines how vocational schools in Baden-Württemberg deal with the challenges and the opportunities of a digital world: digitalisation can help stakeholders at vocational schools to facilitate students' digital competencies by changing educational processes, enhancing cooperation and strengthening self-regulated learning. Nevertheless, formal regulations and guidelines in the form of curricula are scarce. Providers of (pre-service) teacher education in-cooperate digital topics into their programmes too slowly, leaving educators unprepared for digital teaching practices or the utilisation of digital school development tools. The missing training programmes are reflected in the lack of appropriate feedback concepts and students' dissatisfaction with regard to transparency and workload. Most importantly, the current state of school development leaves many digital potentials unharnessed, such as a broad implementation of AI systems, a closer cooperation of stakeholders and a stronger connection between different learning places. Therefore, many areas of digitalisation and school development can currently not be thoroughly examined with regard to effectives or learner success.

Digitalisation is not a mere end in itself, especially in the context of education. Vocational schools, educational research, training companies as well as school administrations at the federal and national level have to work together to derive meaningful implications for practice based on comprehensive research projects. Well-grounded didactical concepts and instructional design build the basis for effective learning processes on-site and online. The introduction of digital tools into school development has to be become a catalyst for the professional action of teachers and trainers. It has to support their education activities, effectively reducing their workload rather than being perceived as forced a concept. The thoughtful implantation of digitalisation at the school level should be supported by proactive school leaders, who utilise the synergies of school networks to foster the competencies of teaching and administrative staff. First and foremost, transparency and ethical considerations have to be factored in whenever decision makers implement new processes and ideas, especially in the light of AI systems and data-driven approaches.

As a superior goal of digital transformation in school development, the facilitation of students' competencies has to be paramount. In the future, these competencies will keep

reshaping and reforming. Consequently, the education of young people has to further focus on subject-specific, interdisciplinary and socio-economic competencies in the self-perception of vocational education and training. The COVID-19 pandemic bears impressive witness to the shortcomings and missed opportunities for digital transformation in vocational school development. More importantly, the presented study uncovers the willingness of all stakeholders to continuously take up the emerging challenges of digitalisation to prepare the citizens of tomorrow for their life in a digital world.

7.5 References

Abele, E., Chryssolouris, G., Sihn, W., Metternich, J., ElMaraghy, H., Seliger, G., Sivard, G., ElMaraghy, W., Hummel, V., Tisch, M., & Seifermann, S. (2017). Learning factories for future oriented research and education in manufacturing. *CIRP Annals*, *66*(2), 803–826. https://doi.org/10.1016/j.cirp.2017.05.005

Adamowicz, M., & Pyra, M. (2019). Computer Simulation as an Innovative Didactic Method. *International Journal of Innovation in Management*, *7*(2), 101–108.

Adams, W. C. (2015). Conducting Semi-Structured Interviews. In *Handbook of Practical Program Evaluation* (pp. 492–505). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119171386.ch19

Aguilar, S. J., Galperin, H., Noguera, P. A., Arkatov, A., Baek, C., & Gonzalez, E. (2020). *When school comes home: How low-income families are adapting to distance learning*. EdArXiv. https://doi.org/https://doi.org/10.35542/osf.io/su8wk

Alinsunurin, J. (2020). School learning climate in the lens of parental involvement and school leadership: lessons for inclusiveness among public schools. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-020-00139-2

Alsdorf, V., Böhnhardt, L., & Jäger, U. (2020). Die neue Berufsbildposition 5 in den industriellen Metall- und Elektroberufen – ein Umsetzungsansatz aus der Ausbildungspraxis. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 119–138). wbv Media GmbH & Co. KG.

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203–220. https://doi.org/10.1080/21532974.2019.1646169

Antony, M. K., Paidi, Subali, B., Pradana, S. P., Hapsari, N., & Astuti, F. E. C. (2019). Teacher's TPACK Profile: The Affect of Teacher Qualification and Teaching Experience. *Journal of Physics: Conference Series*, *1397*(1), 12054. https://doi.org/10.1088/1742-6596/1397/1/012054

Aprea, C., Sappa, V., & Tenberg, R. (2020). *Konnektivität und lernortintegrierte Kompetenzentwicklung in der beruflichen Bildung / Connectivity and Integrative Competence Development in Vocational and Professional Education and Training (VET/PET)*. Franz Steiner Verlag.

Attwell, G., Bekiaridis, G., Deitmer, L., Perini, M., Roppertz, S., & Tutlys, V. (2020). *Artificial Intelligence in Policies, Processes and Practices of Vocational Education and Training*. Universität Bremen. https://media.suub.uni-bremen.de/bitstream/elib/4510/4/fb_71.pdf

Baier, F., Decker, A., Voss, T., Kleickmann, T., Klusmann, U., & Kunter, M. (2019). What makes a good teacher? The relative importance of mathematics teachers' cognitive ability, personality, knowledge, beliefs, and motivation for instructional quality. *British Journal of Educational Psychology*, *89*(4), 767–786. https://doi.org/10.1111/bjep.12256

Baker, R., & Siemens, G. (2015). Educational Data Mining and Learning Analytics. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 253–272). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.016

Barnová, S., Krásna, S., & Čepelová, S. (2020). Digital Technologies as a Means of Teachers' Professional Development. *Online Journal for Reseach Adn Education*, *18*. https://journal.ph-noe.ac.at/index.php/resource/article/view/838/796

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-Service Teachers' Perceptions of School Development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., & Matsuo, A. (2018). quanteda: An R package for the quantitative analysis of textual data. *Journal of Open Source Software*, *3*(30), 774. https://doi.org/10.21105/joss.00774

Böhm-Kasper, O., Dizinger, V., & Gausling, P. (2016). Multiprofessional Collaboration Between Teachers and Other Educational Staff at German All-day Schools as a Characteristic of Today's Professionalism. *International Journal for Research on Extended Education*, *4*(1), 29–51. https://doi.org/10.3224/ijree.v4i1.24774

Borba, M. C., Chiari, A. S. de S., & de Almeida, H. R. F. L. (2018). Interactions in virtual learning environments: new roles for digital technology. *Educational Studies in Mathematics*, *98*(3), 269–286. https://doi.org/10.1007/s10649-018-9812-9

Brookhart, S. M. (2017). *How to Give Effective Feedback to Your Students* (2nd ed.). ASCD.

Brookhart, S. M. (2018). Appropriate Criteria: Key to Effective Rubrics. *Frontiers in Education*, *3*. https://doi.org/10.3389/feduc.2018.00022

Bueno-Alastuey, M. C., Villarreal, I., & García Esteban, S. (2018). Can telecollaboration contribute to the TPACK development of pre-service teachers? *Technology, Pedagogy and Education*, *27*(3), 367–380. https://doi.org/10.1080/1475939X.2018.1471000

Butter, M. C., Pérez, L. J., & Quintana, M. G. B. (2014). School networks to promote ICT competences among teachers. Case study in intercultural schools. *Computers in Human Behavior*, *30*, 442–451. https://doi.org/10.1016/j.chb.2013.06.024

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Cardoso, P., & Sales, C. M. D. (2019). Individualized Career Counseling Outcome Assessment: A Case Study Using the Personal Questionnaire. *The Career Development Quarterly*, *67*(1), 21–31. https://doi.org/10.1002/cdq.12160

Castaño-Muñoz, J., Kalz, M., Kreijns, K., & Punie, Y. (2018). Who is taking MOOCs for teachers' professional development on the use of ICT? A cross-sectional study from Spain. *Technology, Pedagogy and Education*, *27*(5), 607–624. https://doi.org/10.1080/1475939X.2018.1528997

Castaño Muñoz, J., Vuorikari, R., Costa, P., Hippe, R., & Kampylis, P. (2021). Teacher collaboration and students' digital competence - evidence from the SELFIE tool. *European Journal of Teacher Education*, 1–22. https://doi.org/10.1080/02619768.2021.1938535

Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, *24*(4), 2523–2546. https://doi.org/10.1007/s10639-019-09886-3

Chen, L.-T., Liu, L., & Tretheway, P. (2021). Using Multilayer Videos for Remote Learning: Videos of Session Guidance, Content Instruction, and Activity. *Computers in the Schools*, 1–32. https://doi.org/10.1080/07380569.2021.1989220

Cohen-Scali, V., Rossier, J., & Nota, L. (Eds.). (2018). *New perspectives on career counseling and guidance in Europe*. Springer International Publishing. https://doi.org/10.1007/978-3-319-61476-2

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: the digital revolution and schooling in America* (2nd ed.). Teachers College Press.

Cornelissen, F., McLellan, R. W., & Schofield, J. (2017). Fostering research engagement in partnership schools: networking and value creation. *Oxford Review of Education*, *43*(6), 695–717. https://doi.org/10.1080/03054985.2017.1316251

Croft, M., & Beard, J. J. (2021). Development and Evolution of the SAT and ACT. In B. E. Clauser & M. B. Bunch (Eds.), *The History of Educational Measurement* (1st ed., p. 20). Routledge. https://doi.org/https://doi.org/10.4324/9780367815318

Cropley, A. J., & Dave, R. H. (2014). *Lifelong Education and the Training of Teachers: Developing a Curriculum for Teacher Education on the Basis of the Principles of Lifelong Education*. Elsevier Science.

Dahdouh, K., Oughdir, L., Dakkak, A., & Ibriz, A. (2018). Smart Courses Recommender System for Online Learning Platform. *2018 IEEE 5th International Congress on Information Science and Technology (CiSt)*, 328–333. https://doi.org/10.1109/CIST.2018.8596516

Day, C. (2002). *Developing Teachers*. Routledge. https://doi.org/10.4324/9780203021316

Deissinger, T. (2015). The German dual vocational education and training system as 'good practice'? *Local Economy: The Journal of the Local Economy Policy Unit*, *30*(5), 557–567. https://doi.org/10.1177/0269094215589311

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826

Deschênes, M. (2020). Recommender systems to support learners' Agency in a Learning Context: a systematic review. *International Journal of Educational Technology in Higher Education*, *17*(1), 50. https://doi.org/10.1186/s41239-020-00219-w

Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences*, *116*(39), 19251–19257. https://doi.org/10.1073/pnas.1821936116

Ditton, H., & Müller, A. (2011). Schulqualität. In H. Reinders, H. Ditton, C. Gräsel, & B. Gniewosz (Eds.), *Empirische Bildungsforschung: Gegenstandsbereiche* (pp. 99–111). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93021-3_9

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, *57*(2), 1469–1483. https://doi.org/10.1016/j.compedu.2011.02.014

Drago-Severson, E., & Blum-DeStefano, J. (2018). Building a developmental culture of feedback. *Journal of Professional Capital and Community*, *3*(2), 62–78. https://doi.org/10.1108/JPCC-06-2017-0016

Du, X., Yang, J., Shelton, B. E., Hung, J.-L., & Zhang, M. (2019). A systematic meta-Review and analysis of learning analytics research. *Behaviour & Information Technology*, *40*(1), 49–62. https://doi.org/10.1080/0144929X.2019.1669712

Ebil, S. H., Salleh, S. M., & Shahrill, M. (2020). The use of E-portfolio for self-reflection to promote learning: a case of TVET students. *Education and Information Technologies*, *25*(6), 5797–5814. https://doi.org/10.1007/s10639-020-10248-7

Edgerly, H., Wilcox, J., & Easter, J. (2018). Creating a Positive Feedback Culture: Eight Practical Principles to Improve Students' Learning. *Science Scope*, *041*(05). https://doi.org/10.2505/4/ss18_041_05_43

Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen*, *29*(4), 111–115.

Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1

Ewing, L.-A., & Cooper, H. B. (2021). Technology-enabled remote learning during Covid-19: perspectives of Australian teachers, students and parents. *Technology, Pedagogy and Education*, *30*(1), 41–57. https://doi.org/10.1080/1475939X.2020.1868562

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*,

68(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Faßhauer, U., Windelband, L., Mutzke, B., & Harm, S. (2021). Lernfabriken an beruflichen Schulen als Gegenstand fachdidaktischer Professionalisierung – Entwicklung von standortübergreifenden Medienpaketen im beruflichen Lehramtsstudium. *Berufs- Und Wirtschaftspädagogik Online*, *40*. https://www.bwpat.de/ausgabe40/fasshauer_etal_bwpat40.pdf

Fletcher, A. (2019). An Invited Outsider or an Enriched Insider? Challenging Contextual Knowledge as a Critical Friend Researcher. In *Educational Researchers and the Regional University* (pp. 75–92). Springer Singapore. https://doi.org/10.1007/978-981-13-6378-8_5

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

Fries, J., Göbel, C., & Maier, M. F. (2013). *Do Employment Subsidies Reduce Early Apprenticeship Dropout?* Zentrum für Europäische Wirtschaftsforschung GmbH. https://ftp.zew.de/pub/zew-docs/dp/dp13053.pdf

García-Martínez, I., Tadeu, P., Montenegro-Rueda, M., & Fernández-Batanero, J. M. (2020). Networking for online teacher collaboration. *Interactive Learning Environments*, 1–15. https://doi.org/10.1080/10494820.2020.1764057

García-Peñalvo, F. J. (2021). Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education. *Sustainability*, *13*(4), 2023. https://doi.org/10.3390/su13042023

Genlott, A. A., & Grönlund, Å. (2016). Closing the gaps – Improving literacy and mathematics by ict-enhanced collaboration. *Computers & Education*, *99*, 68–80. https://doi.org/10.1016/j.compedu.2016.04.004

Gerritsen-van Leeuwenkamp, K. J., Joosten-ten Brinke, D., & Kester, L. (2019). Students' perceptions of assessment quality related to their learning approaches and learning outcomes. *Studies in Educational Evaluation*, *63*, 72–82. https://doi.org/10.1016/j.stueduc.2019.07.005

Gessler, M. (2017). The Lack of Collaboration Between Companies and Schools in the German Dual Apprenticeship System: Historical Background and Recent Data. *International Journal for Research in Vocational Education and Training*, *4*(2), 164–195. https://doi.org/10.13152/IJRVET.4.2.4

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Gorshenin, A. (2018). Toward Modern Educational IT-ecosystems: from Learning Management Systems to Digital Platforms. *2018 10th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT)*, 1–5. https://doi.org/10.1109/ICUMT.2018.8631229

Gougas, V., & Malinova, L. (2021). School Leadership. Models and Tools: A Review. *Open Journal of Social Sciences*, *09*(01), 120–139. https://doi.org/10.4236/jss.2021.91009

Govindarajan, K., Kumar, V. S., & Kinshuk. (2016). Dynamic Learning Path Prediction — A Learning Analytics Solution. *2016 IEEE Eighth International Conference on Technology for Education (T4E)*, 188–193. https://doi.org/10.1109/T4E.2016.047

Gudjons, H. (2011). *Frontalunterricht - neu entdeckt* (3rd ed.). Verlag Julius Klinkhardt.

Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*, 1–11. https://doi.org/10.1016/j.chb.2020.106613

Gurr, D., & Drysdale, L. (2018). Leading High Needs Schools: Findings from the

International School Leadership Development Network. *International Studies in Educational Administration*, *46*(1), 147–156.

Gurr, D., & Huerta, M. (2013). The Role of the Critical Friend in Leadership and School Improvement. *Procedia - Social and Behavioral Sciences*, *106*, 3084–3090. https://doi.org/10.1016/j.sbspro.2013.12.356

Gusukuma, L., Bart, A. C., Kafura, D., & Ernst, J. (2018). Misconception-Driven Feedback. *Proceedings of the 2018 ACM Conference on International Computing Education Research*, 160–168. https://doi.org/10.1145/3230977.3231002

Haasler, S. R. (2020). The German system of vocational education and training: challenges of gender, academisation and the integration of low-achieving youth. *Transfer: European Review of Labour and Research*, *26*(1), 57–71. https://doi.org/10.1177/1024258919898115

Hall, N. M., & Jones, J. M. (2021). Student-Produced Podcasts as a Teaching and Learning Tool. *American Journal of Distance Education*, 1–13. https://doi.org/10.1080/08923647.2021.1995256

Hammond, M. (2017). Online collaboration and cooperation: The recurring importance of evidence, rationale and viability. *Education and Information Technologies*, *22*(3), 1005–1024. https://doi.org/10.1007/s10639-016-9469-x

Hana, G. M., Hansen, R., Johnsen-Høines, M., Lilland, I. E., & Rangnes, T. E. (2013). *Learning Conversation in Mathematics Practice School–Industry Partnerships as Arena for Teacher Education* (pp. 147–155). https://doi.org/10.1007/978-3-319-02270-3_13

Hanberger, A. (2014). What PISA Intends to and Can Possibly Achieve: A Critical Programme Theory Analysis. *European Educational Research Journal*, *13*(2), 167–180. https://doi.org/10.2304/eerj.2014.13.2.167

Handelzalts, A. (2019). Collaborative Curriculum Development in Teacher Design Teams. In J. Pieters, J. Voogt, & N. Pareja Roblin (Eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning* (pp. 159–173). Springer International Publishing. https://doi.org/10.1007/978-3-030-20062-6_9

Harderer, A., Imboden, S., Glassey-Previdoli, D., & Schumann, S. (2020). Schulleitungshandeln in Zeiten der digitalen Transformation – „Business as usual“ oder „Alles ist neu“? In K. Heinrichs, K. Kögler, & C. Siegfried (Eds.), *Berufliches Lehren und Lernen: Grundlagen, Schwerpunkte und Impulse wirtschaftspädagogischer Forschung. Digitale Festschrift für Eveline Wuttke* (pp. 1–17). https://www.bwpat.de/profil6_wuttke/harder_etal_profil6.pdf

Harteis, C., Goller, M., & Fischer, C. (2019). Die Auswirkungen der Digitalisierung auf die Bedeutung beruflicher Qualifikation aus betrieblicher Sicht. In B.-J. Ertelt, K. Beck, A. Frey, & J. Seifried (Eds.), *Beruf, Beruflichkeit, Employability* (pp. 239–253).

Harvey, L., & Green, D. (1993). Defining Quality. *Assessment & Evaluation in Higher Education*, *18*(1), 9–34. https://doi.org/10.1080/0260293930180102

Hatlevik, I. K. R., & Hatlevik, O. E. (2018). Examining the Relationship Between Teachers' ICT Self-Efficacy for Educational Purposes, Collegial Collaboration, Lack of Facilitation and the Use of ICT in Teaching Practice. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00935

Hatlevik, O. E. (2017). Examining the Relationship between Teachers' Self-Efficacy, their Digital Competence, Strategies to Evaluate Information, and use of ICT at School. *Scandinavian Journal of Educational Research*, *61*(5), 555–567. https://doi.org/10.1080/00313831.2016.1172501

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hawley, R., & Allen, C. (2018). Student-generated video creation for assessment: can it transform assessment within Higher Education? *International Journal for*

Transformative Research, *5*(1), 1–11. https://doi.org/10.2478/ijtr-2018-0001
Heck, R. H., & Hallinger, P. (2010). Testing a longitudinal model of distributed leadership effects on school improvement. *The Leadership Quarterly*, *21*(5), 867–885. https://doi.org/10.1016/j.leaqua.2010.07.013
Hilburg, R., Patel, N., Ambruso, S., Biewald, M. A., & Farouk, S. S. (2020). Medical Education During the COVID-19 Pandemic: Learning From A Distance. *Advances in Chronic Kidney Disease*, *27*(5), 412–417. https://doi.org/https://doi.org/10.1053/j.ackd.2020.05.017
Holden, O. L., Norris, M. E., & Kuhlmeier, V. A. (2021). Academic Integrity in Online Assessment: A Research Review. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.639814
Hopmann, S. T. (2003). On the evaluation of curriculum reforms. *Journal of Curriculum Studies*, *35*(4), 459–478. https://doi.org/10.1080/00220270305520
Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2020). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 1–18. https://doi.org/10.1080/1475939X.2020.1839543
Hox, J. J., Moerbeek, M., & van de Schoot, R. (2017). The Basic Two-Level Regression Model. In J. J. Hox, M. Moerbeek, & R. van de Schoot (Eds.), *Multilevel Analysis* (3rd ed., p. 19). Routledge. https://doi.org/10.4324/9781315650982
Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability*, *32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y
Ifenthaler, D. (2015). Learning Analytics. In *The SAGE Encyclopedia of Educational Technology* (pp. 447–451). SAGE Publications, Inc. https://doi.org/10.4135/9781483346397.n187
Ifenthaler, D. (2019). *MEPS – Medienentwicklungsplanung für Schulen in Baden-Württemberg. Bericht zum Projekt des Kultusministeriums Baden-Württemberg*. Kultusministerium Baden-Württemberg.
Ifenthaler, D., Gibson, D., Prasse, D., Shimada, A., & Yamada, M. (2020). Putting learning back into learning analytics: actions for policy makers, researchers, and practitioners. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-020-09909-8
Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8
Jæger, M. M., & Blaabæk, E. H. (2020). Inequality in learning opportunities during Covid-19: Evidence from library takeout. *Research in Social Stratification and Mobility*, *68*(4), 100524. https://doi.org/https://doi.org/10.1016/j.rssm.2020.100524
Jin, X., Li, T., Meirink, J., van der Want, A., & Admiraal, W. (2021). Learning from novice–expert interaction in teachers' continuing professional development. *Professional Development in Education*, *47*(5), 745–762. https://doi.org/10.1080/19415257.2019.1651752
Kabooha, R., & Elyas, T. (2018). The Effects of YouTube in Multimedia Instruction for Vocabulary Learning: Perceptions of EFL Students and Teachers. *English Language Teaching*, *11*(2), 72. https://doi.org/10.5539/elt.v11n2p72
Kärner, T., Warwas, J., & Schumann, S. (2021). A Learning Analytics Approach to Address Heterogeneity in the Classroom: The Teachers' Diagnostic Support System. *Technology, Knowledge and Learning*, *26*(1), 31–52. https://doi.org/10.1007/s10758-020-09448-4
Kemp, J., Mellor, A., Kotter, R., & Oosthoek, J. W. (2012). Student-Produced Podcasts as an Assessment Tool: An Example from Geomorphology. *Journal of Geography in Higher*

Education, *36*(1), 117–130. https://doi.org/10.1080/03098265.2011.576754
Kerres, M. (2020). Against All Odds: Education in Germany Coping with Covid-19. *Postdigital Science and Education*, *2*(3), 690–694. https://doi.org/10.1007/s42438-020-00130-7
KI-Campus. (2021). *AI-VET Micro Degree zu Ki in der beruflichen Bildung*. https://doi.org/https://ki-campus.org/courses/aivet2020
Kiffer, S., Bertrand, É., Eneau, J., Gilliot, J.-M., & Geneviève, L. (2021). Enhancing Learners' Autonomy With E-Portfolios And Open Learner Models: A Literature Review. *Education Thinking*, *1*(1), 1–9.
Kim, S., Jang, Y., Choi, S., Kim, W., Jung, H., Kim, S., & Kim, H. (2021). Analyzing Teacher Competency with TPACK for K-12 AI Education. *KI - Künstliche Intelligenz*, *35*(2), 139–151. https://doi.org/10.1007/s13218-021-00731-9
km-bw. (2021). *Rollout von itslearning als Lernmanagementsystem gestartet*. Ministerium für Kultus, Jugend und Sport Baden-Württemberg. https://km-bw.de/,Len/startseite/service/2021-06-10-rollout-itslearning-gestartet
KMK. (2017a). *Bildung in der digitalen Welt - Strategie der Kultusministerkonferenz*. Sekretariat der Kultusministerkonferenz. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2018/Digitalstrategie_2017_mit_Weiterbildung.pdf
KMK. (2017b). *The Standing Conference's "Education in the Digital World" strategy - Summary*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2017/KMK-Strategie_Bildung_in_der_digitalen_Welt_Zusammenfassung_en.pdf
KMK. (2019a). *Basic Structure of the Education System in the Federal Republic of Germany*. KMK. https://www.kmk.org/fileadmin/Dateien/pdf/Dokumentation/en_2019.pdf
KMK. (2019b). *Verwaltungsvereinbarung DigitalPakt Schule 2019 bis 2024* (p. 19). KMK. https://www.digitalpaktschule.de/files/VV_DigitalPaktSchule_Web.pdf
Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J. M. Spector, M. D. Merill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology: Fourth Edition* (4th ed., pp. 101–111). Springer Science+Business Media. https://doi.org/10.1007/978-1-4614-3185-5
König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*, *43*(4), 608–622. https://doi.org/10.1080/02619768.2020.1809650
König, L. (2021). Podcasts in higher education: teacher enthusiasm increases students' excitement, interest, enjoyment, and learning motivation. *Educational Studies*, *47*(5), 627–630. https://doi.org/10.1080/03055698.2019.1706040
Kreijns, K., Van Acker, F., Vermeulen, M., & van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior*, *29*(1), 217–225. https://doi.org/10.1016/j.chb.2012.08.008
Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. *Journal of Business Research*, *117*(12), 1–5. https://doi.org/10.1016/j.jbusres.2020.05.034
Kronberger, N., & Wagner, W. (2000). Keywords in context: Statistical analysis of text features. *Qualitative Researching with Text, Image and Sound: A Practical Handbook*, 299–317.
Krouska, A., Troussas, C., & Virvou, M. (2018). Social Annotation Tools in Digital Learning:

A Literature Review. *2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)*, 1–4. https://doi.org/10.1109/IISA.2018.8633609

Kwartler, T. (2017). *Text Mining in Practice with R*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/unimannheim-ebooks/detail.action?docID=4860512

Kyriakides, L., Charalambous, E., Creemers, B. P. M., Antoniou, P., Devine, D., Papastylianou, D., & Fahie, D. (2019). Using the dynamic approach to school improvement to promote quality and equity in education: a European study. *Educational Assessment, Evaluation and Accountability*, *31*(1), 121–149. https://doi.org/10.1007/s11092-018-9289-1

Lantz-Andersson, A., Lundin, M., & Selwyn, N. (2018). Twenty years of online teacher communities: A systematic review of formally-organized and informally-developed professional learning groups. *Teaching and Teacher Education*, *75*, 302–315. https://doi.org/10.1016/j.tate.2018.07.008

Leithwood, K., & Mascall, B. (2008). Collective Leadership Effects on Student Achievement. *Educational Administration Quarterly*, *44*(4), 529–561. https://doi.org/10.1177/0013161X08321221

Leithwood, K., Sun, J., & Schumacker, R. (2020). How School Leadership Influences Student Learning: A Test of "The Four Paths Model." *Educational Administration Quarterly*, *56*(4), 570–599. https://doi.org/10.1177/0013161X19878772

Lemay, D. J., Baek, C., & Doleck, T. (2021). Comparison of learning analytics and educational data mining: A topic modeling approach. *Computers and Education: Artificial Intelligence*, *2*, 100016. https://doi.org/https://doi.org/10.1016/j.caeai.2021.100016

Lin, J., Pu, H., Li, Y., & Lian, J. (2018). Intelligent Recommendation System for Course Selection in Smart Education. *Procedia Computer Science*, *129*, 449–453. https://doi.org/10.1016/j.procs.2018.03.023

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology*, 69–88. https://doi.org/10.14742/ajet.5583

Ludwig, S., Mayer, C., Hansen, C., Eilers, K., & Brandt, S. (2021). Automated Essay Scoring Using Transformer Models. *Psych*, *3*(4), 897–915. https://doi.org/10.3390/psych3040056

Luke, A., Sefton-Green, J., GGraham, P., Kellner, D., & Ladwig, J. (2017). Digital ethics, political economy, and the curriculum: This changes everything. In K. A. Mills, A. Stornaiuolo, A. Smith, & P. Jessica Zacher (Eds.), *Handbook of Writing, Literacies, and Education in Digital Cultures*. Routledge. https://doi.org/10.4324/9781315465258

Ma, B., Lu, M., Taniguchi, Y., & Konomi, S. (2021). CourseQ: the impact of visual and interactive course recommendation in university environments. *Research and Practice in Technology Enhanced Learning*, *16*(1), 18. https://doi.org/10.1186/s41039-021-00167-7

Maramba, I. D., Davey, A., Elliott, M. N., Roberts, M., Roland, M., Brown, F., Burt, J., Boiko, O., & Campbell, J. (2015). Web-Based Textual Analysis of Free-Text Patient Experience Comments From a Survey in Primary Care. *JMIR Medical Informatics*, *3*(2), e20. https://doi.org/10.2196/medinform.3783

Markowitsch, J., & Hefler, G. (2018). Staying in the Loop: Formal Feedback Mechanisms Connecting Vocational Training to the World of Work in Europe. *International Journal for Research in Vocational Education and Training*, *5*(4), 285–306. https://doi.org/10.13152/IJRVET.5.4.3

Matos, J., Pedro, A., & Piedade, J. (2019). Integrating Digital Technology in the School Curriculum. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(21), 4. https://doi.org/10.3991/ijet.v14i21.10863

Mayring, P. (2004). Qualitative Content Analysis. In U. Flick, E. von Kardoff, I. Steinke, &

B. Jenner (Eds.), *A Companion to Qualitative Research*. SAGE Publications.
Mayring, P. (2015). *Qualitative Inhaltsanalyse : Grundlagen und Techniken* (12., übera).
McCabe, A., & O'Connor, U. (2014). Student-centred learning: the role and responsibility of the lecturer. *Teaching in Higher Education*, *19*(4), 350–359. https://doi.org/10.1080/13562517.2013.860111
Menon, D., Bp, S., Romero, M., & Viéville, T. (2019). Going beyond digital literacy to develop computational thinking in K-12 education,. In L. Daniela (Ed.), *Smart Pedagogy of Digital Learning*. Taylor\\&Francis (Routledge). https://hal.inria.fr/hal-02281037
Merrill, M. D. (2002). First principles of instruction. *Educational Technology Research and Development*, *50*(3), 43–59. https://doi.org/10.1007/BF02505024
Metcalfe, J. (2017). Learning from Errors. *Annual Review of Psychology*, *68*(1), 465–489. https://doi.org/10.1146/annurev-psych-010416-044022
Miller, A. L., & Dumford, A. D. (2014). Open-Ended Survey Questions: Item Nonresponse Nightmare or Qualitative Data Dream? *Survey Practice*, *7*(5), 1–11. https://doi.org/10.29115/SP-2014-0024
Mishnick, N. (2017). *An Analysis of the Relationship between Professional Development, School Leadership, Technology Infrastructure, and Technology Use*. ProQuest Dissertations Publishing.
Misra, P. (2018). MOOCs for Teacher Professional Development: Reflections and Suggested Actions. *Open Praxis*, *10*(1), 67–77. https://www.learntechlib.org/p/183570
Moreira, M. A., Rivero, V. M. H., & Sosa Alonso, J. J. (2019). Leadership and school integration of ICT. Teachers perceptions in Spain. *Education and Information Technologies*, *24*(1), 549–565. https://doi.org/10.1007/s10639-018-9789-0
Morgan, R. M. (1992). Educational Reform: Top-Down or Bottom-Up? *Educational Technology*, *32*(11), 47–51.
Mousavinasab, E., Zarifsanaiey, N., R. Niakan Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi Saeedi, M. (2018). Intelligent tutoring systems: a systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments*, *29*(1), 142–163. https://doi.org/10.1080/10494820.2018.1558257
Muftić, A. (2012). *Schulentwicklung : Begriff - Theorie - Definition*.
Mulford, B. (2003). *School Leaders: Challenging Roles and Impact on Teaching and School Effectiveness*. OECD. https://www.oecd.org/education/school/37133393.pdf
Ndlovu, M. C., & Mostert, I. (2018). Teacher Perceptions of Moodle and Throughput in a Blended Learning Programme for In-Service Secondary School Mathematics Teachers. *Africa Education Review*, *15*(2), 131–151. https://doi.org/10.1080/18146627.2016.1241667
Neuber-Pohl, C. (2021). Apprenticeship non-completion in Germany: a money matter? *Empirical Research in Vocational Education and Training*, *13*(1), 12. https://doi.org/10.1186/s40461-021-00115-1
Nguyen, H. T. M. (2017). *Models of Mentoring in Language Teacher Education*. Springer International Publishing. https://doi.org/10.1007/978-3-319-44151-1
Nixon, J. (2021). Critique and the video production classroom: providing students the skills to navigate new media literacies. *English Teaching: Practice & Critique*, *20*(2), 163–179. https://doi.org/10.1108/ETPC-07-2020-0070
Norton, P., & Hathaway, D. (2010). Video Production as an Instructional Strategy: Content Learning and Teacher Practice. *Contemporary Issues in Technology and Teacher Education*, *10*(1).
Obermöller, M. (2019). *Medienentwicklungsplanung in NRW*. Medienberatung NRW. https://www.logineo.schulministerium.nrw.de/_Medienberatung-NRW/Publikationen/Broschuere_Medienentwicklungsplanung_NRW_ES_final.pdf
Ortoleva, G., & Bétrancourt, M. (2016). Supporting productive collaboration in a computer-

supported instructional activity: peer-feedback on critical incidents in health care education. *Journal of Vocational Education & Training*, *68*(2), 178–197. https://doi.org/10.1080/13636820.2015.1133693

Paladines, J., & Ramirez, J. (2020). A Systematic Literature Review of Intelligent Tutoring Systems With Dialogue in Natural Language. *IEEE Access*, *8*, 164246–164267. https://doi.org/10.1109/ACCESS.2020.3021383

Palau, R., Fuentes, M., Mogas, J., & Cebrián, G. (2021). Analysis of the implementation of teaching and learning processes at Catalan schools during the Covid-19 lockdown. *Technology, Pedagogy and Education*, *30*(1), 183–199. https://doi.org/10.1080/1475939X.2020.1863855

Pan, F. (2018). Short Video Production for Language Learning and Assessment. In C. H. Xiang (Ed.), *Cases on Audio-Visual Media in Language Education* (pp. 194–217). London School of Economics and Political Science. https://doi.org/10.4018/978-1-5225-2724-4.ch008

Papamitsiou, Z., Filippakis, M. E., Poulou, M., Sampson, D., Ifenthaler, D., & Giannakos, M. (2021). Towards an educational data literacy framework: enhancing the profiles of instructional designers and e-tutors of online and blended courses with new competences. *Smart Learning Environments*, *8*(1), 18. https://doi.org/10.1186/s40561-021-00163-w

Patzina, A., & Wydra-Somaggio, G. (2020). Early Careers of Dropouts from Vocational Training: Signals, Human Capital Formation, and Training Firms. *European Sociological Review*, *36*(5), 741–759. https://doi.org/10.1093/esr/jcaa011

Peters, O., Körndle, H., & Narciss, S. (2018). Effects of a formative assessment script on how vocational students generate formative feedback to a peer's or their own performance. *European Journal of Psychology of Education*, *33*(1), 117–143. https://doi.org/10.1007/s10212-017-0344-y

Pettersson, F. (2021). Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technologies*, *26*(1), 187–204. https://doi.org/10.1007/s10639-020-10239-8

Platz, L., Jüttler, M., & Schumann, S. (2021). Game-Based Learning in Economics Education at Upper Secondary Level: The Impact of Game Mechanics and Reflection on Students' Financial Literacy. In C. Aprea & D. Ifenthaler (Eds.), *Game-based Learning Across the Disciplines. Advances in Game-Based Learning* (pp. 25–42). Springer. https://doi.org/10.1007/978-3-030-75142-5_2

Pleshakova, A. Y. (2019). Germany's dual education system: The assessment by its subjects. *The Education and Science Journal*, *21*(5), 130–156. https://doi.org/10.17853/1994-5639-2019-5-131-157

Praetorius, A.-K., Lauermann, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education*, *65*, 241–254. https://doi.org/10.1016/j.tate.2017.03.023

Qian, Y., & Lehman, J. D. (2019). Using Targeted Feedback to Address Common Student Misconceptions in Introductory Programming: A Data-Driven Approach. *SAGE Open*, *9*(4), 215824401988513. https://doi.org/10.1177/2158244019885136

Queiroga, E. M., Lopes, J. L., Kappel, K., Aguiar, M., Araújo, R. M., Munoz, R., Villarroel, R., & Cechinel, C. (2020). A Learning Analytics Approach to Identify Students at Risk of Dropout: A Case Study with a Technical Distance Education Course. *Applied Sciences*, *10*(11), 3998. https://doi.org/10.3390/app10113998

Raaheim, A., Mathiassen, K., Moen, V., Lona, I., Gynnild, V., Bunæs, B. R., & Hasle, E. T. (2019). Digital assessment – how does it challenge local practices and national law? A Norwegian case study. *European Journal of Higher Education*, *9*(2), 219–231.

https://doi.org/10.1080/21568235.2018.1541420
Rafail, P., & Freitas, I. (2020). Natural Language Processing. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *SAGE Research Methods Foundations*. SAGE Publications Ltd. https://doi.org/10.4135/9781526421036879118
Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The Importance of Cybersecurity Education in School. *International Journal of Information and Education Technology*, *10*(5), 378–382. https://doi.org/10.18178/ijiet.2020.10.5.1393
Ramani, S., Könings, K. D., Mann, K. V., Pisarski, E. E., & van der Vleuten, C. P. M. (2018). About Politeness, Face, and Feedback. *Academic Medicine*, *93*(9), 1348–1358. https://doi.org/10.1097/ACM.0000000000002193
Rasooli, A., Zandi, H., & DeLuca, C. (2018). Re-conceptualizing classroom assessment fairness: A systematic meta-ethnography of assessment literature and beyond. *Studies in Educational Evaluation*, *56*, 164–181. https://doi.org/10.1016/j.stueduc.2017.12.008
Rausch, A., Deutscher, V., Seifried, J., Brandt, S., & Winther, E. (2021). Die web-basierte Bürosimulation LUCA – Funktionen, Einsatzmöglichkeiten und Forschungsausblick. *Zeitschrift Für Berufsund Wirtschaftspädagogik*, *117*(3), 372. https://doi.org/10.25162/zbw-2021-0017
Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu* (Y. Punie (Ed.)). Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107466/pdf_digcomedu_a4_final.pdf
Rivera, A. C., Tapia-Leon, M., & Lujan-Mora, S. (2018). Recommendation Systems in Education: A Systematic Mapping Study. In Á. Rocha & T. Guarda (Eds.), *Proceedings of the International Conference on Information Technology & Systems (ICITS 2018)* (pp. 937–947). Springer International Publishing.
Rolff, H.-G. (2019). Wandel durch Schulentwicklung: Essays zu Bildungsreform und Schulpraxis. In *Wandel durch Schulentwicklung*. Beltz Verlagsgruppe.
Rolff, H.-G., & Thünken, U. (2020). Digital gestütztes Lernen: Praxisbeispiele für eine zeitgemäße Schulentwicklung. In *Digital gestütztes Lernen*. Beltz Verlagsgruppe.
Roll, M., & Ifenthaler, D. (2020). Lernort-übergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.
Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4
Romeu, T., Guitert, M., & Sangrà, A. (2016). Teacher collaboration network in Higher Education: reflective visions from praxis. *Innovations in Education and Teaching International*, *53*(6), 592–604. https://doi.org/10.1080/14703297.2015.1025807
Rubach, C., & Lazarides, R. (2021). Addressing 21st-century digital skills in schools – Development and validation of an instrument to measure teachers' basic ICT competence beliefs. *Computers in Human Behavior*, *118*, 106636. https://doi.org/10.1016/j.chb.2020.106636
Sampson, Y. (2019). *Effects of peer feedback and assessment on successive drafts of student narrative writing: the case for student assessor and assessee* [Memorial University of Newfoundland]. https://research.library.mun.ca/14365/1/thesis.pdf
Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher Digital Literacy: The Indisputable Challenge after COVID-19. *Sustainability*, *13*(4), 1858. https://doi.org/10.3390/su13041858
Santi;, S., Dumitru, P., Marc;, D., Gilleran, A., Alexa, J., & Vuorikari, R. (2009). European Schoolnet: Enabling School Networking. *European Journal of Education Research,*

Development and Policies ; the Official Journal of the European Institute of Education and Social Policy, *44*(4), 475.

Scantlebury, K., Gallo-Fox, J., & Wassell, B. (2008). Coteaching as a model for preservice secondary science teacher education. *Teaching and Teacher Education*, *24*(4), 967–981. https://doi.org/10.1016/j.tate.2007.10.008

Scheller, H. (2018). Educational Federalism in Germany. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries.* Information Age Publishing.

Schmid, M., Brianza, E., & Petko, D. (2021). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, *115*(September 2020), 106586. https://doi.org/10.1016/j.chb.2020.106586

Schmid, U., Blanc, B., Toepel, M., Pinkwart, N., & Drachsler, H. (2021). *KI@Bildung: Lehren und Lernen in der Schule mit Werkzeugen Künstlicher Intelligenz*. https://www.mmb-institut.de/wp-content/uploads/KI@Bildung_Schlussbericht.pdf

Schneider, R., Sachse, K. A., Schipolowski, S., & Enke, F. (2021). Teaching in Times of COVID-19: The Evaluation of Distance Teaching in Elementary and Secondary Schools in Germany. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.702406

Schulz-Zander, R., Büchter, A., & Dalmer, R. (2002). The role of ICT as a promoter of students' cooperation. *Journal of Computer Assisted Learning*, *18*(4), 438–448. https://doi.org/10.1046/j.0266-4909.2002.002.x

Schumacher, C. (2019). *Cognitive, metacognitive and motivational perspectives on learning analytics : Synthesizing self-regulated learning, assessment, and feedback with Learning Analytics* [University of Mannheim]. https://madoc.bib.uni-mannheim.de/53712/

Schumacher, C., & Ifenthaler, D. (2017). Features Students Really Expect from Learning Analytics. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.06.030

Scully, D., Lehane, P., & Scully, C. (2021). 'It is no longer scary': digital learning before and during the Covid-19 pandemic in Irish secondary schools. *Technology, Pedagogy and Education*, *30*(1), 159–181. https://doi.org/10.1080/1475939X.2020.1854844

Sedgewick, A., Souppaya, M. P., & Scarfone, K. A. (2015). *Guide to Application Whitelisting*. https://doi.org/10.6028/NIST.SP.800-167

Seifried, J., Brandt, S., Kögler, K., & Rausch, A. (2020). The computer-based assessment of domain-specific problem-solving competence—A three-step scoring procedure. *Cogent Education*, *7*(1), 1719571. https://doi.org/10.1080/2331186X.2020.1719571

Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, *54*(2), 273–286. https://doi.org/10.1111/ejed.12330

Shang, H.-F. (2019). An investigation of plagiarism software use and awareness training on English as a foreign language (EFL) students. *Journal of Computing in Higher Education*, *31*(1), 105–120. https://doi.org/10.1007/s12528-018-9193-1

Snelson, C. (2018). Video production in content-area pedagogy: a scoping study of the research literature. *Learning, Media and Technology*, *43*(3), 294–306. https://doi.org/10.1080/17439884.2018.1504788

Snijders, T. A. B., & Bosker, R. J. (2011). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. SAGE Publications.

Sokal, L., Trudel, L. E., & Babb, J. (2020). Canadian teachers' attitudes toward change, efficacy, and burnout during the COVID-19 pandemic. *International Journal of Educational Research Open*, *1*, 100016. https://doi.org/10.1016/j.ijedro.2020.100016

Spener, C., Häuber, G., Horlacher, T., & Schumann, S. (2019). Der berufsschulische Einsatz von ERP-Systemen in der Ausbildung von Industriekaufleuten. In K. Wilbers (Ed.),

Digitale Transformation kaufmännischer Bildung. Ausbildung in Industrie und Handel hinterfragt (Vol. 23, pp. 195–216). epubli GmbH.

Starkey, L., Shonfeld, M., Prestridge, S., & Cervera, M. G. (2021). Special issue: Covid-19 and the role of technology and pedagogy on school education during a pandemic. *Technology, Pedagogy and Education*, *30*(1), 1–5. https://doi.org/10.1080/1475939X.2021.1866838

statistik-bw. (2020). *Öffentliche berufliche Schulen: Rückgang der Schülerzahlen setzt sich fort*. Pressemitteilung 51/2020. https://www.statistik-bw.de/Presse/Pressemitteilungen/2020051

Straub, R., & Vilsmaier, U. (2020). Pathways to educational change revisited– controversies and advances in the German teacher education system. *Teaching and Teacher Education, 96*, 103140. https://doi.org/10.1016/j.tate.2020.103140

Swaffield, S., & MacBeath, J. (2005). School self-evaluation and the role of a critical friend. *Cambridge Journal of Education, 35*(2), 239–252. https://doi.org/10.1080/03057640500147037

Tondeur, J., Aesaert, K., Prestridge, S., & Consuegra, E. (2018). A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies. *Computers & Education, 122*, 32–42. https://doi.org/10.1016/j.compedu.2018.03.002

Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap! *Australasian Journal of Educational Technology, 33*(3). https://doi.org/10.14742/ajet.3504

Tovey, M., & Owen, J. (2000). Sketching and direct CAD modelling in automotive design. *Design Studies, 21*(6), 569–588. https://doi.org/10.1016/S0142-694X(99)00027-7

Valtonen, T., Hoang, N., Sointu, E., Näykki, P., Virtanen, A., Pöysä-Tarhonen, J., Häkkinen, P., Järvelä, S., Mäkitalo, K., & Kukkonen, J. (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective. *Computers in Human Behavior*, *116*. https://doi.org/10.1016/j.chb.2020.106643

Virdia, S., & Schindler, S. (2019). Educational upgrading, career advancement, and social inequality development from a life-course perspective in Germany. *Research in Social Stratification and Mobility*, *60*(2), 29–38. https://doi.org/10.1016/j.rssm.2019.02.002

Vitale, D. C., Armenakis, A. A., & Feild, H. S. (2008). Integrating Qualitative and Quantitative Methods for Organizational Diagnosis. *Journal of Mixed Methods Research*, *2*(1), 87–105. https://doi.org/10.1177/1558689807309968

Vuorikari, R., Punie, Y., Carretero, S., & Van Den Brande, L. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens* (pp. 1-). Publications Office of the European Union. https://doi.org/10.2791/11517

Wakefield, J., Frawley, J. K., Tyler, J., & Dyson, L. E. (2018). The impact of an iPad-supported annotation and sharing technology on university students' learning. *Computers & Education*, *122*, 243–259. https://doi.org/10.1016/j.compedu.2018.03.013

Wang, P. S. (2017). *From Computing to Computational Thinking*. Chapman and Hall/CRC. https://doi.org/10.1201/9781315115320

Watt, D. (2019). Video Production in Elementary Teacher Education as a Critical Digital Literacy Practice. *Media and Communication*, *7*(2), 82–99. https://doi.org/10.17645/mac.v7i2.1967

Weber, K. E., Gold, B., Prilop, C. N., & Kleinknecht, M. (2018). Promoting pre-service teachers' professional vision of classroom management during practical school training: Effects of a structured online- and video-based self-reflection and feedback intervention. *Teaching and Teacher Education, 76*, 39–49. https://doi.org/10.1016/j.tate.2018.08.008

Wells, C. L. (2017). Understanding issues of control in top-down management pedagogies. *Power and Education*, *9*(3), 192–201. https://doi.org/10.1177/1757743817737334

Wijaya, H., & Gruber, K. E. (2018). Ethics perspective and regulation of plagiarism in Higher

Education. *International Journal of Humanities and Innovation (IJHI)*, *1*(1), 17–25. https://doi.org/10.33750/ijhi.v1i1.4

Willis, R. L., Lynch, D., Fradale, P., & Yeigh, T. (2019). Influences on purposeful implementation of ICT into the classroom: An exploratory study of K-12 teachers. *Education and Information Technologies*, *24*(1), 63–77. https://doi.org/10.1007/s10639-018-9760-0

Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *366*(1881), 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Wong, K. K. (2018). *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries*. Information Age Publishing.

Yeh, Y.-F., Chan, K. K. H., & Hsu, Y.-S. (2021). Toward a framework that connects individual TPACK and collective TPACK: A systematic review of TPACK studies investigating teacher collaborative discourse in the learning by design process. *Computers & Education*, *171*, 104238. https://doi.org/10.1016/j.compedu.2021.104238

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Zawacki-Richter, O. (2021). The current state and impact of Covid-19 on digital higher education in Germany. *Human Behavior and Emerging Technologies*, *3*(1), 218–226. https://doi.org/10.1002/hbe2.238

Zhang, Y., & Teng, Z. (2021). *Natural Language Processing*. Cambridge University Press. https://doi.org/10.1017/9781108332873

Zylka, J. (2018). *Digitale Schulentwicklung: Das Praxisbuch für Schulleitung und Steuergruppen*. Beltz

Complete List of References

Abele, E., Chryssolouris, G., Sihn, W., Metternich, J., ElMaraghy, H., Seliger, G., Sivard, G., ElMaraghy, W., Hummel, V., Tisch, M., & Seifermann, S. (2017). Learning factories for future oriented research and education in manufacturing. *CIRP Annals*, *66*(2), 803–826. https://doi.org/10.1016/j.cirp.2017.05.005

Adamowicz, M., & Pyra, M. (2019). Computer Simulation as an Innovative Didactic Method. *International Journal of Innovation in Management*, *7*(2), 101–108.

Adams, W. C. (2015). Conducting Semi-Structured Interviews. In *Handbook of Practical Program Evaluation* (pp. 492–505). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119171386.ch19

Adolfsson, C.-H., & Håkansson, J. (2019). Evaluating teacher and school development by learning capital: A conceptual contribution to a fundamental problem. *Improving Schools*, *22*(2), 130–143. https://doi.org/10.1177/1365480218784039

Aguado, T., Ballesteros, B., & Malik, B. (2003). Cultural Diversity and School Equity. A Model to Evaluate and Develop Educational Practices in Multicultural Education Contexts. *Equity & Excellence in Education*, *36*(1), 50–63. https://doi.org/10.1080/10665680303500

Aguilar, S. J., Galperin, H., Noguera, P. A., Arkatov, A., Baek, C., & Gonzalez, E. (2020). *When school comes home: How low-income families are adapting to distance learning*. EdArXiv. https://doi.org/https://doi.org/10.35542/osf.io/su8wk

Alinsunurin, J. (2020). School learning climate in the lens of parental involvement and school leadership: lessons for inclusiveness among public schools. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-020-00139-2

Almarri, K., & Boussabaine, H. (2017). The Influence of Critical Success Factors on Value for Money Viability Analysis in Public–Private Partnership Projects. *Project Management Journal*, *48*(4), 93–106. https://doi.org/10.1177/875697281704800408

Almerino, P. M., Ocampo, L. A., Abellana, D. P. M., Almerino, J. G. F., Mamites, I. O., Pinili, L. C., Tenerife, J. J. L., Sitoy, R. E., Abelgas, L. J., & Peteros, E. D. (2020). Evaluating the Academic Performance of K-12 Students in the Philippines: A Standardized Evaluation Approach. *Education Research International*, *2020*, 1–8. https://doi.org/10.1155/2020/8877712

Alsdorf, V., Böhnhardt, L., & Jäger, U. (2020). Die neue Berufsbildposition 5 in den industriellen Metall- und Elektroberufen – ein Umsetzungsansatz aus der Ausbildungspraxis. In D. Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 119–138). wbv Media GmbH & Co. KG.

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203–220. https://doi.org/10.1080/21532974.2019.1646169

Andersen, K., & Strömbäck, J. (2021). Media Platforms and Political Learning: The Democratic Challenge of News Consumption on Computers and Mobile Devices. *International Journal of Communication*, *15*.

Anderson, G., Boud, D., & Sampson, J. (2014). *Learning Contracts*. Routledge. https://doi.org/10.4324/9781315041766

Angell, K., & Tewell, E. (2017). Teaching and Un-Teaching Source Evaluation: Questioning Authority in Information Literacy Instruction. *Comminfolit*, *11*(1), 95. https://doi.org/10.15760/comminfolit.2017.11.1.37

Antony, M. K., Paidi, Subali, B., Pradana, S. P., Hapsari, N., & Astuti, F. E. C. (2019). Teacher's TPACK Profile: The Affect of Teacher Qualification and Teaching

Experience. *Journal of Physics: Conference Series*, *1397*(1), 12054. https://doi.org/10.1088/1742-6596/1397/1/012054

Aprea, C., Sappa, V., & Tenberg, R. (2020). *Konnektivität und lernortintegrierte Kompetenzentwicklung in der beruflichen Bildung / Connectivity and Integrative Competence Development in Vocational and Professional Education and Training (VET/PET)*. Franz Steiner Verlag.

Ardid, M., Gómez-Tejedor, J. A., Meseguer-Dueñas, J. M., Riera, J., & Vidaurre, A. (2015). Online exams for blended assessment. Study of different application methodologies. *Computers & Education*, *81*(2), 296–303. https://doi.org/10.1016/j.compedu.2014.10.010

Arends, H. (2017). Equal Living Conditions vs. Cultural Sovereignty? Federalism Reform, Educational Poverty and Spatial Inequalities in Germany. *Publius: The Journal of Federalism*, *47*(4), 673–706. https://doi.org/10.1093/publius/pjw042

Attwell, G., Bekiaridis, G., Deitmer, L., Perini, M., Roppertz, S., & Tutlys, V. (2020). *Artificial Intelligence in Policies, Processes and Practices of Vocational Education and Training*. Universität Bremen. https://media.suub.uni-bremen.de/bitstream/elib/4510/4/fb_71.pdf

Baier, F., Decker, A., Voss, T., Kleickmann, T., Klusmann, U., & Kunter, M. (2019). What makes a good teacher? The relative importance of mathematics teachers' cognitive ability, personality, knowledge, beliefs, and motivation for instructional quality. *British Journal of Educational Psychology*, *89*(4), 767–786. https://doi.org/10.1111/bjep.12256

Baker, R., & Siemens, G. (2015). Educational Data Mining and Learning Analytics. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 253–272). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.016

Balkin, J. M. (2003). Digital Speech and Democratic Culture: A Theory of Freedom of Expression for the Information Society. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.470842

Balsmeier, B., & Woerter, M. (2019). Is this time different? How digitalization influences job creation and destruction. *Research Policy*, *48*(8), 103765. https://doi.org/10.1016/j.respol.2019.03.010

Balzer, L., & Schorn, I. (2021). *Check-up Distance Learning für die Sekundarstufe II. Beitrag präsentiert im Webinar "Erfolgreiche digitale Transformation an unseren Berufsfachschulen" der Schweizerischen Direktorinnen- und Direktorenkonferenz der Berufsfachschulen (SDK) und der Schweize*.

Barblett, L., & Kirk, G. (2018). National Quality Standard in Schools: Leadership Enabling Power and Agency. *Australasian Journal of Early Childhood*, *43*(3), 43–51. https://doi.org/10.23965/AJEC.43.3.05

Barker, H., & Hamlett, J. (2010). Living above the Shop: Home, Business, and Family in the English '"Industrial Revolution."' *Journal of Family History*, *35*(4), 311–328. https://doi.org/10.1177/0363199010373544

Barnes, J., & Kennewell, S. (2017). Investigating teacher perceptions of teaching ICT in Wales. *Education and Information Technologies*, *22*(5), 2485–2497. https://doi.org/10.1007/s10639-016-9549-y

Barnová, S., Krásna, S., & Čepelová, S. (2020). Digital Technologies as a Means of Teachers' Professional Development. *Online Journal for Reseach Adn Education*, *18*. https://journal.ph-noe.ac.at/index.php/resource/article/view/838/796

Basu Ray, J., & Maitra, S. (2017). Collaborative Interdisciplinary Teaching and Learning Across Borders, Using Mobile Technologies and Smart Devices. *2017 5th IEEE International Conference on MOOCs, Innovation and Technology in Education (MITE)*, 77–82. https://doi.org/10.1109/MITE.2017.00020

Bateman, J., & Schmidt-Borcherding, F. (2018). The Communicative Effectiveness of

Education Videos: Towards an Empirically-Motivated Multimodal Account. *Multimodal Technologies and Interaction*, *2*(3), 59. https://doi.org/10.3390/mti2030059

Batzel, G., & Börgmann, S. (2017). *Berufsbildungsbegriffe Deutsch-Englisch : Terminologiesammlung für Berufsbildungsfachleut*. Bundesinstitut für Berufsbildung.

Bell, D. (1975). *The Coming of post-industrial society : a venture in social forecasting* (5.). Heinemann Educational Publisher.

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-Service Teachers' Perceptions of School Development. In *Competencies in Teaching, Learning and Educational Leadership in the Digital Age* (pp. 57–76). Springer International Publishing. https://doi.org/10.1007/978-3-319-30295-9_5

Bennett, S., Maton, K., & Kervin, L. (2008). The 'Digital Natives' Debate: A Critical Review of the Evidence. *British Journal of Educational Technology*, *39*. https://doi.org/10.1111/j.1467-8535.2007.00793.x

Benoit, K., Watanabe, K., & Muhr, D. (2021). *stopwords - Multilingual Stopword Lists in R*. https://github.com/quanteda/stopwords

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., & Matsuo, A. (2018). quanteda: An R package for the quantitative analysis of textual data. *Journal of Open Source Software*, *3*(30), 774. https://doi.org/10.21105/joss.00774

Berisha-Gawlowski, A., Caruso, C., Goller, G., & Harteis, C. (2020). Auswirkungen der Digitalisierung industrieller Arbeit auf die berufliche und allgemeine Bildung. In Dietmar Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56). wbv Media GmbH & Co. KG.

Beycioglu, K., & Kondakci, Y. (2020). Organizational Change in Schools. *ECNU Review of Education*, 209653112093217. https://doi.org/10.1177/2096531120932177

BIBB. (2020). *Datenreport zum Berufsbildungsbericht 2020. Informationen und Analysen zur Entwicklung der beruflichen Bildung*. Bundesinstitut für Berufsbildung. https://www.bibb.de/dokumente/pdf/bibb_datenreport_2020.pdf

BIBB. (2021). *Verzeichniss der anerkannten Ausbildungsberufe 2021*. https://www.bibb.de/dienst/veroeffentlichungen/de/publication/download/17368

Biggs, J., & Tang, C. (2011). *Teaching For Quality Learning At University*. McGraw-Hill Education.

Billett, S. (2020). Developing a Skillful and Adaptable Workforce: In E. Wuttke, J. Seifried, & H. M. Niegemann (Eds.), *Vocational Education and Training in the Age of Digitization* (pp. 251–272). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.15

Blatchford, P., Bassett, P., & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher–pupil interaction: Differences in relation to pupil prior attainment and primary vs. secondary schools. *Learning and Instruction*, *21*(6), 715–730. https://doi.org/10.1016/j.learninstruc.2011.04.001

Bleiberg, J. (2021). Does the Common Core Have a Common Effect? An Exploration of Effects on Academically Vulnerable Students. *AERA Open*, *7*, 233285842110107. https://doi.org/10.1177/23328584211010727

Blok, H., Sleegers, P., & Karsten, S. (2008). Looking for a balance between internal and external evaluation of school quality: evaluation of the SVI model. *Journal of Education Policy*, *23*(4), 379–395. https://doi.org/10.1080/02680930801923773

BMBF. (2015). *Datenreport zum Berufsbildungsbericht 2015. Informationen und Analysen zur Entwicklung der beruflichen Bildung*. Bundesinstitut für Berufsbildung. http://datenreport.bibb.de/media2012/BIBB_Datenreport_2012.pdf

Boekaerts, M., & Corno, L. (2005). Self-Regulation in the Classroom: A Perspective on Assessment and Intervention. *Applied Psychology*, *54*(2), 199–231.

https://doi.org/10.1111/j.1464-0597.2005.00205.x
Böhm-Kasper, O., Dizinger, V., & Gausling, P. (2016). Multiprofessional Collaboration Between Teachers and Other Educational Staff at German All-day Schools as a Characteristic of Today's Professionalism. *International Journal for Research on Extended Education*, *4*(1), 29–51. https://doi.org/10.3224/ijree.v4i1.24774
Bol, T. (2020). *Inequality in homeschooling during the Corona crisis in the Netherlands. First results from the LISS Panel.* SocArXiv. https://doi.org/10.31235/osf.io/hf32q
Borba, M. C., Chiari, A. S. de S., & de Almeida, H. R. F. L. (2018). Interactions in virtual learning environments: new roles for digital technology. *Educational Studies in Mathematics*, *98*(3), 269–286. https://doi.org/10.1007/s10649-018-9812-9
Borman, G. D., Hewes, G. M., Overman, L. T., & Brown, S. (2003). Comprehensive School Reform and Achievement: A Meta-Analysis. *Review of Educational Research*, *73*(2), 125–230. https://doi.org/10.3102/00346543073002125
Bottino, R. (2020). Schools and the digital challenge: Evolution and perspectives. *Education and Information Technologies*, *25*(3), 2241–2259. https://doi.org/10.1007/s10639-019-10061-x
Boyle, P., & Bowden, J. A. (1997). Educational Quality Assurance in Universities: an enhanced model. *Assessment & Evaluation in Higher Education*, *22*(2), 111–121. https://doi.org/10.1080/0260293970220202
Brandon, J., Hollweck, T., Donlevy, J. K., & Whalen, C. (2018). Teacher supervision and evaluation challenges: Canadian perspectives on overall instructional leadership. *Teachers and Teaching*, *24*(3), 263–280. https://doi.org/10.1080/13540602.2018.1425678
Brečka, P., Valentová, M., & Lančarič, D. (2022). The implementation of critical thinking development strategies into technology education: The evidence from Slovakia. *Teaching and Teacher Education*, *109*, 103555. https://doi.org/10.1016/j.tate.2021.103555
Brewer, D. J., Krop, C., Gill, B. P., & Reichardt, R. (1999). Estimating the Cost of National Class Size Reductions Under Different Policy Alternatives. *Educational Evaluation and Policy Analysis*, *21*(2), 179–192. https://doi.org/10.3102/01623737021002179
Brookhart, S. M. (2017). *How to Give Effective Feedback to Your Students* (2nd ed.). ASCD.
Brookhart, S. M. (2018). Appropriate Criteria: Key to Effective Rubrics. *Frontiers in Education*, *3*. https://doi.org/10.3389/feduc.2018.00022
Bryk, A. S. (2010). Organizing Schools for Improvement. *Phi Delta Kappan*, *91*(7), 23–30. https://doi.org/10.1177/003172171009100705
Brzinsky-Fay, C., & Solga, H. (2016). Compressed, postponed, or disadvantaged? School-to-work-transition patterns and early occupational attainment in West Germany. *Research in Social Stratification and Mobility*, *46*, 21–36. https://doi.org/10.1016/j.rssm.2016.01.004
Bueno-Alastuey, M. C., Villarreal, I., & García Esteban, S. (2018). Can telecollaboration contribute to the TPACK development of pre-service teachers? *Technology, Pedagogy and Education*, *27*(3), 367–380. https://doi.org/10.1080/1475939X.2018.1471000
Buentello-Montoya, D. A., Lomelí-Plascencia, M. G., & Medina-Herrera, L. M. (2021). The role of reality enhancing technologies in teaching and learning of mathematics. *Computers & Electrical Engineering*, *94*, 107287. https://doi.org/10.1016/j.compeleceng.2021.107287
Buhren, C. G., & Rolff, H.-G. (2011). *Personalmanagement für die Schule: ein Handbuch für Schulleitung und Kollegium*. Beltz.
Bulman, G., & Fairlie, R. W. (2016). Chapter 5 - Technology and Education: Computers, Software, and the Internet. In E. A. Hanushek, S. Machin, & L. Woessmann (Eds.), *Handbook of the Economics of Education* (Vol. 5, pp. 239–280). Elsevier.

https://doi.org/https://doi.org/10.1016/B978-0-444-63459-7.00005-1
Butler-Henderson, K., & Crawford, J. (2020). A systematic review of online examinations: A pedagogical innovation for scalable authentication and integrity. *Computers and Education*, *159*(17), 104024. https://doi.org/10.1016/j.compedu.2020.104024
Butter, M. C., Pérez, L. J., & Quintana, M. G. B. (2014). School networks to promote ICT competences among teachers. Case study in intercultural schools. *Computers in Human Behavior*, *30*, 442–451. https://doi.org/10.1016/j.chb.2013.06.024
Cáceres, M., Nussbaum, M., & Ortiz, J. (2020). Integrating critical thinking into the classroom: A teacher's perspective. *Thinking Skills and Creativity*, *37*, 100674. https://doi.org/10.1016/j.tsc.2020.100674
Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345
Çakır, M. P., Acartürk, C., Alaşehir, O., & Çilingir, C. (2015). A comparative analysis of global and national university ranking systems. *Scientometrics*, *103*(3), 813–848. https://doi.org/10.1007/s11192-015-1586-6
Calderón Gómez, D. (2021). The third digital divide and Bourdieu: Bidirectional conversion of economic, cultural, and social capital to (and from) digital capital among young people in Madrid. *New Media & Society*, *23*(9), 2534–2553. https://doi.org/10.1177/1461444820933252
Cameron, A. F., & Webster, J. (2005). Unintended consequences of emerging communication technologies: Instant Messaging in the workplace. *Computers in Human Behavior*, *21*(1), 85–103. https://doi.org/10.1016/j.chb.2003.12.001
Caputo, A., & Rastelli, V. (2014). School improvement plans and student achievement: Preliminary evidence from the Quality and Merit Project in Italy. *Improving Schools*, *17*(1), 72–98. https://doi.org/10.1177/1365480213515800
Cardoso, P., & Sales, C. M. D. (2019). Individualized Career Counseling Outcome Assessment: A Case Study Using the Personal Questionnaire. *The Career Development Quarterly*, *67*(1), 21–31. https://doi.org/10.1002/cdq.12160
Carmichael, M., Reid, A.-K., & Karpicke, J. D. (2018). *Assessing the Impact of Educational Video on Student Engagement, Critical Thinking and Learning: The Current State of Play*. SAGE Publications. www.sagepublishing.com
Carrington, S., & Robinson, R. (2004). A case study of inclusive school development: a journey of learning. *International Journal of Inclusive Education*, *8*(2), 141–153. https://doi.org/10.1080/1360311032000158024
Castaño-Muñoz, J., Kalz, M., Kreijns, K., & Punie, Y. (2018). Who is taking MOOCs for teachers' professional development on the use of ICT? A cross-sectional study from Spain. *Technology, Pedagogy and Education*, *27*(5), 607–624. https://doi.org/10.1080/1475939X.2018.1528997
Castaño Muñoz, J., Vuorikari, R., Costa, P., Hippe, R., & Kampylis, P. (2021). Teacher collaboration and students' digital competence - evidence from the SELFIE tool. *European Journal of Teacher Education*, 1–22. https://doi.org/10.1080/02619768.2021.1938535
Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, *24*(4), 2523–2546. https://doi.org/10.1007/s10639-019-09886-3
Chan, H. K., Griffin, J., Lim, J. J., Zeng, F., & Chiu, A. S. F. (2018). The impact of 3D Printing Technology on the supply chain: Manufacturing and legal perspectives. *International Journal of Production Economics*, *205*, 156–162. https://doi.org/10.1016/j.ijpe.2018.09.009

Chan, J. K.-S. (2010). Teachers' responses to curriculum policy implementation: colonial constraints for curriculum reform. *Educational Research for Policy and Practice*, *9*(2), 93–106. https://doi.org/10.1007/s10671-010-9082-5

Chekanushkina, E. N., Timoshchuk, N. A., Kolyvanova, L. A., & Fakhrutdinova, E. V. (2021). *Social and Environmental Competence as a Component of University Graduate's Competitiveness BT - Engineering Economics: Decisions and Solutions from Eurasian Perspective* (S. I. Ashmarina, V. V. Mantulenko, & M. Vochozka (Eds.); pp. 676–681). Springer International Publishing.

Chen, C.-M. (2009). Personalized E-learning system with self-regulated learning assisted mechanisms for promoting learning performance. *Expert Systems with Applications*, *36*(5), 8816–8829. https://doi.org/10.1016/j.eswa.2008.11.026

Chen, C. W. (2018). Developing EFL students' digital empathy through video production. *System*, *77*, 50–57. https://doi.org/10.1016/j.system.2018.01.006

Chen, L.-T., Liu, L., & Tretheway, P. (2021). Using Multilayer Videos for Remote Learning: Videos of Session Guidance, Content Instruction, and Activity. *Computers in the Schools*, 1–32. https://doi.org/10.1080/07380569.2021.1989220

Cherner, T., Dix, J., & Lee, C. (2014). Cleaning Up That Mess: A Framework for Classifying Educational Apps. *Contemporary Issues in Technology and Teacher Education*, *14*(2), 158–193.

Chua, C. S. K., & Chai, C. S. (2019). Information Communication Technology. In B. Wong, S. Hairon, & P. T. Ng (Eds.), *School Leadership and Educational Change in Singapore* (pp. 149–168). Springer International Publishing. https://doi.org/10.1007/978-3-319-74746-0_9

Church, C. H. (1988). The qualities of validation. *Studies in Higher Education*, *13*(1), 27–43. https://doi.org/10.1080/03075078812331377945

Cidral, W. A., Oliveira, T., Di Felice, M., & Aparicio, M. (2018). E-learning success determinants: Brazilian empirical study. *Computers & Education*, *122*, 273–290. https://doi.org/10.1016/j.compedu.2017.12.001

Clayson, D. E., & Haley, D. A. (2011). Are Students Telling Us the Truth? A Critical Look at the Student Evaluation of Teaching. *Marketing Education Review*, *21*(2), 101–112. https://doi.org/10.2753/MER1052-8008210201

Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: a critical review of the literature. *Learning Environments Research*, *17*(1), 1–28. https://doi.org/10.1007/s10984-013-9149-3

Cohen-Scali, V., Rossier, J., & Nota, L. (Eds.). (2018). *New perspectives on career counseling and guidance in Europe*. Springer International Publishing. https://doi.org/10.1007/978-3-319-61476-2

Colby, J., & Witt, M. (2000). *Defining Quality in Education*. UNICEF. https://www.right-to-education.org/sites/right-to-education.org/files/resource-attachments/UNICEF_Defining_Quality_Education_2000.PDF

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: the digital revolution and schooling in America* (2nd ed.). Teachers College Press.

Conrad, M., & Schumann, S. (2021). Emotionales Erleben beim Lernen mit Tablet-PCs im Wirtschaftsunterricht: Berufsbildung. Zeitschrift für Theorie-Praxis-Dialog. *Berufsbildung. Zeitschrift Für Theorie-Praxis-Dialog*, *75*(187), 13–15.

Cornelissen, F., McLellan, R. W., & Schofield, J. (2017). Fostering research engagement in partnership schools: networking and value creation. *Oxford Review of Education*, *43*(6), 695–717. https://doi.org/10.1080/03054985.2017.1316251

Cortina, K. S., & Thames, M. H. (2013). Teacher Education in Germany. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers:*

Results from the COACTIV Project (pp. 49–62). Springer US. https://doi.org/10.1007/978-1-4614-5149-5_3

Creemers, B., Kyriakides, L., & Antoniou, P. (2013). Establishing the Field of Teacher Effectiveness Research: Moving from Investigating Personal Characteristics of Teachers to Understanding Effective Teaching Practices. In *Teacher Professional Development for Improving Quality of Teaching* (pp. 65–79). Springer Netherlands. https://doi.org/10.1007/978-94-007-5207-8_5

Crissien-Borrero, T.-J., Velásquez-Rodriguez, J., Neira-Rodado, D., & Turizo-Martínez, L.-G. (2020). Measuring the quality of management in education. Review article. *El Profesional de La Información, 28*(6). https://doi.org/10.3145/epi.2019.nov.04

Croft, M., & Beard, J. J. (2021). Development and Evolution of the SAT and ACT. In B. E. Clauser & M. B. Bunch (Eds.), *The History of Educational Measurement* (1st ed., p. 20). Routledge. https://doi.org/https://doi.org/10.4324/9780367815318

Cropley, A. J., & Dave, R. H. (2014). *Lifelong Education and the Training of Teachers: Developing a Curriculum for Teacher Education on the Basis of the Principles of Lifelong Education*. Elsevier Science.

Cummings, S., Bridgman, T., & Brown, K. G. (2016). Unfreezing change as three steps: Rethinking Kurt Lewin's legacy for change management. *Human Relations, 69*(1), 33–60. https://doi.org/10.1177/0018726715577707

Dadds, M. (2020). *Passionate Enquiry and School Development*. Routledge. https://doi.org/10.4324/9781003059073

Dahdouh, K., Oughdir, L., Dakkak, A., & Ibriz, A. (2018). Smart Courses Recommender System for Online Learning Platform. *2018 IEEE 5th International Congress on Information Science and Technology (CiSt)*, 328–333. https://doi.org/10.1109/CIST.2018.8596516

Damşa, C., Langford, M., Uehara, D., & Scherer, R. (2021). Teachers' agency and online education in times of crisis. *Computers in Human Behavior, 121*, 106793. https://doi.org/10.1016/j.chb.2021.106793

Darling-Hammond, L., Hyler, M. E., & Gardener, M. (2017). *Effective Teacher Professional Development*.

DataReportal. (2021). *Digital 2021 Global Digital Overview*. https://datareportal.com/reports/digital-2021-global-digital-overview

Day, C. (2002). *Developing Teachers*. Routledge. https://doi.org/10.4324/9780203021316

De Paola, M., Ponzo, M., & Scoppa, V. (2013). Class size effects on student achievement: heterogeneity across abilities and fields. *Education Economics, 21*(2), 135–153. https://doi.org/10.1080/09645292.2010.511811

De Smet, C., Bourgonjon, J., De Wever, B., Schellens, T., & Valcke, M. (2012). Researching instructional use and the technology acceptation of learning management systems by secondary school teachers. *Computers & Education*, *58*(2), 688–696. https://doi.org/10.1016/j.compedu.2011.09.013

Deissinger, T. (2015). The German dual vocational education and training system as 'good practice'? *Local Economy: The Journal of the Local Economy Policy Unit*, *30*(5), 557–567. https://doi.org/10.1177/0269094215589311

Delcker, J., Honal, A., & Ifenthaler, D. (2016). Mobile device usage in higher education. *Proceedings of the 13th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2016*.

Delcker, J., & Ifenthaler, D. (n.d.). Distance learning and the influence of schools' organizational characteristics on the students perceived learning success. In V. Dennen, C. Dickson-Deane, X. Ge, D. Ifenthaler, S. Murthy, & J. C. Richardson (Eds.), *Global perspectives on educational innovations for emergency situations*. Springer.

Delcker, J., & Ifenthaler, D. (2020). Teachers' perspective on school development at German

vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and Education*, 1–15. https://doi.org/10.1080/1475939X.2020.1857826

Delgado, A., Wardlow, L., O'malley, K. J., & Mcknight, K. M. (2015). *Educational Technology: A Review of the Integration, Resources, and Effectiveness of Technology in K-12 Classrooms.*

Delgado, J. M. P. Q. (2016). Indoor Environmental Quality of School Buildings. *Defect and Diffusion Forum*, *369*, 24–29. https://doi.org/10.4028/www.scientific.net/DDF.369.24

Deschênes, M. (2020). Recommender systems to support learners' Agency in a Learning Context: a systematic review. *International Journal of Educational Technology in Higher Education*, *17*(1), 50. https://doi.org/10.1186/s41239-020-00219-w

Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences*, *116*(39), 19251–19257. https://doi.org/10.1073/pnas.1821936116

Dexter, S. (2008). Leadership for IT in Schools. In *International Handbook of Information Technology in Primary and Secondary Education* (pp. 543–554). Springer US. https://doi.org/10.1007/978-0-387-73315-9_32

Dib, C. Z. (1988). Formal, non-formal and informal education: concepts/applicability. *AIP Conference Proceedings*, *173*, 300–315. https://doi.org/10.1063/1.37526

Ditton, H., & Müller, A. (2011). Schulqualität. In H. Reinders, H. Ditton, C. Gräsel, & B. Gniewosz (Eds.), *Empirische Bildungsforschung: Gegenstandsbereiche* (pp. 99–111). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93021-3_9

Dole, S., Bloom, L., & Kowalske, K. (2015). Transforming Pedagogy: Changing Perspectives from Teacher-Centered to Learner-Centered. *Interdisciplinary Journal of Problem-Based Learning*, *10*(1). https://doi.org/10.7771/1541-5015.1538

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, *57*(2), 1469–1483. https://doi.org/10.1016/j.compedu.2011.02.014

Drachsler, H., & Kirschner, P. A. (2012). Learner Characteristics. In *Encyclopedia of the Sciences of Learning* (pp. 1743–1745). Springer US. https://doi.org/10.1007/978-1-4419-1428-6_347

Drago-Severson, E., & Blum-DeStefano, J. (2018). Building a developmental culture of feedback. *Journal of Professional Capital and Community*, *3*(2), 62–78. https://doi.org/10.1108/JPCC-06-2017-0016

Drossel, K., & Eickelmann, B. (2017). Teachers' participation in professional development concerning the implementation of new technologies in class: a latent class analysis of teachers and the relationship with the use of computers, ICT self-efficacy and emphasis on teaching ICT skills. *Large-Scale Assessments in Education*, *5*(1), 19. https://doi.org/10.1186/s40536-017-0053-7

Du, X., Yang, J., Shelton, B. E., Hung, J.-L., & Zhang, M. (2019). A systematic meta-Review and analysis of learning analytics research. *Behaviour & Information Technology*, *40*(1), 49–62. https://doi.org/10.1080/0144929X.2019.1669712

DuFour, R., & Mattos, M. (2013). How do principals really improve schools? *Educational Leadership*, *70*, 34–40.

Dürscheid, C., & Elspaß, S. (2018). Variantengrammatik des Standarddeutschen. In *Regionale Variation des Deutschen*. DE GRUYTER. https://doi.org/10.1515/9783110363449-024

Duvekot, R. (2015). *Netherlands country report - How informal and non-formal learning is recognised in Europe: Bertelsmann Stiftung*. https://www.bertelsmann-stiftung.de/en/publications/publication/did/how-informal-and-non-formal-learning-is-recognised-in-europe-3

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, *15*(1), 3. https://doi.org/10.1186/s41239-017-0087-5

Ebil, S. H., Salleh, S. M., & Shahrill, M. (2020). The use of E-portfolio for self-reflection to promote learning: a case of TVET students. *Education and Information Technologies*, *25*(6), 5797–5814. https://doi.org/10.1007/s10639-020-10248-7

Edgerly, H., Wilcox, J., & Easter, J. (2018). Creating a Positive Feedback Culture: Eight Practical Principles to Improve Students' Learning. *Science Scope*, *041*(05). https://doi.org/10.2505/4/ss18_041_05_43

Egloffstein, M. (2018). Massive Open Online Courses in Digital Workplace Learning. In D. Ifenthaler (Ed.), *Digital Workplace Learning* (pp. 149–166). Springer International Publishing. https://doi.org/10.1007/978-3-319-46215-8_9

Eickelmann, B., Drossel, K., & Heldt, M. (2020). Vorteile digital fortgeschrittener Schulen in der Pandemie-Zeit. Ergebnisse einer repräsentativen Lehrkräftebefragung. *Schulmanagement. Fachzeitschrift Für Schul- Und Unterrichtsentwicklung*, *51*(3), 28–31.

Eickelmann, B., & Gerick, J. (2018). Herausforderungen und Zielsetzungen im Kontext der Digitalisierung von Schule und Unterricht (II). Fünf Dimensionen der Schulentwicklung zur erfolgreichen Integration digitaler Medien. *Schulverwaltung. Nordrhein-Westfalen*, *29*(4), 111–115.

Ellis, A. K. (2004). *Exemplars of Curriculum Theory*. Routledge.

Erdener, M. A., & Knoeppel, R. C. (2018). Parents' Perceptions of Their Involvement in Schooling. *International Journal of Research in Education and Science*, 1–13. https://doi.org/10.21890/ijres.369197

ET2020 Working Group on Schools. (2018). *Quality assurance for school development - Guiding principles for policy development on quality assurance in school education*. European Commision. https://www.schooleducationgateway.eu/downloads/Governance/2018-wgs2-quality-assurance-school_en.pdf

Euler, D. (2013). *Germany´s dual vocational training system - a model for other countries?* Bertelsmann Stiftung. https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Bibliothek/Doi_Publikationen/GP_Germanys_dual_vocational_training_system.pdf

Euler, D., & Wilbers, K. (2018). Berufsbildung in digitalen Lernumgebungen. In R. Arnold, A. Lipsmeier, & M. Rohs (Eds.), *Handbuch Berufsbildung* (pp. 1–13). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-19372-0_34-1

European Commission. (2019). *2nd survey of schools: ICT in education. Objective 1: Benchmarking progress in ICT in schools*. European Commission. https://doi.org/10.2759/23401

Ewing, L.-A., & Cooper, H. B. (2021). Technology-enabled remote learning during Covid-19: perspectives of Australian teachers, students and parents. *Technology, Pedagogy and Education*, *30*(1), 41–57. https://doi.org/10.1080/1475939X.2020.1868562

Falck, O., Mang, C., & Woessmann, L. (2018). Virtually No Effect? Different Uses of Classroom Computers and their Effect on Student Achievement. *Oxford Bulletin of Economics and Statistics*, *80*(1), 1–38. https://doi.org/10.1111/obes.12192

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Faßhauer, U., Windelband, L., Mutzke, B., & Harm, S. (2021). Lernfabriken an beruflichen Schulen als Gegenstand fachdidaktischer Professionalisierung – Entwicklung von

standortübergreifenden Medienpaketen im beruflichen Lehramtsstudium. *Berufs- Und Wirtschaftspädagogik Online*, *40*. https://www.bwpat.de/ausgabe40/fasshauer_etal_bwpat40.pdf

Feinerer, I., Hornik, K., & Meyer, D. (2008). Text Mining Infrastructure in R. *Journal of Statistical Software*, *25*(5). https://doi.org/10.18637/jss.v025.i05

Fennes, H., & Otten, H. (2008). *Quality in non-formal education and training in the field of European youth work.*

Fletcher, A. (2019). An Invited Outsider or an Enriched Insider? Challenging Contextual Knowledge as a Critical Friend Researcher. In *Educational Researchers and the Regional University* (pp. 75–92). Springer Singapore. https://doi.org/10.1007/978-981-13-6378-8_5

Forkel, I., Seidenberg, P., & Pabst, R. (2018). *5G National Roaming*. P3 communications.

forsa. (2019). *Die Schule aus Sicht der Schulleiterinnen und Schulleiter – Digitalisierung und digitale Ausstattung Ergebnisse einer bundesweiten Repräsentativbefragung*. forsa Politik- und Sozialforschung GmbH.

Fox, C., & Jones, R. (2019). *State K-12 Broadband Leadership 2019: Driving Connectivity, Access and Student Success*. https://files.eric.ed.gov/fulltext/ED594505.pdf

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020). Preparing for Life in a Digital World. In *Preparing for Life in a Digital World*. Springer International Publishing. https://doi.org/10.1007/978-3-030-38781-5

Francom, G. M. (2020). Barriers to technology integration: A time-series survey study. *Journal of Research on Technology in Education*, *52*(1), 1–16. https://doi.org/10.1080/15391523.2019.1679055

Frank, T. E., & Scharff, L. F. V. (2013). Learning Contracts in Undergraduate Courses: Impacts on Student Behaviors and Academic Performance. *Journal of the Scholarship of Teaching and Learning*, *13*, 36–53.

Freiling, T., & Mozer, P. (2020). Digitale Lernformen unterstützen die Lernortkooperation in der beruflichen Bildung! In Dietmar Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf: Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (pp. 139–152). wbv Media GmbH & Co. KG.

Freundl, V., Lergetporer, P., & Zierow, L. (2021). Germany's education policy during the COVID-19 crisis. *Zeitschrift Für Politikwissenschaft*, *31*(1), 109–116. https://doi.org/10.1007/s41358-021-00262-7

Fries, J., Göbel, C., & Maier, M. F. (2013). *Do Employment Subsidies Reduce Early Apprenticeship Dropout?* Zentrum für Europäische Wirtschaftsforschung GmbH. https://ftp.zew.de/pub/zew-docs/dp/dp13053.pdf

Fu, Y. C., Quetzal, A. S., & Teo, E. J. (2021). The Development of Institutional Research and Its Implications for University Governance in Taiwan. In A. Y.-C. Hou, T. Chiang, & S.-J. Chan (Eds.), *Higher Education in Taiwan: Global, Political and Social Challenges and Future Trends* (pp. 233–248). Springer Singapore. https://doi.org/10.1007/978-981-15-4554-2_13

Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of Instructional Design*. Thomson/Wadsworth.

Ganz, W., Dworschak, B., & Schnalzer, K. (2019). Competences and Competence Development in a Digitalized World of Work. In I. Nunes (Ed.), *Advances in Human Factors and Systems Interaction. AHFE 2018. Advances in Intelligent Systems and Computing* (Vol. 781, pp. 312–320). https://doi.org/10.1007/978-3-319-94334-3_31

García-Martínez, I., Tadeu, P., Montenegro-Rueda, M., & Fernández-Batanero, J. M. (2020). Networking for online teacher collaboration. *Interactive Learning Environments*, 1–15. https://doi.org/10.1080/10494820.2020.1764057

García-Peñalvo, F. J. (2021). Avoiding the Dark Side of Digital Transformation in Teaching.

An Institutional Reference Framework for eLearning in Higher Education. *Sustainability*, *13*(4), 2023. https://doi.org/10.3390/su13042023

Genlott, A. A., & Grönlund, Å. (2016). Closing the gaps – Improving literacy and mathematics by ict-enhanced collaboration. *Computers & Education*, *99*, 68–80. https://doi.org/10.1016/j.compedu.2016.04.004

George, M. L. (2020). Effective teaching and examination strategies for undergraduate learning during COVID-19 school restrictions. *Journal of Educational Technology Systems*, *49*(1), 23–48.

Gerecht, M. (2006). *Schulqualität und Schulevaluation. Schulspezifische Rückmeldung auf der Basis der pädagogischen Entwicklungsbilanzen.* DIPF. https://nbn-resolving.org/urn:nbn:de:0111-opus-31203

Gerritsen-van Leeuwenkamp, K. J., Joosten-ten Brinke, D., & Kester, L. (2019). Students' perceptions of assessment quality related to their learning approaches and learning outcomes. *Studies in Educational Evaluation*, *63*, 72–82. https://doi.org/10.1016/j.stueduc.2019.07.005

Gessler, M. (2017). The Lack of Collaboration Between Companies and Schools in the German Dual Apprenticeship System: Historical Background and Recent Data. *International Journal for Research in Vocational Education and Training*, *4*(2), 164–195. https://doi.org/10.13152/IJRVET.4.2.4

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Glossary of Statistical Terms. (2006). *Quality - ISO*. https://stats.oecd.org/glossary/detail.asp?ID=5150

Godhe, A.-L. (2019). Digital Literacies or Digital Competence: Conceptualizations in Nordic Curricula. *Media and Communication*, *7*(2), 25–35. https://doi.org/10.17645/mac.v7i2.1888

Goller, M., Caruso, C., Berisha-Gawlowski, A., & Harteis, C. (2020). Digitalisierung in der Landwirtschaft: Gründe, Optionen und Bewertungen aus Perspektive von Milchviehlandwirtinnen und -landwirten. In Dietmar Heisler & J. Meier (Eds.), *Digitalisierung am Übergang Schule Beruf. Ansätze und Perspektiven in Arbeitsdomänen und beruflicher Förderung* (Vol. 56, pp. 53–80). wbv Media GmbH & Co. KG. https://doi.org/10.3278/6004725w

González-Martínez, J. A., Bote-Lorenzo, M. L., Gómez-Sánchez, E., & Cano-Parra, R. (2015). Cloud computing and education: A state-of-the-art survey. *Computers and Education*, *80*(1), 132–151. https://doi.org/10.1016/j.compedu.2014.08.017

Goos, M., & Salomons, A. (2017). Measuring teaching quality in higher education: assessing selection bias in course evaluations. *Research in Higher Education*, *58*(4), 341–364. https://doi.org/10.1007/s11162-016-9429-8

Gorlewski, J. (2013). Research for the Classroom: Standards, Standardization, and Student Learning. *The English Journal*, *102*(5), 84–88.

Gorshenin, A. (2018). Toward Modern Educational IT-ecosystems: from Learning Management Systems to Digital Platforms. *2018 10th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT)*, 1–5. https://doi.org/10.1109/ICUMT.2018.8631229

Gougas, V., & Malinova, L. (2021). School Leadership. Models and Tools: A Review. *Open Journal of Social Sciences*, *09*(01), 120–139. https://doi.org/10.4236/jss.2021.91009

Govindarajan, K., Kumar, V. S., & Kinshuk. (2016). Dynamic Learning Path Prediction — A Learning Analytics Solution. *2016 IEEE Eighth International Conference on Technology for Education (T4E)*, 188–193. https://doi.org/10.1109/T4E.2016.047

Graham, C., Borup, J., Short, C., & Archambault, L. (2019). *K-12 Blended Teaching: A Guide to Personalized Learning and Online Integration*.

Grothus, I., Renz, M., Rzejak, D., Schlamp, K., Daschner, P., Imschweiler, V., Lipowsky, F., Schoof-Wetzig, D., & Steffens, U. (2018). *Recherchen für eine Bestandsaufnahme der Lehrkräftefortbildung in Deutschland DVLfB*. Deutscher Verein zur Förderung der Lehrerinnen und Lehrerfortbildung e.V. (DVLfB). http://www.lehrerinnenfortbildung.de

Gudjons, H. (2011). *Frontalunterricht - neu entdeckt* (3rd ed.). Verlag Julius Klinkhardt.

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: implications for teacher education. *European Journal of Teacher Education*, *41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*, 1–11. https://doi.org/10.1016/j.chb.2020.106613

Gurr, D., & Drysdale, L. (2018). Leading High Needs Schools: Findings from the International School Leadership Development Network. *International Studies in Educational Administration*, *46*(1), 147–156.

Gurr, D., & Huerta, M. (2013). The Role of the Critical Friend in Leadership and School Improvement. *Procedia - Social and Behavioral Sciences*, *106*, 3084–3090. https://doi.org/10.1016/j.sbspro.2013.12.356

Gürtzgen, N., van den Berg, G. J., Nolte, A., & Pohlan, L. (2018). Do Digital Information Technologies Help Unemployed Job Seekers Find a Job? Evidence from the Broadband Internet Expansion in Germany. *IZA Discussion Papers*, *11555*, 1–62.

Gusukuma, L., Bart, A. C., Kafura, D., & Ernst, J. (2018). Misconception-Driven Feedback. *Proceedings of the 2018 ACM Conference on International Computing Education Research*, 160–168. https://doi.org/10.1145/3230977.3231002

Haasler, S. R. (2020). The German system of vocational education and training: challenges of gender, academisation and the integration of low-achieving youth. *Transfer: European Review of Labour and Research*, *26*(1), 57–71. https://doi.org/10.1177/1024258919898115

Håkansson Lindqvist, M., & Pettersson, F. (2019). Digitalization and school leadership: on the complexity of leading for digitalization in school. *The International Journal of Information and Learning Technology*, *36*(3), 218–230. https://doi.org/10.1108/IJILT-11-2018-0126

Hall, N. M., & Jones, J. M. (2021). Student-Produced Podcasts as a Teaching and Learning Tool. *American Journal of Distance Education*, 1–13. https://doi.org/10.1080/08923647.2021.1995256

Hammond, M. (2017). Online collaboration and cooperation: The recurring importance of evidence, rationale and viability. *Education and Information Technologies*, *22*(3), 1005–1024. https://doi.org/10.1007/s10639-016-9469-x

Hana, G. M., Hansen, R., Johnsen-Høines, M., Lilland, I. E., & Rangnes, T. E. (2013). *Learning Conversation in Mathematics Practice School–Industry Partnerships as Arena for Teacher Education* (pp. 147–155). https://doi.org/10.1007/978-3-319-02270-3_13

Hanberger, A. (2014). What PISA Intends to and Can Possibly Achieve: A Critical Programme Theory Analysis. *European Educational Research Journal*, *13*(2), 167–180. https://doi.org/10.2304/eerj.2014.13.2.167

Hanberger, A., Carlbaum, S., Hult, A., Lindgren, L., & Lundström, U. (2016). School evaluation in Sweden in a local perspective: A synthesis. *Education Inquiry*, *7*(3), 30115. https://doi.org/10.3402/edui.v7.30115

Handelzalts, A. (2019). Collaborative Curriculum Development in Teacher Design Teams. In J. Pieters, J. Voogt, & N. Pareja Roblin (Eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning* (pp. 159–173). Springer International

Publishing. https://doi.org/10.1007/978-3-030-20062-6_9
Harderer, A., Imboden, S., Glassey-Previdoli, D., & Schumann, S. (2020). Schulleitungshandeln in Zeiten der digitalen Transformation – „Business as usual“ oder „Alles ist neu“? In K. Heinrichs, K. Kögler, & C. Siegfried (Eds.), *Berufliches Lehren und Lernen: Grundlagen, Schwerpunkte und Impulse wirtschaftspädagogischer Forschung. Digitale Festschrift für Eveline Wuttke* (pp. 1–17). https://www.bwpat.de/profil6_wuttke/harder_etal_profil6.pdf
Harris, A. (2010). Leading system transformation. *School Leadership & Management*, *30*(3), 197–207. https://doi.org/10.1080/13632434.2010.494080
Harteis, C. (2018). *Machines, Change and Work: An Educational View on the Digitalization of Work* (pp. 1–10). https://doi.org/10.1007/978-3-319-63257-5_1
Harteis, C., Goller, M., & Fischer, C. (2019). Die Auswirkungen der Digitalisierung auf die Bedeutung beruflicher Qualifikation aus betrieblicher Sicht. In B.-J. Ertelt, K. Beck, A. Frey, & J. Seifried (Eds.), *Beruf, Beruflichkeit, Employability* (pp. 239–253).
Harvey, L., & Askling, B. (2003). Quality in Higher Education. In *The Dialogue between Higher Education Research and Practice* (pp. 69–83). Springer Netherlands. https://doi.org/10.1007/978-0-306-48368-4_6
Harvey, L., & Green, D. (1993). Defining Quality. *Assessment & Evaluation in Higher Education*, *18*(1), 9–34. https://doi.org/10.1080/0260293930180102
Harvey, L., & Green, D. (2000). Qualität definieren. Fünf unterschiedliche Ansätze. In E. Terhart (Ed.), *Qualität und Qualitätssicherung im Bildungsbereich; Schule, Sozialpädagogik, Hochschule.* (pp. 17–39). Beltz.
Hatlevik, I. K. R., & Hatlevik, O. E. (2018). Examining the Relationship Between Teachers' ICT Self-Efficacy for Educational Purposes, Collegial Collaboration, Lack of Facilitation and the Use of ICT in Teaching Practice. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00935
Hatlevik, O. E. (2017). Examining the Relationship between Teachers' Self-Efficacy, their Digital Competence, Strategies to Evaluate Information, and use of ICT at School. *Scandinavian Journal of Educational Research*, *61*(5), 555–567. https://doi.org/10.1080/00313831.2016.1172501
Hattie, J. (2005). The paradox of reducing class size and improving learning outcomes. *International Journal of Educational Research*, *43*(6), 387–425. https://doi.org/10.1016/j.ijer.2006.07.002
Hattie, J. (2012). *Visible Learning for Teachers*. Routledge. https://doi.org/10.4324/9780203181522
Hattie, J., Hodis, F. A., & Kang, S. H. K. (2020). Theories of motivation: Integration and ways forward. *Contemporary Educational Psychology*, *61*, 101865. https://doi.org/10.1016/j.cedpsych.2020.101865
Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487
Hauge, T. E. (2016). On the Life of ICT and School Leadership in a Large-Scale Reform Movement. In *Digital Expectations and Experiences in Education* (pp. 97–115). SensePublishers. https://doi.org/10.1007/978-94-6300-648-4_6
Hawley, R., & Allen, C. (2018). Student-generated video creation for assessment: can it transform assessment within Higher Education? *International Journal for Transformative Research*, *5*(1), 1–11. https://doi.org/10.2478/ijtr-2018-0001
Hawlitschek, A., & Joeckel, S. (2017). Increasing the effectiveness of digital educational games: The effects of a learning instruction on students' learning, motivation and cognitive load. *Computers in Human Behavior*, *72*, 79–86. https://doi.org/10.1016/j.chb.2017.01.040
Heck, R. H., & Hallinger, P. (2010). Testing a longitudinal model of distributed leadership

effects on school improvement. *The Leadership Quarterly*, *21*(5), 867–885. https://doi.org/10.1016/j.leaqua.2010.07.013

Heinen, R., & Kerres, M. (2015). Individuelle Förderung mit digitalen Medien. Handlungsfelder für die systematische, lernförderliche Integration digitaler Medien in Schule und Unterricht. In *Individuell fördern mit digitalen Medien – Chancen, Risiken, Erfolgsfaktoren* (pp. 96–161). Bertelsmann-Stiftung.

Henderson, J., & Corry, M. (2021). Data literacy training and use for educational professionals. *Journal of Research in Innovative Teaching & Learning*, *14*(2), 232–244. https://doi.org/10.1108/JRIT-11-2019-0074

Hennessy, S. (2017). International Experiences with Intergrating Interactive Whiteboards: Policy, Practice, Pedagogy and Professional Development. In R. Maclean (Ed.), *Life in Schools and Classrooms: Past, Present and Future* (pp. 633–650). Springer Singapore. https://doi.org/10.1007/978-981-10-3654-5_38

Hernández-Lara, A. B., Serradell-López, E., & Fitó-Bertran, À. (2019). Students' perception of the impact of competences on learning: An analysis with business simulations. *Computers in Human Behavior*, *101*, 311–319. https://doi.org/https://doi.org/10.1016/j.chb.2019.07.023

Hernandez, L., Balmaceda, N., Hernandez, H., Vargas, C., De La Hoz, E., Orellano, N., Vasquez, E., & Uc-Rios, C. E. (2019). *Optimization of a WiFi Wireless Network that Maximizes the Level of Satisfaction of Users and Allows the Use of New Technological Trends in Higher Education Institutions BT - Distributed, Ambient and Pervasive Interactions* (N. Streitz & S. Konomi (Eds.); pp. 144–160). Springer International Publishing.

Hilburg, R., Patel, N., Ambruso, S., Biewald, M. A., & Farouk, S. S. (2020). Medical Education During the COVID-19 Pandemic: Learning From A Distance. *Advances in Chronic Kidney Disease*, *27*(5), 412–417. https://doi.org/https://doi.org/10.1053/j.ackd.2020.05.017

Hirsch-Kreinsen, H. (2016). Digitization of industrial work: development paths and prospects. *Journal for Labour Market Research*, *49*(1), 1–14. https://doi.org/10.1007/s12651-016-0200-6

Hochberg, K., Kuhn, J., & Müller, A. (2018). Using Smartphones as Experimental Tools—Effects on Interest, Curiosity, and Learning in Physics Education. *Journal of Science Education and Technology*, *27*(5), 385–403. https://doi.org/10.1007/s10956-018-9731-7

Holden, O. L., Norris, M. E., & Kuhlmeier, V. A. (2021). Academic Integrity in Online Assessment: A Research Review. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.639814

Hopfenbeck, T. N., Lenkeit, J., El Masri, Y., Cantrell, K., Ryan, J., & Baird, J.-A. (2018). Lessons Learned from PISA: A Systematic Review of Peer-Reviewed Articles on the Programme for International Student Assessment. *Scandinavian Journal of Educational Research*, *62*(3), 333–353. https://doi.org/10.1080/00313831.2016.1258726

Hopkins, E., Hendry, H., Garrod, F., McClare, S., Pettit, D., Smith, L., Burrell, H., & Temple, J. (2016). Teachers' views of the impact of school evaluation and external inspection processes. *Improving Schools*, *19*(1), 52–61. https://doi.org/10.1177/1365480215627894

Hopmann, S. T. (2003). On the evaluation of curriculum reforms. *Journal of Curriculum Studies*, *35*(4), 459–478. https://doi.org/10.1080/00220270305520

Horn, N., & Otto, P. (2021). *Data protection versus functionality: the dilemma of German schools*. Heinrich Böll Stiftung. https://www.boell.de/en/2021/04/15/Data-protection-versus-functionality-the-dilemma-of-German-schools

Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2020). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 1–18. https://doi.org/10.1080/1475939X.2020.1839543

Hox, J. J., Moerbeek, M., & van de Schoot, R. (2017). The Basic Two-Level Regression Model. In J. J. Hox, M. Moerbeek, & R. van de Schoot (Eds.), *Multilevel Analysis* (3rd ed., p. 19). Routledge. https://doi.org/10.4324/9781315650982

Hoxby, C. M. (2014). The economics of online postsecondary education: MOOCs, nonselective education, and highly selective education. *The American Economic Review*, *104*(5), 528–533.

Hrastinski, S. (2019). What Do We Mean by Blended Learning? *TechTrends*, *63*(5), 564–569. https://doi.org/10.1007/s11528-019-00375-5

Hsu, Y. S. (2015). The development of teachers' professional learning and knowledge. In *Development Of Science Teachers' TPACK: East Asian Practices* (pp. 3–15). Springer Singapore. https://doi.org/10.1007/978-981-287-441-2_1

Huang, L., Zhang, T., & Huang, Y. (2020). Effects of school organizational conditions on teacher professional learning in China: The mediating role of teacher self-efficacy. *Studies in Educational Evaluation*, *66*, 100893. https://doi.org/10.1016/j.stueduc.2020.100893

Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability*, *32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y

Hung, H.-T. (2017). Clickers in the flipped classroom: bring your own device (BYOD) to promote student learning. *Interactive Learning Environments*, *25*(8), 983–995. https://doi.org/10.1080/10494820.2016.1240090

Ifenthaler, D. (2015). Learning Analytics. In *The SAGE Encyclopedia of Educational Technology* (pp. 447–451). SAGE Publications, Inc. https://doi.org/10.4135/9781483346397.n187

Ifenthaler, D. (2019). *MEPS – Medienentwicklungsplanung für Schulen in Baden-Württemberg. Bericht zum Projekt des Kultusministeriums Baden-Württemberg*. Kultusministerium Baden-Württemberg.

Ifenthaler, D., Gibson, D., Prasse, D., Shimada, A., & Yamada, M. (2020). Putting learning back into learning analytics: actions for policy makers, researchers, and practitioners. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-020-09909-8

Ifenthaler, D., & Schweinbenz, V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behavior*, *29*(3), 525–534. https://doi.org/10.1016/j.chb.2012.11.004

Ifenthaler, D., & Schweinbenz, V. (2016). Students' Acceptance of Tablet PCs in the Classroom. *Journal of Research on Technology in Education*, *48*(4), 306–321. https://doi.org/10.1080/15391523.2016.1215172

Ignatow, G. (2019). Text Mining. In *Digital and Media Research*. SAGE Publications Ltd. https://doi.org/10.4135/9781526421036821928

IHK Stuttgart. (2021). *Hinweise zum Berufsschulbesuch*. https://www.stuttgart.ihk24.de/fuer-unternehmen/fachkraefte-und-ausbildung/ausbildung/waehrend-der-ausbildung/hinweise-zum-berufsschulbesuch-2989002

Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*, *55*(6), 102183. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2020.102183

Ilomäki, L. (2008). *The effects of ICT on school: teachers' and students' perspectives* [University of Turku]. https://www.utupub.fi/bitstream/handle/10024/42311/B314.pdf?sequence=3&isAllowed

=y
Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, *13*(1), 25. https://doi.org/10.1186/s41039-018-0094-8
Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. *Education and Information Technologies*, *21*(3), 655–679. https://doi.org/10.1007/s10639-014-9346-4
Imboden, D., Lütjen-Drecoll, E., Bargmann, S., Casper, G., Gächter, S., Kratky, C., Nahrstedt, K., Besch Nosch, M.-L., Pauss, F., & Scheidegger, D. (2016). *Internationale Expertenkommission zur Evaluation der Exzellenzinitiative - Endbericht*. Interationale Expertenkmission Exzellenzinitative. https://www.gwk-bonn.de/fileadmin/Redaktion/Dokumente/Papers/Imboden-Bericht-2016.pdf
Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education*, *67*, 37–45. https://doi.org/10.1016/j.tate.2017.05.016
International Organization for Standardization. (2015). *ISO 9000:2015(en) Quality management systems — Fundamentals and vocabulary*. https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en
Ismail, N., & Yusof, M. A. M. (2012). Using Language Learning Contracts as a Strategy to Promote Learner Autonomy among ESL Learners. *Procedia - Social and Behavioral Sciences*, *66*, 472–480. https://doi.org/10.1016/j.sbspro.2012.11.291
Jacob, B. A., & Wilder, T. (2010). *Educational Expectations and Attainment* (Working Paper Series, Issue 15683). https://doi.org/10.3386/w15683
Jæger, M. M., & Blaabæk, E. H. (2020). Inequality in learning opportunities during Covid-19: Evidence from library takeout. *Research in Social Stratification and Mobility*, *68*(4), 100524. https://doi.org/https://doi.org/10.1016/j.rssm.2020.100524
Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., & Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Computers & Education*, *68*, 473–481. https://doi.org/10.1016/j.compedu.2013.06.008
Jarvis, M. C. (2018). *DSpace Startseite ETDs: Virginia Tech Electronic Theses and Dissertations Doctoral Dissertations Dokumentanzeige Facilities Infrastructure Needs and Practices to Support Technology Implementation in Two Rural School Divisions in Virginia* [Virginia Polytechnic Institute and State University]. http://hdl.handle.net/10919/93595
Jensvoll, M. H., & Lekang, T. (2018). Strengthening professionalism through cooperative learning. *Professional Development in Education*, *44*(4), 466–475. https://doi.org/10.1080/19415257.2017.1376223
Jin, X., Li, T., Meirink, J., van der Want, A., & Admiraal, W. (2021). Learning from novice–expert interaction in teachers' continuing professional development. *Professional Development in Education*, *47*(5), 745–762. https://doi.org/10.1080/19415257.2019.1651752
Johansson, S., & Myrberg, E. (2019). Teacher specialization and student perceived instructional quality: what are the relationships to student reading achievement? *Educational Assessment, Evaluation and Accountability*, *31*(2), 177–200. https://doi.org/10.1007/s11092-019-09297-5
Jossberger, H., Brand-Gruwel, S., van de Wiel, M. W. J., & Boshuizen, H. (2018). Learning in Workplace Simulations in Vocational Education: a Student Perspective. *Vocations and Learning*, *11*(2), 179–204. https://doi.org/10.1007/s12186-017-9186-7
Jossberger, H., Brand-Gruwel, S., Boshuizen, H., & van de Wiel, M. (2010). The challenge of self-directed and self-regulated learning in vocational education: a theoretical analysis and synthesis of requirements. *Journal of Vocational Education & Training*, *62*(4), 415–

440. https://doi.org/10.1080/13636820.2010.523479
Jurkowski, S., & Müller, B. (2018). Co-teaching in inclusive classes: The development of multi-professional cooperation in teaching dyads. *Teaching and Teacher Education*, *75*, 224–231. https://doi.org/10.1016/j.tate.2018.06.017
K. Massner, C. (2021). The Use of Videoconferencing in Higher Education. In *Communication Management [Working Title]*. IntechOpen. https://doi.org/10.5772/intechopen.99308
Kabooha, R., & Elyas, T. (2018). The Effects of YouTube in Multimedia Instruction for Vocabulary Learning: Perceptions of EFL Students and Teachers. *English Language Teaching*, *11*(2), 72. https://doi.org/10.5539/elt.v11n2p72
Kärner, T., Warwas, J., & Schumann, S. (2021). A Learning Analytics Approach to Address Heterogeneity in the Classroom: The Teachers' Diagnostic Support System. *Technology, Knowledge and Learning*, *26*(1), 31–52. https://doi.org/10.1007/s10758-020-09448-4
Kasper, B. (2017). *Implementation von Schulqualität*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-17311-1
Katsenou, C., Flogaitis, E., & Liarakou, G. (2015). Action Research to Encourage Pupils' Active Participation in the Sustainable School. *Applied Environmental Education & Communication*, *14*(1), 14–22. https://doi.org/10.1080/1533015X.2014.994820
Kay, R., & Schellenberg, D. (2019). Comparing BYOD and One-to-One Laptop Programs in Secondary School Classrooms: A Review of the Literature. In K. Graziano (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 1862–1866). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/207900/
Keeley, P. (2020). Student Voice and Leadership: Creating a Feedback Model for Improving School Culture and Climate and Creating Inspired Engaged Students [San Diego State University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/student-voice-leadership-creating-feedback-model/docview/2478103025/se-2?accountid=14570
Kelchtermans, G., Smith, K., & Vanderlinde, R. (2018). Towards an 'international forum for teacher educator development': an agenda for research and action. *European Journal of Teacher Education*, *41*(1), 120–134. https://doi.org/10.1080/02619768.2017.1372743
Kemp, J., Mellor, A., Kotter, R., & Oosthoek, J. W. (2012). Student-Produced Podcasts as an Assessment Tool: An Example from Geomorphology. *Journal of Geography in Higher Education*, *36*(1), 117–130. https://doi.org/10.1080/03098265.2011.576754
Kerres, M. (2020). Against All Odds: Education in Germany Coping with Covid-19. *Postdigital Science and Education*, *2*(3), 690–694. https://doi.org/10.1007/s42438-020-00130-7
Kerres, M., & Schmidt, A. (2011). Zur Anatomie von Bologna-Studiengängen. Eine empirische Analyse von Modulhandbüchern. *Die Hochschule : Journal Für Wissenschaft Und Bildung*, *20*(2), 173–191. https://nbn-resolving.org/urn:nbn:de:0111-pedocs-163314
Khalil, S., & Fakir, M. (2017). RCrawler: An R package for parallel web crawling and scraping. *SoftwareX*, *6*, 98–106. https://doi.org/10.1016/j.softx.2017.04.004
KI-Campus. (2021). *AI-VET Micro Degree zu Ki in der beruflichen Bildung*. https://doi.org/https://ki-campus.org/courses/aivet2020
Kiffer, S., Bertrand, É., Eneau, J., Gilliot, J.-M., & Geneviève, L. (2021). Enhancing Learners' Autonomy With E-Portfolios And Open Learner Models: A Literature Review. *Education Thinking*, *1*(1), 1–9.
Kim, Sangkyun, Song, K., Lockee, B., & Burton, J. (2018). What is Gamification in Learning and Education? In Sangkyun Kim, K. Song, B. Lockee, & J. Burton (Eds.), *Gamification in Learning and Education: Enjoy Learning Like Gaming* (pp. 25–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-47283-6_4

Kim, Seonghun, Jang, Y., Choi, S., Kim, W., Jung, H., Kim, S., & Kim, H. (2021). Analyzing Teacher Competency with TPACK for K-12 AI Education. *KI - Künstliche Intelligenz*, *35*(2), 139–151. https://doi.org/10.1007/s13218-021-00731-9

Kiss, M. (2017). *Digital Skills in the EU labour market*. European Parliamentary Research Service. http://hdl.voced.edu.au/10707/455741.

km-bw. (2021). *Rollout von itslearning als Lernmanagementsystem gestartet*. Ministerium für Kultus, Jugend und Sport Baden-Württemberg. https://km-bw.de/,Len/startseite/service/2021-06-10-rollout-itslearning-gestartet

KMK. (2017a). *Bildung in der digitalen Welt - Strategie der Kultusministerkonferenz*. Sekretariat der Kultusministerkonferenz. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2018/Digitalstrategie_2017_mit_Weiterbildung.pdf

KMK. (2017b). *The Standing Conference's "Education in the Digital World" strategy - Summary*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany. https://www.kmk.org/fileadmin/Dateien/pdf/PresseUndAktuelles/2017/KMK-Strategie_Bildung_in_der_digitalen_Welt_Zusammenfassung_en.pdf

KMK. (2019a). *Basic Structure of the Education System in the Federal Republic of Germany*. KMK. https://www.kmk.org/fileadmin/Dateien/pdf/Dokumentation/en_2019.pdf

KMK. (2019b). *The Education System in the Federal Republic of Germany 2017/2018 - A description of the responsibilities, s truc tures and development s in education poli cy for the exchange of information in Europe*. Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany.

KMK. (2019c). *Verwaltungsvereinbarung DigitalPakt Schule 2019 bis 2024* (p. 19). KMK. https://www.digitalpaktschule.de/files/VV_DigitalPaktSchule_Web.pdf

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J. M. Spector, M. D. Merill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology: Fourth Edition* (4th ed., pp. 101–111). Springer Science+Business Media. https://doi.org/10.1007/978-1-4614-3185-5

Koltay, T. (2017). Data literacy for researchers and data librarians. *Journal of Librarianship and Information Science*, *49*(1), 3–14. https://doi.org/10.1177/0961000615616450

König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*, *43*(4), 608–622. https://doi.org/10.1080/02619768.2020.1809650

König, L. (2021). Podcasts in higher education: teacher enthusiasm increases students' excitement, interest, enjoyment, and learning motivation. *Educational Studies*, *47*(5), 627–630. https://doi.org/10.1080/03055698.2019.1706040

König, P., & Wenzelburger, G. (2019). Why parties take up digitization in their manifestos. *Journal of European Public Policy*, *26*(11), 1678–1695. https://doi.org/10.1080/13501763.2018.1544268

Kreijns, K., Van Acker, F., Vermeulen, M., & van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior*, *29*(1), 217–225. https://doi.org/10.1016/j.chb.2012.08.008

Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. *Journal of Business Research*, *117*(12), 1–5. https://doi.org/10.1016/j.jbusres.2020.05.034

Kronberger, N., & Wagner, W. (2000). Keywords in context: Statistical analysis of text

features. *Qualitative Researching with Text, Image and Sound: A Practical Handbook*, 299–317.

Krouska, A., Troussas, C., & Virvou, M. (2018). Social Annotation Tools in Digital Learning: A Literature Review. *2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)*, 1–4. https://doi.org/10.1109/IISA.2018.8633609

Kuijpers, J. M., Houtveen, A. A. M., & Wubbels, T. (2010). An integrated professional development model for effective teaching. *Teaching and Teacher Education*, *26*(8), 1687–1694. https://doi.org/10.1016/j.tate.2010.06.021

Kulgemeyer, C., & Schecker, H. (2014). Research on Educational Standards in German Science Education – Towards a model of student competences. *EURASIA Journal of Mathematics, Science and Technology Education*, *10*(4). https://doi.org/10.12973/eurasia.2014.1081a

Kunter, M., & Baumert, J. (2007). Who is the expert? Construct and criteria validity of student and teacher ratings of instruction. *Learning Environments Research*, *9*(3), 231–251. https://doi.org/10.1007/s10984-006-9015-7

Kwartler, T. (2017). *Text Mining in Practice with R*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/unimannheim-ebooks/detail.action?docID=4860512

Kyriakides, L., Charalambous, E., Creemers, B. P. M., Antoniou, P., Devine, D., Papastylianou, D., & Fahie, D. (2019). Using the dynamic approach to school improvement to promote quality and equity in education: a European study. *Educational Assessment, Evaluation and Accountability*, *31*(1), 121–149. https://doi.org/10.1007/s11092-018-9289-1

Kyriakides, L., Christoforou, C., & Charalambous, C. Y. (2013). What matters for student learning outcomes: A meta-analysis of studies exploring factors of effective teaching. *Teaching and Teacher Education*, *36*, 143–152. https://doi.org/10.1016/j.tate.2013.07.010

Labusch, A., Eickelmann, B., & Conze, D. (2020). ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland. In *ICILS 2018 #Transfer. Gestaltung digitaler Schulentwicklung in Deutschland*. Waxmann Verlag GmbH. https://doi.org/10.31244/9783830993087

Lamb, R. L., Annetta, L., Firestone, J., & Etopio, E. (2018). A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations. *Computers in Human Behavior*, *80*, 158–167. https://doi.org/10.1016/j.chb.2017.10.040

Länderkonferenz Medienbildung. (2015). *Länderkonferenz MedienBildung: Kompetenzorientiertes Konzept für die schulische Medienbildung: LKM-Positionspapier*. https://lkm.lernnetz.de/files/Dateien_lkm/Dokumente/LKM-Positionspapier_2015.pdf

Lantz-Andersson, A., Lundin, M., & Selwyn, N. (2018). Twenty years of online teacher communities: A systematic review of formally-organized and informally-developed professional learning groups. *Teaching and Teacher Education*, *75*, 302–315. https://doi.org/10.1016/j.tate.2018.07.008

Larsson-Lund, M. (2018). The digital society: Occupational therapists need to act proactively to meet the growing demands of digital competence. *British Journal of Occupational Therapy*, *81*(12), 733–735. https://doi.org/10.1177/0308022618776879

Lauricella, S., & Kay, R. (2013). Exploring the use of text and instant messaging in higher education classrooms. *Research in Learning Technology*, *21*(1). https://doi.org/10.3402/rlt.v21i0.19061

Leclerc, M., Moreau, A. C., Dumouchel, C., & Sallafranque-St-Louis, F. (2012). Factors that promote Progression in Schools Functioning as a Professional Learning Community. *International Journal of Education Policy and Leadership*, *7*(7). https://doi.org/10.22230/ijepl.2012v7n7a417

Lee, E., & Hannafin, M. J. (2016). A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it. *Educational Technology Research and Development*, *64*(4), 707–734. https://doi.org/10.1007/s11423-015-9422-5

Leech, N. L., & Onwuegbuzie, A. J. (2007). An array of qualitative data analysis tools: A call for data analysis triangulation. *School Psychology Quarterly*, *22*(4), 557–584. https://doi.org/10.1037/1045-3830.22.4.557

Leithwood, K., & Mascall, B. (2008). Collective Leadership Effects on Student Achievement. *Educational Administration Quarterly*, *44*(4), 529–561. https://doi.org/10.1177/0013161X08321221

Leithwood, K., Sun, J., & Schumacker, R. (2020). How School Leadership Influences Student Learning: A Test of "The Four Paths Model." *Educational Administration Quarterly*, *56*(4), 570–599. https://doi.org/10.1177/0013161X19878772

Lemay, D. J., Baek, C., & Doleck, T. (2021). Comparison of learning analytics and educational data mining: A topic modeling approach. *Computers and Education: Artificial Intelligence*, *2*, 100016. https://doi.org/https://doi.org/10.1016/j.caeai.2021.100016

Lewin, C., & McNicol, S. (2015). Supporting the Development of 21st Century Skills through ICT. *KEYCIT 2014 - Key Competencies in Informatics and ICT*, *7*, 181–198.

Lichtenberg, P. (2015). *Zuordnung nationaler Bildungsprogramme zur ISCED 2011*. OECD. https://www.oecd.org/berlin/publikationen/Zuordnung nationaler Bildungsprogramme zur ISCED 2011.pdf

Liebowitz, D. D., & Porter, L. (2019). The Effect of Principal Behaviors on Student, Teacher, and School Outcomes: A Systematic Review and Meta-Analysis of the Empirical Literature. *Review of Educational Research*, *89*(5), 785–827. https://doi.org/10.3102/0034654319866133

Lin, J., Pu, H., Li, Y., & Lian, J. (2018). Intelligent Recommendation System for Course Selection in Smart Education. *Procedia Computer Science*, *129*, 449–453. https://doi.org/10.1016/j.procs.2018.03.023

Lindberg, O. J., Olofsson, A. D., & Fransson, G. (2017). Same but different? An examination of Swedish upper secondary school teachers' and students' views and use of ICT in education. *The International Journal of Information and Learning Technology*, *34*(2), 122–132. https://doi.org/10.1108/IJILT-09-2016-0043

Linn, R. L. (2001). A Century of Standardized Testing: Controversies and Pendulum Swings. *Educational Assessment*, *7*(1), 29–38. https://doi.org/10.1207/S15326977EA0701_4

Lobo, A., & Gurney, L. (2014). What did they expect? Exploring a link between students' expectations, attendance and attrition on English language enhancement courses. *Journal of Further and Higher Education*, *38*(5), 730–754. https://doi.org/10.1080/0309877X.2013.817002

LoBuono, D. L., Shea, K. S., Tovar, A., Leedahl, S. N., Mahler, L., Xu, F., & Lofgren, I. E. (2021). Acceptance and perception of digital health for managing nutrition in people with Parkinson's disease and their caregivers and their digital competence in the United States: A <scp>mixed-methods</scp> study. *Health Science Reports*, *4*(4). https://doi.org/10.1002/hsr2.412

Lochner, B., Conrad, R.-M., & Graham, E. (2015). Secondary Teachers' Concerns in Adopting Learning Management Systems: A U.S. Perspective. *TechTrends*, *59*(5), 62–70. https://doi.org/10.1007/s11528-015-0892-4

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology*, 69–88. https://doi.org/10.14742/ajet.5583

Lucey, T. A. (2003). Economic Influenced Perceptions and Their Implications for Early 21st

Century Education. *Educational Foundations*, *17*(1), 41–54.
Ludwig, S., Mayer, C., Hansen, C., Eilers, K., & Brandt, S. (2021). Automated Essay Scoring Using Transformer Models. *Psych*, *3*(4), 897–915. https://doi.org/10.3390/psych3040056
Luke, A., Sefton-Green, J., GGraham, P., Kellner, D., & Ladwig, J. (2017). Digital ethics, political economy, and the curriculum: This changes everything. In K. A. Mills, A. Stornaiuolo, A. Smith, & P. Jessica Zacher (Eds.), *Handbook of Writing, Literacies, and Education in Digital Cultures*. Routledge. https://doi.org/10.4324/9781315465258
Lundahl, C., Hultén, M., & Tveit, S. (2017). The power of teacher-assigned grades in outcome-based education. *Nordic Journal of Studies in Educational Policy*, *3*(1), 56–66. https://doi.org/10.1080/20020317.2017.1317229
Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, *117*, 168–179. https://doi.org/10.1016/j.psep.2018.04.018
Lytvyn, A., Lytvyn, V., Rudenko, L., Pelekh, Y., Didenko, O., Muszkieta, R., & Żukow, W. (2020). Informatization of technical vocational schools: Theoretical foundations and practical approaches. *Education and Information Technologies*, *25*(1), 583–609. https://doi.org/10.1007/s10639-019-09966-4
Ma, B., Lu, M., Taniguchi, Y., & Konomi, S. (2021). CourseQ: the impact of visual and interactive course recommendation in university environments. *Research and Practice in Technology Enhanced Learning*, *16*(1), 18. https://doi.org/10.1186/s41039-021-00167-7
Maass, K., Cobb, P., Krainer, K., & Potari, D. (2019). Different ways to implement innovative teaching approaches at scale. *Educational Studies in Mathematics*, *102*(3), 303–318. https://doi.org/10.1007/s10649-019-09920-8
Mahat, M. (2007). The impact of ranking systems on Higher Education and its stakeholders. *Journal of Institutional Research*, *13*, 83–96.
Maher, D., & Twining, P. (2017). Bring your own device – a snapshot of two Australian primary schools. *Educational Research*, *59*(1), 73–88. https://doi.org/10.1080/00131881.2016.1239509
Majuri, J., Koivisto, J., & Hamari, J. (2018). *Gamification of Education and Learning: A Review of Empirical Literature.*
Maramba, I. D., Davey, A., Elliott, M. N., Roberts, M., Roland, M., Brown, F., Burt, J., Boiko, O., & Campbell, J. (2015). Web-Based Textual Analysis of Free-Text Patient Experience Comments From a Survey in Primary Care. *JMIR Medical Informatics*, *3*(2), e20. https://doi.org/10.2196/medinform.3783
Markowitsch, J., & Hefler, G. (2018). Staying in the Loop: Formal Feedback Mechanisms Connecting Vocational Training to the World of Work in Europe. *International Journal for Research in Vocational Education and Training*, *5*(4), 285–306. https://doi.org/10.13152/IJRVET.5.4.3
Mata, L., Lazar, G., & Lazar, I. (2016). Effects of study levels on students' attitudes towards interactive whiteboards in higher education. *Computers in Human Behavior*, *54*, 278–289. https://doi.org/10.1016/j.chb.2015.07.044
Matos, J., Pedro, A., & Piedade, J. (2019). Integrating Digital Technology in the School Curriculum. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(21), 4. https://doi.org/10.3991/ijet.v14i21.10863
Maxwell, S., Reynolds, K. J., Lee, E., Subasic, E., & Bromhead, D. (2017). The Impact of School Climate and School Identification on Academic Achievement: Multilevel Modeling with Student and Teacher Data. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.02069
Mayring, P. (2004). Qualitative Content Analysis. In U. Flick, E. von Kardoff, I. Steinke, & B. Jenner (Eds.), *A Companion to Qualitative Research*. SAGE Publications.
Mayring, P. (2015). *Qualitative Inhaltsanalyse : Grundlagen und Techniken* (12., übera).

McCabe, A., & O'Connor, U. (2014). Student-centred learning: the role and responsibility of the lecturer. *Teaching in Higher Education*, *19*(4), 350–359. https://doi.org/10.1080/13562517.2013.860111

McCoy, S., Lyons, S., Coyne, B., & Darmody, M. (2016). *Teaching and Learning in Second-Level Schools at the Advent of High Speed Broadband*. The Economic and Social Research Institute. www.esri.ie

McNay, I. (2015). Debate: Does research quality assessment increase output and give value for money? *Public Money & Management*, *35*(1), 67–68. https://doi.org/10.1080/09540962.2015.986888

McPartland, J., Balfanz, R., Jordan, W., & Legters, N. (1998). Improving Climate and Achievement in a Troubled Urban High School Through the Talent Development Model. *Journal of Education for Students Placed at Risk (JESPAR)*, *3*(4), 337–361. https://doi.org/10.1207/s15327671espr0304_4

McPherson, M. S., & Bacow, L. S. (2015). Online higher education: Beyond the hype cycle. *The Journal of Economic Perspectives*, *29*(4), 135–154.

Menon, D., Bp, S., Romero, M., & Viéville, T. (2019). Going beyond digital literacy to develop computational thinking in K-12 education,. In L. Daniela (Ed.), *Smart Pedagogy of Digital Learning*. Taylor\\&Francis (Routledge). https://hal.inria.fr/hal-02281037

Merrill, M. D. (2002). First principles of instruction. *Educational Technology Research and Development*, *50*(3), 43–59. https://doi.org/10.1007/BF02505024

Metcalfe, J. (2017). Learning from Errors. *Annual Review of Psychology*, *68*(1), 465–489. https://doi.org/10.1146/annurev-psych-010416-044022

Miller, A. L., & Dumford, A. D. (2014). Open-Ended Survey Questions: Item Nonresponse Nightmare or Qualitative Data Dream? *Survey Practice*, *7*(5), 1–11. https://doi.org/10.29115/SP-2014-0024

Million, A. (2021). 'No one listens to us … ' COVID-19 and its socio-spatial impact on children and young people in Germany. *Children's Geographies*, 1–9. https://doi.org/10.1080/14733285.2021.1908520

Mims-Word, M. (2012). The Importance Of Technology Usage In The Classroom, Does Gender Gaps Exist. *Contemporary Issues in Education Research (CIER)*, *5*(4), 271. https://doi.org/10.19030/cier.v5i4.7271

Mishnick, N. (2017). *An Analysis of the Relationship between Professional Development, School Leadership, Technology Infrastructure, and Technology Use*. ProQuest Dissertations Publishing.

Mishra, P. (2019). Considering Contextual Knowledge: The TPACK Diagram Gets an Upgrade. *Journal of Digital Learning in Teacher Education*, *35*(2), 76–78. https://doi.org/10.1080/21532974.2019.1588611

Mishra, P., & Koehler, M. (2008). Introducing Technological Pedagogical Content Knowledge. *Teachers College Record*, *9*.

Misra, P. (2018). MOOCs for Teacher Professional Development: Reflections and Suggested Actions. *Open Praxis*, *10*(1), 67–77. https://www.learntechlib.org/p/183570

Mitchell, R., Sun, J., Zhang, S., Mendiola, B., & Tarter, J. (2015). *School Effectiveness: A Meta-Analytic Review of Published Research*.

Mitter, W. (1987). Expectations of schools and teachers in the context of social and economic changes. *International Review of Education*, *33*(3), 263–276. https://doi.org/10.1007/BF00615298

Mohamed, H., & Lamia, M. (2018). Implementing flipped classroom that used an intelligent tutoring system into learning process. *Computers & Education*, *124*, 62–76. https://doi.org/10.1016/j.compedu.2018.05.011

Molnar, A. (2003). School Commercialism Hurts All Children, Ethnic Minority Group Children Most of All. *The Journal of Negro Education*, *72*(4), 371.

https://doi.org/10.2307/3211189
Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and Learning with Mobile Technology: A Qualitative Explorative Study about the Introduction of Tablet Devices in Secondary Education. *PLOS ONE*, *10*(12), e0144008. https://doi.org/10.1371/journal.pone.0144008
Moreira, M. A., Rivero, V. M. H., & Sosa Alonso, J. J. (2019). Leadership and school integration of ICT. Teachers perceptions in Spain. *Education and Information Technologies*, *24*(1), 549–565. https://doi.org/10.1007/s10639-018-9789-0
Morgan, R. M. (1992). Educational Reform: Top-Down or Bottom-Up? *Educational Technology*, *32*(11), 47–51.
Mori, Y., & Stracke, E. (2021). Student teachers' expectations and their sense of fulfillment in a TESOL program. *Australian Review of Applied Linguistics*. https://doi.org/10.1075/aral.19054.mor
Moro, S., Pires, G., Rita, P., & Cortez, P. (2019). A text mining and topic modelling perspective of ethnic marketing research. *Journal of Business Research*, *103*, 275–285. https://doi.org/10.1016/J.JBUSRES.2019.01.053
Mościcki, J. T., & Mascetti, L. (2018). Cloud storage services for file synchronization and sharing in science, education and research. In *Future Generation Computer Systems* (Vol. 78, pp. 1052–1054). Elsevier B.V. https://doi.org/10.1016/j.future.2017.09.019
Mousavinasab, E., Zarifsanaiey, N., R. Niakan Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi Saeedi, M. (2018). Intelligent tutoring systems: a systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments*, *29*(1), 142–163. https://doi.org/10.1080/10494820.2018.1558257
Muftić, A. (2012). *Schulentwicklung : Begriff - Theorie - Definition*.
Mulford, B. (2003). *School Leaders: Challenging Roles and Impact on Teaching and School Effectiveness*. OECD. https://www.oecd.org/education/school/37133393.pdf
Müller, M. (2011). *Qualitätsorientierte Schulentwicklung an der Berufsschule : Entwicklung von Unterrichtsqualität mit Lehrerklassenteams*.
Murphy, R. (2019). *Artificial Intelligence Applications to Support K–12 Teachers and Teaching: A Review of Promising Applications, Challenges, and Risks*. RAND Corporation. https://doi.org/10.7249/PE315
Musk, E. (2020). *"Mars, here we come!!"* https://twitter.com/elonmusk/status/1336810077555019779?s=20
Mutch, C. (2012). Complementary Evaluation: The Development of a Conceptual Framework to Integrate External and Internal Evaluation in the New Zealand School Context. *Policy Futures in Education*, *10*(5), 569–586. https://doi.org/10.2304/pfie.2012.10.5.569
Mylonakou Keke, I., & Kekes, I. (2007). School, family and the community in cooperation: the model of syneducation. *International Journal about Parents in Education*, *1*, 73–82.
Nadkarni, S., & Prügl, R. (2021). Digital transformation: a review, synthesis and opportunities for future research. *Management Review Quarterly*, *71*(2), 233–341. https://doi.org/10.1007/s11301-020-00185-7
Navaridas-Nalda, F., Clavel-San Emeterio, M., Fernández-Ortiz, R., & Arias-Oliva, M. (2020). The strategic influence of school principal leadership in the digital transformation of schools. *Computers in Human Behavior*, *112*(11), 106481. https://doi.org/10.1016/j.chb.2020.106481
Naveh, G., Tubin, D., & Pliskin, N. (2012). Student satisfaction with learning management systems: a lens of critical success factors. *Technology, Pedagogy and Education*, *21*(3), 337–350. https://doi.org/10.1080/1475939X.2012.720413
Ndlovu, M. C., & Mostert, I. (2018). Teacher Perceptions of Moodle and Throughput in a Blended Learning Programme for In-Service Secondary School Mathematics Teachers. *Africa Education Review*, *15*(2), 131–151.

https://doi.org/10.1080/18146627.2016.1241667
Nettles, M. T. (2019). History of Testing in the United States: Higher Education. *The ANNALS of the American Academy of Political and Social Science*, *683*(1), 38–55. https://doi.org/10.1177/0002716219847139
Neuber-Pohl, C. (2021). Apprenticeship non-completion in Germany: a money matter? *Empirical Research in Vocational Education and Training*, *13*(1), 12. https://doi.org/10.1186/s40461-021-00115-1
Nevo, D. (2001). School evaluation: internal or external? *Studies in Educational Evaluation*, *27*(2), 95–106. https://doi.org/10.1016/S0191-491X(01)00016-5
Nguyen, H. T. M. (2017). *Models of Mentoring in Language Teacher Education*. Springer International Publishing. https://doi.org/10.1007/978-3-319-44151-1
Nguyen, M. H., Hunsaker, A., & Hargittai, E. (2020). Older adults' online social engagement and social capital: the moderating role of Internet skills. *Information, Communication & Society*, 1–17. https://doi.org/10.1080/1369118X.2020.1804980
Nguyen, T. D. (2021). Linking school organizational characteristics and teacher retention: Evidence from repeated cross-sectional national data. *Teaching and Teacher Education*, *97*, 103220. https://doi.org/10.1016/j.tate.2020.103220
Niegemann, H. M. (2020). Introduction–A Look Back Ahead. In E. Wuttke, J. Seifried, & H. M. Niegemann (Eds.), *Vocational Education and Training in the Age of Digitization* (pp. 15–20). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.4
Nixon, J. (2021). Critique and the video production classroom: providing students the skills to navigate new media literacies. *English Teaching: Practice & Critique*, *20*(2), 163–179. https://doi.org/10.1108/ETPC-07-2020-0070
Norton, P., & Hathaway, D. (2010). Video Production as an Instructional Strategy: Content Learning and Teacher Practice. *Contemporary Issues in Technology and Teacher Education*, *10*(1).
O'Brien, S., McNamara, G., O'Hara, J., & Brown, M. (2017). External specialist support for school self-evaluation: Testing a model of support in Irish post-primary schools. *Evaluation*, *23*(1), 61–79. https://doi.org/10.1177/1356389016684248
O'Callaghan, F. V., Neumann, D. L., Jones, L., & Creed, P. A. (2017). The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues. *Education and Information Technologies*, *22*(1), 399–415. https://doi.org/10.1007/s10639-015-9451-z
Oberländer, M., Beinicke, A., & Bipp, T. (2020). Digital competencies: A review of the literature and applications in the workplace. *Computers & Education*, *146*(4), 103752. https://doi.org/10.1016/j.compedu.2019.103752
Obermöller, M. (2019). *Medienentwicklungsplanung in NRW*. Medienberatung NRW. https://www.logineo.schulministerium.nrw.de/_Medienberatung-NRW/Publikationen/Broschuere_Medienentwicklungsplanung_NRW_ES_final.pdf
OECD. (2007). Indicator A4 What are students' expectations for education?. In *Education at a Glance 2007: OECD Indicators* (pp. 74–88). OECD Publishing. https://doi.org/10.1787/eag-2007-6-en
OECD. (2014). *Measuring the Digital Economy*. https://doi.org/https://doi.org/https://doi.org/10.1787/9789264221796-en
OECD. (2015). *ISCED 2011 Operational Manual*. OECD, European Union, UNESCO Institute for Statistics. https://doi.org/10.1787/9789264228368-en
Oelkers, J. (2007). *Schule und Wettbewerb: Neue Perspektiven für Leistung und Qualität* (p. 20). https://www.ife.uzh.ch/dam/jcr:00000000-4a53-efb2-ffff-ffff8761d4e8/271b_Biblis.pdf
Olofsson, A. D., Fransson, G., & Lindberg, J. O. (2020). A study of the use of digital technology and its conditions with a view to understanding what 'adequate digital

competence' may mean in a national policy initiative. *Educational Studies*, *46*(6), 727–743. https://doi.org/10.1080/03055698.2019.1651694

Ortoleva, G., & Bétrancourt, M. (2016). Supporting productive collaboration in a computer-supported instructional activity: peer-feedback on critical incidents in health care education. *Journal of Vocational Education & Training*, *68*(2), 178–197. https://doi.org/10.1080/13636820.2015.1133693

Osiurak, F., & Heinke, D. (2018). Looking for intoolligence: A unified framework for the cognitive study of human tool use and technology. *American Psychologist*, *73*(2), 169–185. https://doi.org/10.1037/amp0000162

Otterborn, A., Schönborn, K., & Hultén, M. (2019). Surveying preschool teachers' use of digital tablets: general and technology education related findings. *International Journal of Technology and Design Education*, *29*(4), 717–737. https://doi.org/10.1007/s10798-018-9469-9

Page, L. (2016). The impact of lesson observation on practice, professionalism and teacher identity. In M. O'Leary (Ed.), *Reclaiming Lesson Observation - Supporting excellence in teacher learning* (1st ed., pp. 62–74). Routledge.

Pahl, J.-P. (2014). *Berufsschule: Annäherungen an eine Theorie des Lernortes 3. überarbeitete und erweiterte Auflage*. wbv Media.

Paladines, J., & Ramirez, J. (2020). A Systematic Literature Review of Intelligent Tutoring Systems With Dialogue in Natural Language. *IEEE Access*, *8*, 164246–164267. https://doi.org/10.1109/ACCESS.2020.3021383

Palau, R., Fuentes, M., Mogas, J., & Cebrián, G. (2021). Analysis of the implementation of teaching and learning processes at Catalan schools during the Covid-19 lockdown. *Technology, Pedagogy and Education*, *30*(1), 183–199. https://doi.org/10.1080/1475939X.2020.1863855

Pan, F. (2018). Short Video Production for Language Learning and Assessment. In C. H. Xiang (Ed.), *Cases on Audio-Visual Media in Language Education* (pp. 194–217). London School of Economics and Political Science. https://doi.org/10.4018/978-1-5225-2724-4.ch008

Panayiotou, A., Kyriakides, L., Creemers, B. P. M., McMahon, L., Vanlaar, G., Pfeifer, M., Rekalidou, G., & Bren, M. (2014). Teacher behavior and student outcomes: Results of a European study. *Educational Assessment, Evaluation and Accountability*, *26*(1), 73–93. https://doi.org/10.1007/s11092-013-9182-x

Pant, H. A. (2021). *Einführung in den Bildungsplan 2016 - Warum ein »neuer« Bildungsplan? Anlässe und Absichten der Bildungsplanreform*. http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/EINFUEHRUNG

Papamitsiou, Z., Filippakis, M. E., Poulou, M., Sampson, D., Ifenthaler, D., & Giannakos, M. (2021). Towards an educational data literacy framework: enhancing the profiles of instructional designers and e-tutors of online and blended courses with new competences. *Smart Learning Environments*, *8*(1), 18. https://doi.org/10.1186/s40561-021-00163-w

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest*, *9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

Patterson, R. W., & Patterson, R. M. (2017). Computers and productivity: Evidence from laptop use in the college classroom. *Economics of Education Review*, *57*, 66–79. https://doi.org/10.1016/j.econedurev.2017.02.004

Patzina, A., & Wydra-Somaggio, G. (2020). Early Careers of Dropouts from Vocational Training: Signals, Human Capital Formation, and Training Firms. *European Sociological Review*, *36*(5), 741–759. https://doi.org/10.1093/esr/jcaa011

Pätzold, G., Rauner, F., Husinga, R., Buchmann, U., Kirsch, J.-L., Brandsma, J., Bremer, R.,

Fischer, M., Euler, D., Gomez, J., Keller, M., Walzik, S., Ertl, H., Sloane, P. F. E., Spöttl, G., Windelband, L., Becker, W., Meifort, B., Haasler, B., … Rein, V. (2006). *Qualifikationsforschung und Curriculumentwicklung.* (G. Pätzold & F. Rauner (Eds.)). Steiner.

Peña-Lévano, L. (2020). Personalizing Online Classes: The Use of Evaluation and Participation Tools. *Applied Economics Teaching Resources (AETR)*. https://doi.org/10.22004/ag.econ.302622

Persson, R. S. (2010). Experiences of Intellectually Gifted Students in an Egalitarian and Inclusive Educational System: A Survey Study. *Journal for the Education of the Gifted*, *33*(4), 536–569. https://doi.org/10.1177/016235321003300405

Peters, O., Körndle, H., & Narciss, S. (2018). Effects of a formative assessment script on how vocational students generate formative feedback to a peer's or their own performance. *European Journal of Psychology of Education*, *33*(1), 117–143. https://doi.org/10.1007/s10212-017-0344-y

Pettersson, F. (2018). Digitally Competent School Organizations – Developing Supportive Organizational Infrastructures. *Seminar.Net*, *14*(2), 132–143. https://journals.oslomet.no/index.php/seminar/article/view/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 Technologies*, *26*(1), 187–204. https://doi.org/10.1007/s10639-020-10239-8

Pichler, D., & Stehrer, R. (2021). *Breaking Through the Digital Ceiling: ICT Skills and Labour Market Opportunities* (No. 193). https://wiiw.ac.at/breaking-through-the-digital-ceiling-ict-skills-and-labour-market-opportunities-dlp-5597.pdf

Pietsch, M., Lücken, M., Thonke, F., Klitsche, S., & Musekamp, F. (2016). Der Zusammenhang von Schulleitungshandeln, Unterrichtsgestaltung und Lernerfolg. *Zeitschrift Für Erziehungswissenschaft*, *19*(3), 527–555. https://doi.org/10.1007/s11618-016-0692-4

Pilz, M., & Wiemann, K. (2021). Does Dual Training Make the World Go Round? Training Models in German Companies in China, India and Mexico. *Vocations and Learning*, *14*(1), 95–114. https://doi.org/10.1007/s12186-020-09255-z

Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth grade classrooms in a Florida school district. *Educational Technology Research and Development*, *63*(4), 539–554. https://doi.org/10.1007/s11423-015-9391-8

Platz, L., Jüttler, M., & Schumann, S. (2021). Game-Based Learning in Economics Education at Upper Secondary Level: The Impact of Game Mechanics and Reflection on Students' Financial Literacy. In C. Aprea & D. Ifenthaler (Eds.), *Game-based Learning Across the Disciplines. Advances in Game-Based Learning* (pp. 25–42). Springer. https://doi.org/10.1007/978-3-030-75142-5_2

Pleshakova, A. Y. (2019). Germany's dual education system: The assessment by its subjects. *The Education and Science Journal*, *21*(5), 130–156. https://doi.org/10.17853/1994-5639-2019-5-131-157

Poedjiastutie, D., & Oliver, R. (2017). Exploring Students' Learning Needs: Expectation and Challenges. *English Language Teaching*, *10*(10), 124. https://doi.org/10.5539/elt.v10n10p124

Pont, B., Nusche, D., & Moorman, H. (2008). *Improving School Leadership - Volume 1: Policy and Practice*. OECD.

Porat, M. U. (1977). *The Information Economy: Definition and Measurement* (OT Special Publication; ...). U.S. Government Printing Office. https://eric.ed.gov/?id=ED142205

Praetorius, A.-K., Lauermann, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education*, *65*, 241–254.

https://doi.org/10.1016/j.tate.2017.03.023
Protsch, P., & Solga, H. (2016). The social stratification of the German VET system. *Journal of Education and Work*, *29*(6), 637–661. https://doi.org/10.1080/13639080.2015.1024643
Qian, Y., & Lehman, J. D. (2019). Using Targeted Feedback to Address Common Student Misconceptions in Introductory Programming: A Data-Driven Approach. *SAGE Open*, *9*(4), 215824401988513. https://doi.org/10.1177/2158244019885136
Queiroga, E. M., Lopes, J. L., Kappel, K., Aguiar, M., Araújo, R. M., Munoz, R., Villarroel, R., & Cechinel, C. (2020). A Learning Analytics Approach to Identify Students at Risk of Dropout: A Case Study with a Technical Distance Education Course. *Applied Sciences*, *10*(11), 3998. https://doi.org/10.3390/app10113998
Raaheim, A., Mathiassen, K., Moen, V., Lona, I., Gynnild, V., Bunæs, B. R., & Hasle, E. T. (2019). Digital assessment – how does it challenge local practices and national law? A Norwegian case study. *European Journal of Higher Education*, *9*(2), 219–231. https://doi.org/10.1080/21568235.2018.1541420
Rafail, P., & Freitas, I. (2020). Natural Language Processing. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *SAGE Research Methods Foundations*. SAGE Publications Ltd. https://doi.org/10.4135/9781526421036879118
Rahman, N. A. A., Sairi, I. H., Zizi, N. A. M., & Khalid, F. (2020). The Importance of Cybersecurity Education in School. *International Journal of Information and Education Technology*, *10*(5), 378–382. https://doi.org/10.18178/ijiet.2020.10.5.1393
Ramani, S., Könings, K. D., Mann, K. V., Pisarski, E. E., & van der Vleuten, C. P. M. (2018). About Politeness, Face, and Feedback. *Academic Medicine*, *93*(9), 1348–1358. https://doi.org/10.1097/ACM.0000000000002193
Ramírez-Rueda, M. del C., Cózar-Gutiérrez, R., Roblizo Colmenero, M. J., & González-Calero, J. A. (2021). Towards a coordinated vision of ICT in education: A comparative analysis of Preschool and Primary Education teachers' and parents' perceptions. *Teaching and Teacher Education*, *100*, 103300. https://doi.org/10.1016/j.tate.2021.103300
Rani, R., & Lobiyal, D. K. (2020). Performance evaluation of text-mining models with Hindi stopwords lists. *Journal of King Saud University - Computer and Information Sciences*. https://doi.org/10.1016/j.jksuci.2020.03.003
Rasooli, A., Zandi, H., & DeLuca, C. (2018). Re-conceptualizing classroom assessment fairness: A systematic meta-ethnography of assessment literature and beyond. *Studies in Educational Evaluation*, *56*, 164–181. https://doi.org/10.1016/j.stueduc.2017.12.008
Rausch, A., Deutscher, V., Seifried, J., Brandt, S., & Winther, E. (2021). Die web-basierte Bürosimulation LUCA – Funktionen, Einsatzmöglichkeiten und Forschungsausblick. *Zeitschrift Für Berufsund Wirtschaftspädagogik*, *117*(3), 372. https://doi.org/10.25162/zbw-2021-0017
Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu* (Y. Punie (Ed.)). Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107466/pdf_digcomedu_a4_final.pdf
Reezigt, G. J., & Creemers, B. P. M. (2005). A comprehensive framework for effective school improvement. *School Effectiveness and School Improvement*, *16*(4), 407–424. https://doi.org/10.1080/09243450500235200
Reichardt, R. (2000). *The Cost of Class Size Reduction: Advice for Policy Makers*. RAND Corporation. https://doi.org/10.7249/RGSD156
Rivera, A. C., Tapia-Leon, M., & Lujan-Mora, S. (2018). Recommendation Systems in Education: A Systematic Mapping Study. In Á. Rocha & T. Guarda (Eds.), *Proceedings of the International Conference on Information Technology & Systems (ICITS 2018)* (pp.

937–947). Springer International Publishing.
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. (1998). Entwicklung von Einzelschulen. Viel Praxis, wenig Theorie und kaum Forschung - Ein Versuch, Schulentwicklung zu systematisieren. *Jahrbuch Der Schulentwicklung*, *10*, 295–326.
Rolff, H.-G. (2019). Wandel durch Schulentwicklung: Essays zu Bildungsreform und Schulpraxis. In *Wandel durch Schulentwicklung*. Beltz Verlagsgruppe.
Rolff, H.-G., & Thünken, U. (2020). Digital gestütztes Lernen: Praxisbeispiele für eine zeitgemäße Schulentwicklung. In *Digital gestütztes Lernen*. Beltz Verlagsgruppe.
Roll, M., & Ifenthaler, D. (2020a). Lernort-übergreifende Kompetenzentwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungskompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik, Beiheft*, *29*, 185–209.
Roll, M., & Ifenthaler, D. (2020b). Lernort-übergreifende Kompetenz-entwicklung in der Industrie 4.0: Die Entwicklung digitaler Handlungs-kompetenz in der dualen Berufsausbildung aus der Ausbilderperspektive. *Zeitschrift Für Berufs- Und Wirtschafts-pädagogik*, *29*, 185–209.
Roll, M., & Ifenthaler, D. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. *Empirical Research in Vocational Education and Training*, *13*(1), 7. https://doi.org/10.1186/s40461-021-00112-4
Romeu, T., Guitert, M., & Sangrà, A. (2016). Teacher collaboration network in Higher Education: reflective visions from praxis. *Innovations in Education and Teaching International*, *53*(6), 592–604. https://doi.org/10.1080/14703297.2015.1025807
Rubach, C., & Lazarides, R. (2021). Addressing 21st-century digital skills in schools – Development and validation of an instrument to measure teachers' basic ICT competence beliefs. *Computers in Human Behavior*, *118*, 106636. https://doi.org/10.1016/j.chb.2020.106636
Rudasill, K. M., Snyder, K. E., Levinson, H., & L. Adelson, J. (2018). Systems View of School Climate: a Theoretical Framework for Research. *Educational Psychology Review*, *30*(1), 35–60. https://doi.org/10.1007/s10648-017-9401-y
Sabry, N. S., & Bruna, K. R. (2007). Learning from the Experience of Muslim Students in American Schools: Towards a Proactive Model of School-Community Cooperation. *Multicultural Perspectives*, *9*(3), 44–50. https://doi.org/10.1080/15210960701443730
Sahney, S., Banwet, D. K., & Karunes, S. (2008). An integrated framework of indices for quality management in education: a faculty perspective. *The TQM Journal*, *20*(5), 502–519. https://doi.org/10.1108/17542730810898467
Salle, T. P. La, Meyers, J., Varjas, K., & Roach, A. (2015). A Cultural-Ecological Model of School Climate. *International Journal of School & Educational Psychology*, *3*(3), 157–166. https://doi.org/10.1080/21683603.2015.1047550
Sampson, Y. (2019). *Effects of peer feedback and assessment on successive drafts of student narrative writing: the case for student assessor and assessee* [Memorial University of Newfoundland]. https://research.library.mun.ca/14365/1/thesis.pdf
Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher Digital Literacy: The Indisputable Challenge after COVID-19. *Sustainability*, *13*(4), 1858. https://doi.org/10.3390/su13041858
Sanders, M. G., & Epstein, J. L. (2005). School-Family-Community Partnerships and Educational Change: International Perspectives. In A. Hargreaves (Ed.), *Extending Educational Change* (pp. 202–222). Springer Netherlands. https://doi.org/10.1007/1-4020-4453-4_10

Santi;, S., Dumitru, P., Marc;, D., Gilleran, A., Alexa, J., & Vuorikari, R. (2009). European Schoolnet: Enabling School Networking. *European Journal of Education Research, Development and Policies ; the Official Journal of the European Institute of Education and Social Policy*, *44*(4), 475.

Scantlebury, K., Gallo-Fox, J., & Wassell, B. (2008). Coteaching as a model for preservice secondary science teacher education. *Teaching and Teacher Education*, *24*(4), 967–981. https://doi.org/10.1016/j.tate.2007.10.008

Scheerens, J. (2012). Summary and Conclusion: Instructional Leadership in Schools as Loosely Coupled Organizations. In J. Scheerens (Ed.), *School Leadership Effects Revisited* (pp. 131–152). Springer. https://doi.org/10.1007/978-94-007-2768-7_5

Scheerens, J., Glas, C. A. W., & Thomas, S. M. (2003). *Educational Evaluation, Assessment, and Monitoring: A Systemic Approach*. Taylor and Francis Ltd.

Scheller, H. (2018). Educational Federalism in Germany. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries.* Information Age Publishing.

Schelten, A. (2009). Berufsschule. In S. Blömeke, T. Bohl, L. Haag, G. Lang-Wojtasik, & W. Sacher (Eds.), *Handbuch Schule : Theorie - Organisation - Entwicklung*.

Schildkamp, K., Poortman, C., Luyten, H., & Ebbeler, J. (2017). Factors promoting and hindering data-based decision making in schools. *School Effectiveness and School Improvement*, *28*(2), 242–258. https://doi.org/10.1080/09243453.2016.1256901

Schinske, J., & Tanner, K. (2014). Teaching More by Grading Less (or Differently). *CBE Life Sciences Education*, *13*(2), 159–166. https://doi.org/10.1187/cbe.cbe-14-03-0054

Schmid, M., Brianza, E., & Petko, D. (2021). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, *115*(September 2020), 106586. https://doi.org/10.1016/j.chb.2020.106586

Schmid, U., Blanc, B., Toepel, M., Pinkwart, N., & Drachsler, H. (2021). *KI@Bildung: Lehren und Lernen in der Schule mit Werkzeugen Künstlicher Intelligenz*. https://www.mmb-institut.de/wp-content/uploads/KI@Bildung_Schlussbericht.pdf

Schneider, M. (2018). Digitalization of Production, Human Capital, and Organizational Capital BT - The Impact of Digitalization in the Workplace: An Educational View. In C. Harteis (Ed.), *The Impact of Digitalization in the Workplace. Professional and Practice-based Learning* (Vol. 21, pp. 39–52). Springer International Publishing. https://doi.org/10.1007/978-3-319-63257-5_4

Schneider, R., Sachse, K. A., Schipolowski, S., & Enke, F. (2021). Teaching in Times of COVID-19: The Evaluation of Distance Teaching in Elementary and Secondary Schools in Germany. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.702406

Schneider, S. L. (2021). The classification of education in surveys: a generalized framework for ex-post harmonization. *Quality & Quantity*. https://doi.org/10.1007/s11135-021-01101-1

Schüller, K. (2020). *Future Skills: a Framework for Data Literacy - Competence Framework and Research Report*. https://doi.org/10.5281/ZENODO.3946067

Schulz-Zander, R., Büchter, A., & Dalmer, R. (2002). The role of ICT as a promoter of students' cooperation. *Journal of Computer Assisted Learning*, *18*(4), 438–448. https://doi.org/10.1046/j.0266-4909.2002.002.x

Schumacher, C. (2019). *Cognitive, metacognitive and motivational perspectives on learning analytics : Synthesizing self-regulated learning, assessment, and feedback with Learning Analytics* [University of Mannheim]. https://madoc.bib.uni-mannheim.de/53712/

Schumacher, C., & Ifenthaler, D. (2017). Features Students Really Expect from Learning Analytics. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.06.030

Scott, T. M. (2016). *Teaching Behavior : Managing Classrooms Through Effective*

Instruction. SAGE Publications. http://ebookcentral.proquest.com/lib/unimannheim-ebooks/detail.action?docID=5165196

Scully, D., Lehane, P., & Scully, C. (2021). 'It is no longer scary': digital learning before and during the Covid-19 pandemic in Irish secondary schools. *Technology, Pedagogy and Education*, *30*(1), 159–181. https://doi.org/10.1080/1475939X.2020.1854844

Sebastian, J., Allensworth, E., & Stevens, D. (2014). The Influence of School Leadership on Classroom Participation: Examining Configurations of Organizational Supports. *Teachers College Record*, *116*(8), 1–36.

Sebastian, J., Allensworth, E., Wiedermann, W., Hochbein, C., & Cunningham, M. (2019). Principal Leadership and School Performance: An Examination of Instructional Leadership and Organizational Management. *Leadership and Policy in Schools*, *18*(4), 591–613. https://doi.org/10.1080/15700763.2018.1513151

Sedgewick, A., Souppaya, M. P., & Scarfone, K. A. (2015). *Guide to Application Whitelisting*. https://doi.org/10.6028/NIST.SP.800-167

Seeber, S., & Seifried, J. (2019). Herausforderungen und Entwicklungsperspektiven der beruflichen Bildung unter veränderten Rahmenbedingungen. *Zeitschrift Für Erziehungswissenschaft*, *22*(3), 485–508. https://doi.org/10.1007/s11618-019-00876-2

Seifried, J., Brandt, S., Kögler, K., & Rausch, A. (2020). The computer-based assessment of domain-specific problem-solving competence—A three-step scoring procedure. *Cogent Education*, *7*(1), 1719571. https://doi.org/10.1080/2331186X.2020.1719571

Seleznyov, S., & Czerniawksi, G. (2020). *A Research Approach To Curriculum Development: A British Curriculum Forum Event Report* (S. Seleznyov & G. Czerniawski (Eds.)). British Educational Research Association.

Senkbeil, M., Goldhammer, F., Bos, W., Eickelmann, B., Schwippert, K., & Julia, G. (2014). Das Konstrukt der computer- und informationsbezogenen Kompetenzen in ICILS 2013. In *ICILS 2013. Computer- und informationsbezogene Kompetenzen von Schülerinnen und Schülern in der 8. Jahrgangsstufe im internationalen Vergleich* (pp. 83–112). Waxmann.

Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, *54*(2), 273–286. https://doi.org/10.1111/ejed.12330

Seufert, S., Guggemos, J., Ifenthaler, D., Ertl, H., & Seifried, J. (2021). *Künstliche Intelligenz in der beruflichen Bildung Zukunft der Arbeit und Bildung mit intelligenten Maschinen?!* Franz Steiner Verlag. https://elibrary.steiner-verlag.de/book/99.105010/9783515130752

Shang, H.-F. (2019). An investigation of plagiarism software use and awareness training on English as a foreign language (EFL) students. *Journal of Computing in Higher Education*, *31*(1), 105–120. https://doi.org/10.1007/s12528-018-9193-1

Shapiro, H. B., Lee, C. H., Wyman Roth, N. E., Li, K., Çetinkaya-Rundel, M., & Canelas, D. A. (2017). Understanding the massive open online course (MOOC) student experience: An examination of attitudes, motivations, and barriers. *Computers & Education*, *110*, 35–50. https://doi.org/10.1016/j.compedu.2017.03.003

Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, *7*(1), 33. https://doi.org/10.1186/s40561-020-00140-9

Siemiatycki, M., & Farooqi, N. (2012). Value for Money and Risk in Public–Private Partnerships. *Journal of the American Planning Association*, *78*(3), 286–299. https://doi.org/10.1080/01944363.2012.715525

Silcox, S., & MacNeill, N. (2021). *Leading School Renewal*. Routledge. https://doi.org/10.4324/9781003139935

Silcox, S., Macneill, N., & Cavanagh, R. (2012). *Paper Code 507 PRINCIPAL LEADERSHIP*

AND SCHOOL RENEWAL.

Sinakou, Donche, Boeve-de Pauw, & Van Petegem. (2019). Designing Powerful Learning Environments in Education for Sustainable Development: A Conceptual Framework. *Sustainability*, *11*(21), 5994. https://doi.org/10.3390/su11215994

Singh, A., & Haynes, M. (2020). The challenges of COVID-19 in nursing education: The time for faculty leadership training is now. *Nurse Education in Practice*, *47*, 102831. https://doi.org/https://doi.org/10.1016/j.nepr.2020.102831

Sloat, E., Amrein-Beardsley, A., & Holloway, J. (2018). Different teacher-level effectiveness estimates, different results: inter-model concordance across six generalized value-added models (VAMs). *Educational Assessment, Evaluation and Accountability*, *30*(4), 367–397. https://doi.org/10.1007/s11092-018-9283-7

Snelson, C. (2018). Video production in content-area pedagogy: a scoping study of the research literature. *Learning, Media and Technology*, *43*(3), 294–306. https://doi.org/10.1080/17439884.2018.1504788

Snijders, T. A. B., & Bosker, R. J. (2011). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. SAGE Publications.

Sokal, L., Trudel, L. E., & Babb, J. (2020). Canadian teachers' attitudes toward change, efficacy, and burnout during the COVID-19 pandemic. *International Journal of Educational Research Open*, *1*, 100016. https://doi.org/10.1016/j.ijedro.2020.100016

Sonntag, M., & Veber, M. (2014). Die Arbeit in multiprofessionellen Teams als Herausforderung und Chance für eine inklusionsorientierte LehrerInnenbildung - ein Dialog über den Tellerrand. *Erziehung Und Unterricht*, *164*.

Spener, C., Häuber, G., Horlacher, T., & Schumann, S. (2019). Der berufsschulische Einsatz von ERP-Systemen in der Ausbildung von Industriekaufleuten. In K. Wilbers (Ed.), *Digitale Transformation kaufmännischer Bildung. Ausbildung in Industrie und Handel hinterfragt* (Vol. 23, pp. 195–216). epubli GmbH.

Spiteri, M., & Chang Rundgren, S.-N. (2020). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning*, *25*(1), 115–128. https://doi.org/10.1007/s10758-018-9376-x

Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the Validity of Student Evaluation of Teaching. *Review of Educational Research*, *83*(4), 598–642. https://doi.org/10.3102/0034654313496870

Starkey, L., Shonfeld, M., Prestridge, S., & Cervera, M. G. (2021). Special issue: Covid-19 and the role of technology and pedagogy on school education during a pandemic. *Technology, Pedagogy and Education*, *30*(1), 1–5. https://doi.org/10.1080/1475939X.2021.1866838

statistik-bw. (2020). *Öffentliche berufliche Schulen: Rückgang der Schülerzahlen setzt sich fort*. Pressemitteilung 51/2020. https://www.statistik-bw.de/Presse/Pressemitteilungen/2020051

Stefanou, C. R., Perencevich, K. C., DiCintio, M., & Turner, J. C. (2004). Supporting Autonomy in the Classroom: Ways Teachers Encourage Student Decision Making and Ownership. *Educational Psychologist*, *39*(2), 97–110. https://doi.org/10.1207/s15326985ep3902_2

Stockinger, B. (2019). Broadband internet availability and establishments' employment growth in Germany: evidence from instrumental variables estimations. *Journal for Labour Market Research*, *53*(1), 7. https://doi.org/10.1186/s12651-019-0257-0

Stoney, S. M. (Ed.). (2010). *Beyond Lisbon 2010: perspectives from research and development for education policy in Europe CIDREE Yearbook 2010)*.

Straub, R., & Vilsmaier, U. (2020). Pathways to educational change revisited– controversies and advances in the German teacher education system. *Teaching and Teacher Education*, *96*, 103140. https://doi.org/10.1016/j.tate.2020.103140

Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review, 30,* 100314. https://doi.org/10.1016/j.edurev.2020.100314

Stronge, J. H. (2018). *Qualities of Effective Teachers, 3rd Edition*. ASCD.

Sugarman, J., Morris-Lange, S., & McHugh, M. (2016). *Improving Education for Migrant-Background Students: A Transatlantic Comparison of School Funding*. https://www.stiftung-mercator.de/content/uploads/2020/12/Sugarman_et_al_MPI_SVR_Improving_Education_Migrant_Background_Students_NEU.pdf

Supovitz, J. (2014). *Building a Lattice for School Leadership : The Top-to-Bottom Rethinking of leadership development in England and what it might mean for American education* (Issue October). CPRE Research Reports. http://www.cpre.org/sites/default/files/researchreport/2027_leadershipengland.pdf

Swaffield, S., & MacBeath, J. (2005). School self-evaluation and the role of a critical friend. *Cambridge Journal of Education*, *35*(2), 239–252. https://doi.org/10.1080/03057640500147037

Tawbush, R. L., Stanley, S. D., Campbell, T. G., & Webb, M. A. (2020). International comparison of K-12 STEM teaching practices. *Journal of Research in Innovative Teaching & Learning*, *13*(1), 115–128. https://doi.org/10.1108/JRIT-01-2020-0004

Teichmann, M., Ullrich, A., & Gronau, N. (2019). Subject-oriented learning - A new perspective for vocational training in learning factories. *Procedia Manufacturing*, *31*(5), 72–78. https://doi.org/https://doi.org/10.1016/j.promfg.2019.03.012

Teodorović, J. (2011). Classroom and school factors related to student achievement: what works for students? *School Effectiveness and School Improvement*, *22*(2), 215–236. https://doi.org/10.1080/09243453.2011.575650

Terhart, E. (2006). Giving Marks: Constructing Differences; Explorations in the Micro-Politics of Selection in Schools. In H. Drerup & W. Fölling (Eds.), *Gleichheit und Gerechtigkeit: Pädagogische Revisionen*. TUD.

Terhart, E. (2019). Teacher Education in Germany. In *Oxford Research Encyclopedia of Education*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.377

Thieme, T. (2017). Die Staatsform Monarchie im 21. Jahrhundert – Typologie, Überblick und Vergleich. *Totalitarianism and Democracy*, *14*(2), 309–332. https://doi.org/10.13109/tode.2017.14.2.309

Thompson, A. (2021). *SpaceX launches four civilians into orbit on historic Inspiration4 flight | Space*. https://www.space.com/spacex-launches-inspiration4-civilian-orbital-mission

Tondeur, J., Aesaert, K., Prestridge, S., & Consuegra, E. (2018). A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies. *Computers & Education*, *122*, 32–42. https://doi.org/10.1016/j.compedu.2018.03.002

Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap! *Australasian Journal of Educational Technology*, *33*(3). https://doi.org/10.14742/ajet.3504

Tosuntaş, Ş. B., Karadağ, E., & Orhan, S. (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education*, *81*, 169–178. https://doi.org/10.1016/j.compedu.2014.10.009

Touraine, A. (1972). *Die postindustrielle Gesellschaft* (E. Moldenhauer & A. Touraine (Eds.); 1. Aufl.). Suhrkamp.

Tovey, M., & Owen, J. (2000). Sketching and direct CAD modelling in automotive design. *Design Studies*, *21*(6), 569–588. https://doi.org/10.1016/S0142-694X(99)00027-7

Tsai, M.-J., & Wu, A.-H. (2021). Visual search patterns, information selection strategies, and

information anxiety for online information problem solving. *Computers & Education*, *172*, 104236. https://doi.org/10.1016/j.compedu.2021.104236

Tuffaha, H. W., Aitken, J., Chambers, S., & Scuffham, P. A. (2019). A Framework to Prioritise Health Research Proposals for Funding: Integrating Value for Money. *Applied Health Economics and Health Policy*, *17*(6), 761–770. https://doi.org/10.1007/s40258-019-00495-2

Tulis, M., Steuer, G., & Dresel, M. (2016). Learning from errors: A model of individual processes. *Frontline Learning Research*, *4*(4), 12–26. https://doi.org/10.14786/flr.v4i2.168

Turnbull, D., Chugh, R., & Luck, J. (2019). Learning Management Systems: An Overview. In *Encyclopedia of Education and Information Technologies* (pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-319-60013-0_248-1

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. https://doi.org/10.1111/jcal.12031

Underwood, J., Ault, A., Banyard, P., Bird, K., Dillon, G., Hayes, M., Selwood, I., Somekh, B., & Twining, P. (2005). *The impact of broadband in schools*. Becta.

Uttl, B., White, C. A., & Gonzalez, D. W. (2017). Meta-analysis of faculty's teaching effectiveness: Student evaluation of teaching ratings and student learning are not related. *Studies in Educational Evaluation*, *54*, 22–42. https://doi.org/10.1016/j.stueduc.2016.08.007

Valtonen, T., Hoang, N., Sointu, E., Näykki, P., Virtanen, A., Pöysä-Tarhonen, J., Häkkinen, P., Järvelä, S., Mäkitalo, K., & Kukkonen, J. (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective. *Computers in Human Behavior*, *116*. https://doi.org/10.1016/j.chb.2020.106643

van Ackeren, I., Aufenanger, S., Eickelmann, B., Friedrich, S., Kammerl, R., Knopf, J., Mayrberger, K., Scheika, H., Scheiter, K., & Schiefner-Rohs, M. (2019). Digitalisierung in der Lehrerbildung. Herausforderungen, Entwicklungsfelder und Förderung von Gesamtkonzepten. *DDS – Die Deutsche Schule*, *111*(1), 103–119. https://doi.org/10.31244/dds.2019.01.10

van der Bij, T., Geijsel, F. ., & ten Dam, G. T. . (2016). Improving the quality of education through self-evaluation in Dutch secondary schools. *Studies in Educational Evaluation*, *49*, 42–50. https://doi.org/10.1016/j.stueduc.2016.04.001

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. *Computers in Human Behavior*, *100*(11), 93–104. https://doi.org/https://doi.org/10.1016/j.chb.2019.06.017

Vanhoof, J., & Petegem, P. Van. (2007). Matching Internal and External Evaluation in an Era of Accountability and School Development: Lessons from a Flemish Perspective. *Studies in Educational Evaluation*, *33*(2), 101–119. https://doi.org/10.1016/j.stueduc.2007.04.001

Vannucci, M., & Coll, V. (2010). Educational Software as a Learning Tool for Primary School Students. In *New Achievements in Technology Education and Development*. InTech. https://doi.org/10.5772/9227

Vernon, M. M., Balas, E. A., & Momani, S. (2018). Are university rankings useful to improve research? A systematic review. *PLOS ONE*, *13*(3), e0193762. https://doi.org/10.1371/journal.pone.0193762

Vilcea, M. A. (2014). Quality Culture in Universities and Influences on Formal and Non-formal Education. *Procedia - Social and Behavioral Sciences*, *163*, 148–152. https://doi.org/10.1016/j.sbspro.2014.12.300

Villalobos, C. (2016). Google Chromebook pilot evaluation: An evaluation of professional

development and incorporation of Google Chromebook hardware and software applications [Azusa Pacific University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/google-chromebook-pilot-evaluation-professional/docview/1876895376/se-2?accountid=14570

Virdia, S., & Schindler, S. (2019). Educational upgrading, career advancement, and social inequality development from a life-course perspective in Germany. *Research in Social Stratification and Mobility*, *60*(2), 29–38. https://doi.org/10.1016/j.rssm.2019.02.002

Vitale, D. C., Armenakis, A. A., & Feild, H. S. (2008). Integrating Qualitative and Quantitative Methods for Organizational Diagnosis. *Journal of Mixed Methods Research*, *2*(1), 87–105. https://doi.org/10.1177/1558689807309968

Voas, J., & Laplante, P. (2017). Curriculum Considerations for the Internet of Things. *Computer*, *50*(1), 72–75. https://doi.org/10.1109/MC.2017.27

Vossenkuhl, A. (2010). (Berufs-)Schulpflicht in Deutschland. *Berufsbildung in Wissenschaft Und Praxis*, *39*(6), 53–54. http://www.bibb.de/veroeffentlichungen/de/publication/download/id/6512

Vuorikari, R., Punie, Y., Carretero, S., & Van Den Brande, L. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens* (pp. 1-). Publications Office of the European Union. https://doi.org/10.2791/11517

Wakefield, J., Frawley, J. K., Tyler, J., & Dyson, L. E. (2018). The impact of an iPad-supported annotation and sharing technology on university students' learning. *Computers & Education*, *122*, 243–259. https://doi.org/10.1016/j.compedu.2018.03.013

Walbe Ornstein, S., Saraiva Moreira, N., Ono, R., Limongi França, A. J. G., & Nogueira, R. A. M. F. (2009). Improving the quality of school facilities through building performance assessment. *Journal of Educational Administration*, *47*(3), 350–367. https://doi.org/10.1108/09578230910955782

Waldow, F. (2014). Conceptions of Justice in the Examination Systems of England, Germany, and Sweden: A Look at Safeguards of Fair Procedure and Possibilities of Appeal. *Comparative Education Review*, *58*(2), 322–343. https://doi.org/10.1086/674781

Walker, R., & Baets, W. (2009). Instructional Design for Class-Based and Computer-Mediated Learning. In *Applied E-Learning and E-Teaching in Higher Education* (pp. 244–264). IGI Global. https://doi.org/10.4018/978-1-59904-814-7.ch012

Wang, M.-T., & Degol, J. L. (2016). School Climate: A Review of the Construct, Measurement, and Impact on Student Outcomes. *Educational Psychology Review*, *28*(2), 315–352. https://doi.org/10.1007/s10648-015-9319-1

Wang, M.-T., & Hofkens, T. L. (2020). Beyond Classroom Academics: A School-Wide and Multi-Contextual Perspective on Student Engagement in School. *Adolescent Research Review*, *5*(4), 419–433. https://doi.org/10.1007/s40894-019-00115-z

Wang, P. S. (2017). *From Computing to Computational Thinking*. Chapman and Hall/CRC. https://doi.org/10.1201/9781315115320

Watt, D. (2019). Video Production in Elementary Teacher Education as a Critical Digital Literacy Practice. *Media and Communication*, *7*(2), 82–99. https://doi.org/10.17645/mac.v7i2.1967

Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). Computer science in K-12 school curricula of the 2lst century: Why, what and when? *Education and Information Technologies*, *22*(2), 445–468. https://doi.org/10.1007/s10639-016-9493-x

Weber, K. E., Gold, B., Prilop, C. N., & Kleinknecht, M. (2018). Promoting pre-service teachers' professional vision of classroom management during practical school training: Effects of a structured online- and video-based self-reflection and feedback intervention. *Teaching and Teacher Education*, *76*, 39–49. https://doi.org/10.1016/j.tate.2018.08.008

Weber, S., & Achtenhagen, F. (2017). Competence Domains and Vocational-Professional

Education in Germany BT - Competence-based Vocational and Professional Education: Bridging the Worlds of Work and Education. In M. Mulder (Ed.), *Competence-based Vocational and Professional Education* (pp. 337–359). Springer International Publishing. https://doi.org/10.1007/978-3-319-41713-4_16

Weingartner, S. (2021). Digital omnivores? How digital media reinforce social inequalities in cultural consumption. *New Media & Society*, *23*(11), 3370–3390. https://doi.org/10.1177/1461444820957635

Wells, C. L. (2017). Understanding issues of control in top-down management pedagogies. *Power and Education*, *9*(3), 192–201. https://doi.org/10.1177/1757743817737334

Whitehead, B. M., Jensen, D. F. N., & Boschee, F. (2013). *Planning for Technology : A Guide for School Administrators, Technology Coordinators, and Curriculum Leaders: Vol. Second edi*. Corwin.

Wiedemann, G. (2016). *Text Mining for Qualitative Data Analysis in the Social Sciences*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-15309-0

Wijaya, H., & Gruber, K. E. (2018). Ethics perspective and regulation of plagiarism in Higher Education. *International Journal of Humanities and Innovation (IJHI)*, *1*(1), 17–25. https://doi.org/10.33750/ijhi.v1i1.4

Wild, S., & Schulze Heuling, L. (2020). How do the digital competences of students in vocational schools differ from those of students in cooperative higher education institutions in Germany? *Empirical Research in Vocational Education and Training*, *12*(1), 5. https://doi.org/10.1186/s40461-020-00091-y

Willis, R. L., Lynch, D., Fradale, P., & Yeigh, T. (2019). Influences on purposeful implementation of ICT into the classroom: An exploratory study of K-12 teachers. *Education and Information Technologies*, *24*(1), 63–77. https://doi.org/10.1007/s10639-018-9760-0

Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *366*(1881), 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Wolf, R. (2009). Altersstruktur der Lehrerschaft an öffentlichen Schulen in Baden-Württemberg. *Statistisches Monatsheft Baden-Württemberg*, *8*(4), 3–10. http://www.statistik.baden-wuerttemberg.de/Service/Veroeff/Monatshefte/PDF/Beitrag09_08_01.pdf

Wong, K. K. (2018). *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries*. Information Age Publishing.

Wong, K. K., Knüpling, F., Kölling, M., & Chebenova, D. (2018). Federalism and Education: Cross-National Lessons on Governance, Standards and Accountability for the 21st Century. In *Federalism and Education: Ongoing Challenges and Policy Strategies in Ten Countries* (pp. 1–18). Information Age Publishing.

Wong, K. M. (2021). "A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it" by Lee and Hannafin (2016): an international perspective. *Educational Technology Research and Development*, *69*(1), 93–96. https://doi.org/10.1007/s11423-020-09842-w

Wuttke, E., Seifried, J., & Niegemann, H. M. (2020). Editorial: In *Vocational Education and Training in the Age of Digitization* (pp. 9–14). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctv18dvv1c.3

Yeh, Y.-F., Chan, K. K. H., & Hsu, Y.-S. (2021). Toward a framework that connects individual TPACK and collective TPACK: A systematic review of TPACK studies investigating teacher collaborative discourse in the learning by design process. *Computers & Education*, *171*, 104238. https://doi.org/10.1016/j.compedu.2021.104238

Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S. K. W. (2019). A systematic review of flipped classroom empirical evidence from different fields: what are the gaps and future

trends? *On the Horizon*, *27*(2), 72–86. https://doi.org/10.1108/OTH-09-2018-0027

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Zawacki-Richter, O. (2021). The current state and impact of Covid-19 on digital higher education in Germany. *Human Behavior and Emerging Technologies*, *3*(1), 218–226. https://doi.org/10.1002/hbe2.238

Zhang, Y., & Teng, Z. (2021). *Natural Language Processing*. Cambridge University Press. https://doi.org/10.1017/9781108332873

Zhao, Z. (2014). Curriculum Research. In Z. Zhao & F. Rauner (Eds.), *Areas of Vocational Education Research* (pp. 189–214). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-54224-4_10

Zou, D., & Lambert, J. (2017). Feedback methods for student voice in the digital age. *British Journal of Educational Technology*, *48*(5), 1081–1091. https://doi.org/10.1111/bjet.12522

Zylka, J. (2018). *Digitale Schulentwicklung: Das Praxisbuch für Schulleitung und Steuergruppen*. Beltz.

Appendix

Dictionary of German expressions and Comparable English Translation (Study 1)

German Expression	English Expression
Analog-Digital	analog-digital
Analog-Digital-Umsetzer	analog to digital converter
Analog-Digital-Wandlung	A/D conversion
digital	digital
Digitalagenturen	digital agency
Digital-Analog-	digital-analog
Digital-analog-Wandlern	digital-analog converter
Digital-Analog-Wandlung	digital-analog conversion
Digitalanzeige	digital display
Digitaldruck	digital printing
Digitaldruckarbeiten	digital printing works
Digitaldruckausgabe	digital printing output
Digitaldrucke	digital prints
Digitaldruckfarben	digital printing colours
Digitaldruckmaschine	digital printing machine
Digitaldruckpapier	digital printing paper
Digitaldruckproduktion	production in digital printing
Digitaldrucksystem	digital printing systems
Digitaldrucktestkeil	digital print vedge
Digitaldruckverfahren	digital printing process
Digitalfotografie	digital photography
Digitalgerät	digital machine
digitalisieren	to digitalize
digitalisierte	digitalized
Digitalisierung	digitalization
Digitalisierungsgrad	grade of digitalization
Digitalisierungsinhalte	contents of digitalization
Digitalisierungsmanagement	management of digitalization
Digitalisierungstablett	digitalization tablet
Digitalkamera	digital camera
Digitalmedien	digital media
Digitalmedienprodukte	digital media product
Digitalmedienproduktion	digital media production
Digital-oszilloskop	digital oscilloscope
Digitalquarzuhr	digital quartz clock
Digitalsignalprozessoren	digital signal processor
Digitaltechnik	digital technic
Digitalwaage	digital scale
Digitalwandlung	digital conversion

Note. The list has been reduced to base forms in consideration of language differences.

Coding Guideline – KMK-Strategy Components and Vocational School Curricula (study 2)

Component	Criteria	Examples
Searching, Processing and Storing (SPS)	• search strategies • information retrieval • data storage	"Students learn how to retrieve digital information." "Students know how digital storage works."
Communicating and Cooperating (CC)	• digital communication tools • sharing of information • collaborative work • formal and informal rules of digital communication • participation in the society	"Students are able to communicate with digital messengers." "Students are cooperating with digital tools."
Producing and Presenting (PP)	• creation, editing, presentation of digital resources and products • legal restrictions	"Students use digital presentation tools." "Students are able to work with digital objects."
Protecting and Securing (PS)	• digital risks • psychological and physical challenges • environmental impact • personal data • data privacy	"Students learn how to protect their digital data." "Students are informed about the impact of digitalisation on the environment." "Students have an understanding about digital sustainability."
Problem-solving and Acting (PA)	• identification of technical problems • deploying digital tools • computational thinking	"Students know how to handle digital simulations." "Students are able to identify technical problems and find digital solutions."
Analysing and Reflecting (AR)	• digital media • spreading of information digital influence on society, politics and economy.	"Students know about the influence of digital media." "Students know how digital software can be used to alter media formats."

Coding Guideline - Distance Learning in Vocational Schools (study 4)

Category	Criteria	Examples
Organisation	• Organisation processes within the school • flow of information • introduction of schedules • formalised regulations • unified implementation of tools	"I have all the information I need." "Everything seems chaotic and unorganised." "The teachers should use the same tools."
Technical Infrastructure	• available software • available hardware • server infrastructure • IT administration • Internet connection (within the school/at home) • licencing of software • digital tools • LMS • connectivity of IT systems	"Our servers are too slow." "I have to figure out everything by myself, nobody helps with my computer problems." "The LMS works perfectly."
Teaching	• teaching practices • quality of teaching methods • quality of teaching tools • teacher-student relationship • class-room activities • best-practice examples	"I think video classes are a good way to teach." "The uploaded documents are had to access." "My teacher uses YouTube Videos." "Written assignments are worse than live video classes!"
Feedback	• feedback processes • feedback regulations • feedback tools • perceived importance of feedback • best-practice examples	"I need more feedback for my assignments." "I cannot provide feedback to all my students." "The feedback I am getting helps me to learn. "

Motivation and Learner Success	• changes in motivation • perceived learner success • influence factors on motivation • support processes for learner success • measurement of leaner success • assessment tools and strategies	"I cannot focus during digital distance learning." "Students do learn less during video classes." "We need better way to assess students." "Without grades, students are not motivated to participate in classes."
Social Interaction and Support	• relationship between stakeholder groups • support systems • practical assistance • best-practice examples	"The principal is open for suggestions from the teachers." "My training company does not care about the situation at schools." "We have set up special rooms for students who cannot work from home."
Personal Resources and Stress Factors	• impact on day-to-day life • workload • coping strategies • living situation (family, urban, rural)	"My siblings are bothering me." "Digital distance learning requires more effort than on-site teaching." "I need to ride the bus for a long time to get to the school. If I work from home, I safe a lot of time."
Further Education and Training	• further education needs • perceived competence of teachers • availability of training programmes • pre-service teacher education	"My teachers do know how to use the different tools." "I need further training to implement digital tools in distance learning." "Digital methods have not been part of my pre-service teacher training"

Curriculum Vitae

Appointments

Since 2015	Research Assistant, Economic and Business Education – Learning, Design and Technology, Business School, University of Mannheim, Germany
	Project Assignments: Evaluating the Language Skills of Children with Immigrant Roots Distance Learning in Vocational Schools innoMA – Enabling Innovation and Fostering Transfer: Structures for Digital Teaching at the University of Mannheim

Professional Preparation

2015	Master of Arts, Social Work, University of Applied Science Mannheim, Germany "Pfandsammler"
2012	Bachelor of Arts, Social Work, University of Applied Science Mannheim, Germany "Videospiele als Anlass zur medienpädagogischen Arbeit in Familien"

Teach Activities

Since 2020	Supervising master theses
Since 2019	Teaching at Vocational Schools with Tablets (Graduate level – German)
Since 2015	Statistical Methods for Economic and Business Education (Undergraduate level - German) Educational Management (Undergraduate level – German)
	Supervising bachelor theses Supervising master theses
2016	Learning and Work Strategies (Undergraduate level – German)

Memberships

AERA, AECT