

The Digital Change of Vocational Training and Business Education: What it Takes to Prepare Students for the Future Challenges of the Job Market

Susanne Kamsker
Department of Business Education and Development
University of Graz, Austria

Peter Slepcevic-Zach
Department of Business Education and Development
University of Graz, Austria

Corresponding Author: Susanne Kamsker, susanne.kamsker@uni-graz.at

ABSTRACT

There is no doubt that the increasing use of technology and digitalization leads to a more differentiated discussion of the digital transformation in work and daily life. The digital transformation can now be regarded as central technological and social phenomenon (Fürst, 2019). It has triggered a hype. To “be digital” is now the basic requirement for work and the participation in society (Hartmann et al., 2019; Mertala, 2019). To get digital, it is important to keep pace with the social, cultural, and economic changes which are driven by the digital transformation. Educational institutions over all levels of education are concerned with the question of how educational offerings must be designed to prepare learners for encountering and participating in the digital change. This question will also be addressed in this paper. The paper tries to answer the research question, what are central problems and issues of business education due to new and changing qualification and skill requirements of future workers in the age of digital transformation. The aim of the paper is to show what is needed to design modern digital educational offers to prepare learners for the encounter of the digital transformation and to encourage them to participate in shaping it. To achieve this research goal a literature-based analyses was carried out. In addition to central aspects for further development of business education, like the development of educational staff (e.g. teachers) and the vocational theory, it is important to think about issues of digital transformation for the general business education and development, school education and in-company education and training. The bundling of relevant issues on the digital transformation of business Education and their answers will help to shape the digital transformation and prepare the next generation for the future challenges at work and in daily life.

Keywords: Business education and development, vocational training, digital transformation, future work challenges, digitally transformed students

Introduction

The digital transformation affects all aspect of our (professional) life. Business processes and our understanding of their functionality are changing permanently. In addition to the widespread term digitization that describes a process of conversion and integration of analogue to digital data and

information (Harwardt, 2019), the term digital transformation has established itself around the last turn of the millennium (Becker & Botzkowski, 2019). One generally applicable definition for digital transformation cannot be found. While some definitions focus on the economic aspects, other descriptions concentrate on the consequences for people's live, the social sphere or society. Nevertheless, there is something in common between the attempted definitions for digital transformation: Digital transformation starts with digitization and should be seen as a more far-reaching and demanding process of thinking and structuring (Harwardt, 2019; Perkin & Abraham, 2017). The aim of digital transformation is therefore to realign and adapt technology and business models and to evaluate current basic structures to improve and further develop existing processes based on the knowledge gained (Krcmar, 2018).

These serious changes are a big challenge for the business education system. The digital transformation stimulates change processes in business practice which goes hand in hand with new skill and qualification requirements of future workers. There is also a change of the way of how teaching and learning occurs. All these aspects create new problems and issues for business education. That is the reason why the main goal of this paper is to present relevant issues, that need to be addressed to further develop business education influenced by the digital transformation. For this purpose, a literature-based analysis was carried out. Relevant literature on the digital change of the labor market focussed on new qualification and skill requirements of future workers, new challenges for business education in the age of digital transformation and on further development of business education was analysed and will be discussed.

After a short introduction, section 1 focusses on the new qualification and skill requirements that are necessary to deal with challenges provoked by digital transformation. Section 2 discusses these challenges for the business education in Austria. The following discussion (Section 3) focusses on the Vocational Education and Training (VET) programs in Austria (apprenticeship training (dual system)), VET schools (BMS) and VET colleges (BHS) and the impact of digital transformation on these programs. The paper ends with a conclusion and further work of research.

The digital transformation of the world of work – new qualification and skill requirements

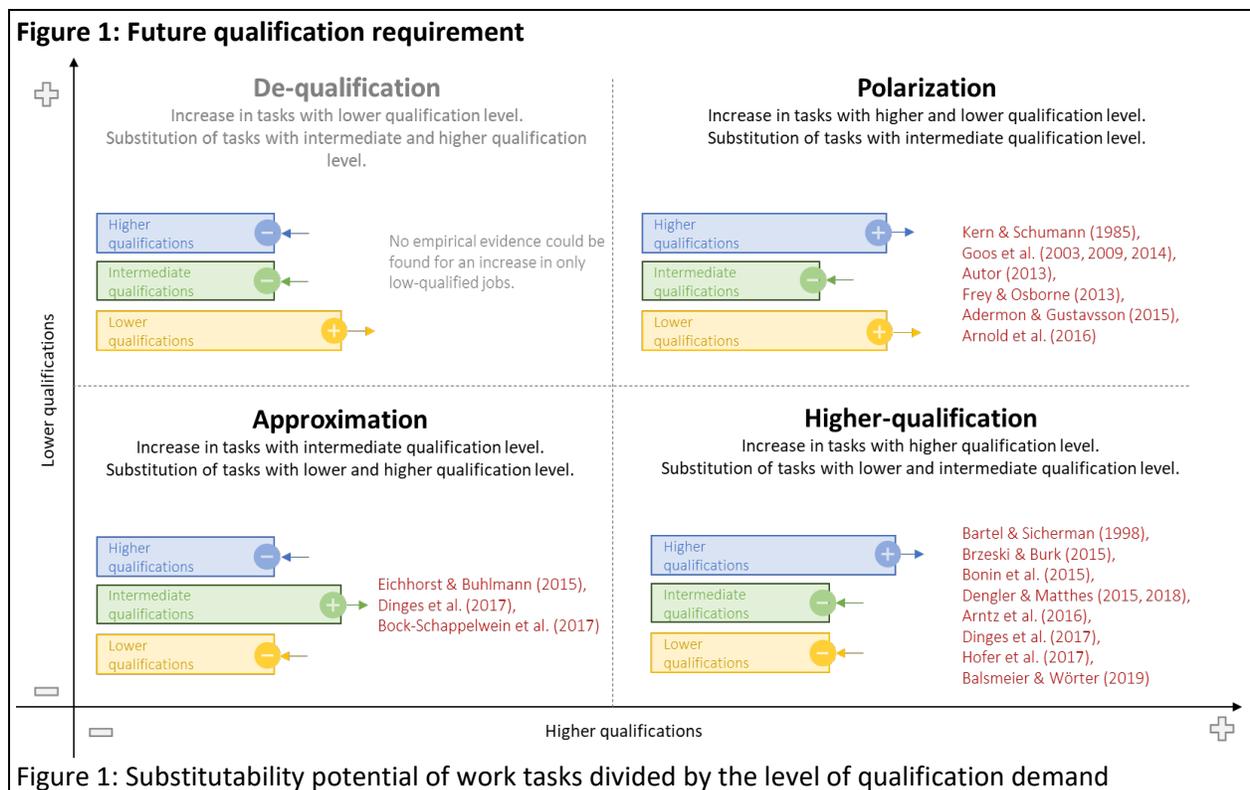
In the context of digital transformation, organisations invest a substantial amount in new technical innovations to make production processes more efficient, create more sustainable structures and build a network of consisting working processes to increase the economic output. New machines driven by computers and artificial intelligence lead to a substitution of human labor force and a massive change in daily working tasks. This disruptive potential leads to serious changes from the perspective of the companies and the employees. The progress of the transformation processes is therefore not questioned and is considered as a reliable constant in a currently volatile and complex world (Ahrens & Gessler, 2018). Starting with mechanization, through assembly line production to the automation of work processes, the world of work has been revolutionized step by step (Kleine Sextro et al., 2019; Lasi et al., 2014). Nowadays, computer-controlled machines and cyber-physical systems as well as artificial intelligence are considered to have the potential of changing working processes significantly. In this context, apart from the increase in resource-saving, efficient production processes are linked to the people who guide the business processes. The use of new technologies leads to a change in individual

work tasks and areas of responsibility of employees. The association of the digital transformation with an increase in efficiency in operational processes as well as the human labor force implies different prognoses regarding current and future employment perspectives (Dinges et al., 2017).

The international controversial discussion about the digital transformation of the labor market is still going on, and there are different opinions about the importance of higher and lower qualifications. Nevertheless, the research results can be located between two opposing aspects – the loss of existing jobs (job destruction), or the generation of new jobs (job creation) (Dosi et al., 2019). Furthermore, this discussion raises the question, of whether the content of labor tasks (task-based approach) or entire occupational profiles (occupation-based approach) will be shifted by technological change. For example, one of the most well-known, and today often criticized thematic studies by Frey & Osborne (2013) is based on the approach that computerization will probably lead to the disappearance of entire occupational profiles (occupation-based approach). The criticism of this approach mainly refers to the inaccuracy of the analysis of entire occupational profiles and the superficiality of the approach by grouping bundles of tasks under a single occupation. Moreover, the working tasks of jobs with the same job title do not necessarily have to be the same (Suta et al., 2018; Bonin et al., 2015). For this reason, the so-called task-based approach, which allows for more precise and targeted analyses, became established in the research landscape shortly afterwards. In this process, individual work tasks are used as object of investigation (Arntz et al., 2016a; Bonin et al., 2015; Dengler & Matthes, 2015) which ultimately determine whether workplaces can be completely or partially automated. The degree to which individual tasks of a workstation can be automated will be measured (Suta et al., 2018). Peneder et al. (2016) conclude from their studies that the automation of individual work tasks will take place within occupational profiles. A change in the occupational structure is therefore rather unlikely, whereas the work contents will continuously change using new technologies.

Regardless of the perspective on the substitutability potential of work tasks or occupational profiles, the scenarios of the digital transformation of the labor market show that especially performing and routine tasks with lower qualification levels could be increasingly replaced by computer-controlled machines and artificial intelligence in the future. By contrast, the probability of substituting tasks of highly qualified employees would be significantly lower since highly qualified personnel is ascribed the further development and maintenance of economic activity with the inclusion of technological innovations. There is still disagreement about the substitutability of tasks with medium qualification levels (Abel, 2018; Cirillo et al., 2020).

Figure 1 provides an overview of the forecast changes in the labor market regarding the substitutability potential of work tasks through the digital transformation. The figure is divided by the level of qualification demand. Furthermore, relevant studies for this discussion are presented to point out which trends are considered to have a higher probability of occurrence and in which area the research findings can currently be located.



The results of the qualification research show different theses. These theses are summarized in four sectors of development and represent the qualification level of employees that will be necessary in the future. The theses presented in Figure 1 can be positioned between the higher-qualification-thesis or the de-qualification-thesis of future employees. If there is an increasing relevance of higher education and the decline of work tasks with lower qualification levels, this trend is assigned to the higher-qualification-thesis. In contrast, the de-qualification-thesis describes the increase in low-qualified jobs on the labor market due to an increasing substitutability potential of jobs at an intermediate or higher qualification level.¹ Between these two directions there are two more trends: the polarization-thesis (tasks with smaller as well as with higher qualification level increase) or the approximation-thesis (tasks with middle qualification will increase) of changed tasks with different requirement levels. Many studies assume that it will be necessary for enterprises to recruit more highly qualified employees in the future. A lot of studies also see a trend towards polarization. To increase work tasks at a higher level of education, there will also be an increase in tasks with lower qualification requirements. In addition to the discussion of the different qualification levels of future employees, it is important to talk about necessary skills in a time which is guided by digital change (European Commission, 2020).

¹ Empirical studies and evidence for the de-qualification-thesis could not be found. That is the reason why the area of de-qualification is printed in grey in Figure 1. However, there are some predictions of an increase in jobs at a low requirement level which can be attributed to the reduction in qualifications of tasks in the middle occupational sector (Klammer, 2017) or to automation gaps and new tasks to control automation processes (Hirsch-Kreinsen, 2016).

Due to the changes in work tasks as a result of the digital transformation, interdisciplinary (e.g., communication and problem-solving skills, process understanding) and personal skills (e.g. language and intercultural skills) are becoming more and more central (Laar et al., 2017; Arntz et al., 2016b). This implies that the technical knowledge and the disciplinary skills can still be regarded as necessary, but no longer as sufficient conditions. In the future multiple qualifications will become increasingly important. Accordingly, each person should develop a broad variety of skills and try to improve his or her skills every time (Schrack, 2018). These requirements of skills from workers and members of society have existed for some time and are not new. Nevertheless, in the context of the digital transformation as a new driver of social and labor policy processes, a different perspective must be adopted, and it must be emphasized that the value of individual skills has shifted. In addition to relevant knowledge, the focus is now on other skills in a personal and social context (Schrack, 2018; Euler, 2017), which can be explained by the competitive advantages of human versus machine forces (Arntz et al., 2016b). These changes and new requirements of qualification and skills from future workers present new challenges for the vocational educational training. The design of educational offers due to the digital transformation is demanded by companies as well as by the society.

New challenges for business education due to digital transformation

The intensity and direction of the consequences of the digital transformation on the labor market has mostly been based on predictions. Forecast trends about the change of the employment structure must be viewed critically under country-specific conditions and the probability of occurrence and scope. However, the growing importance of education in the age of digital transformation should not be questioned (Arnold & Pachner, 2011). Nagl et al. (2017) also illustrate the growing relevance of higher levels of education by the correlation between the automation potential of work tasks and the educational level of Austrians. As early as 2012, the automation probability of work tasks with a primary and lower secondary level of education was about 65%, whereas persons after finishing upper secondary education face a risk of being replaced by computer-controlled machines of about 55%. This shows the negative correlation between automation probability and educational level. The relevance of education and lifelong learning as well as the increase in tertiary education offers and their demand is once again emphasized based on these data. The gap between the high automation potential of work with a low level of education and the low automation potential of work with a high level of education should be pointed out. In the context of the growing importance of education, vocational training is becoming increasingly important. In Austria, VET represents a significant part of the educational landscape, whereby the focus is usually on school-based (VET schools and colleges) and company-based (dual training) educational opportunities (Baethge et al., 2007).

One part of VET is business education and development. In Austria, business teacher education, which allows graduates to teach business subjects in full-time schools for vocational education, is carried out in the economic and social science master's degree program business education. This master's program qualifies students not only for the teaching profession but also for employment in the private sector as well as in public administration. This dual qualification offers a wide spectrum of work possibilities for graduates and is the reason for a broader understanding at the Institute of Business Education and

Development of the University of Graz. In addition to questions of business education, there are also questions of organizational development.

The digital transformation is like an ongoing process, which affords a continuous development in every part of work and daily life. Through this constant development of digital transformation, which means adapted and totally new business models, efficient working processes, basically reformed working structures and a new way of thinking by using digital data and information (also compare the definition of digital transformation in the introduction), there are always new perspectives and opportunities for individuals, organizations, educational institutions, societies and the national economy. For example, individuals get the chance to sell themselves as a labor-brand or to get new generated, interdisciplinary jobs. Organizations have the chance to increase competitive strength through disruptive innovations. In the field of education, it gets much more important for educational institutions to educate future workers, and so it is possible to shape the digital transformation. For example, learning processes can be supported by reconstruction and the use of web-based technologies and artificial intelligence to contribute to the development of future employees (Heuermann et al., 2018).

On the one hand there are a lot of potentials linked to the digital transformation, but on the other hand there are also a lot of risks. For example, it gets increasingly important to analyse the progressive substitution of working tasks which are represented in algorithms and to demonstrate openness to disruptive innovations to be competitive in the competition of future workers. Due to the educational sector, risks like the danger of a future increase in digital illiteracy and the loss of critical thinking are pointed out (Heuermann et al., 2018; Frey & Osborne, 2013). Considering the opportunities and risks cited as examples, it can be mentioned that the digital transformation has a huge impact on various areas of reality and different disciplines.

Thus, also business education must deal with new issues about the topic of digital transformation. Educational policy issues in this context usually still refer to the media level and methodological innovations, whereas other didactical aspects, such as teaching and learning content, are considered on a more semantic level (Braun et al., 2020). However, business education is a part of a broad field of research and practice and is surrounded by digitally influenced developments. Ostendorf (2017) outlines the issues that are relevant for business education in the context of digital transformation (Figure 2).

Figure 2: Research and practice fields of business education and development

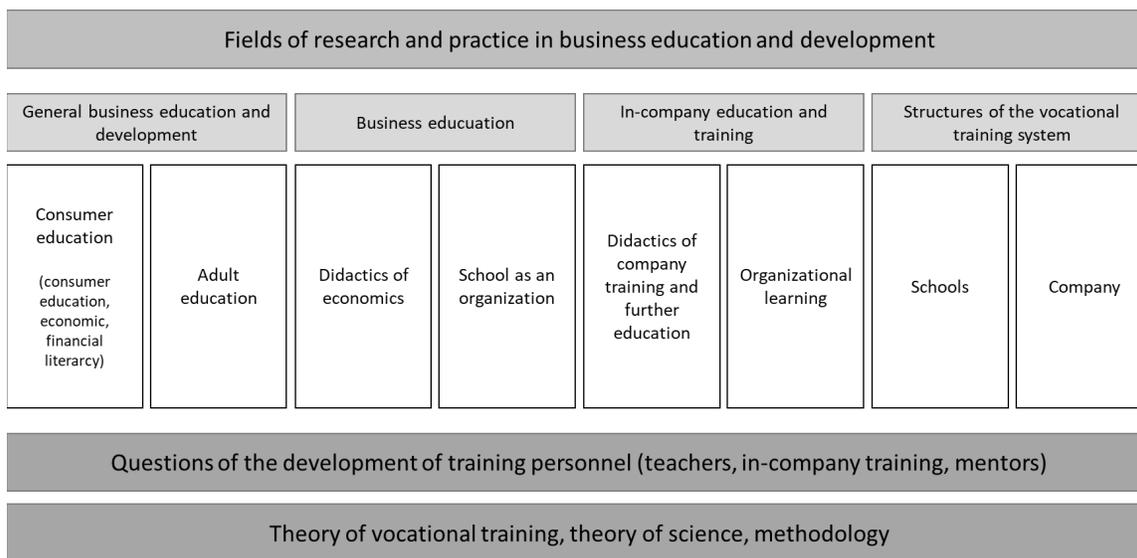
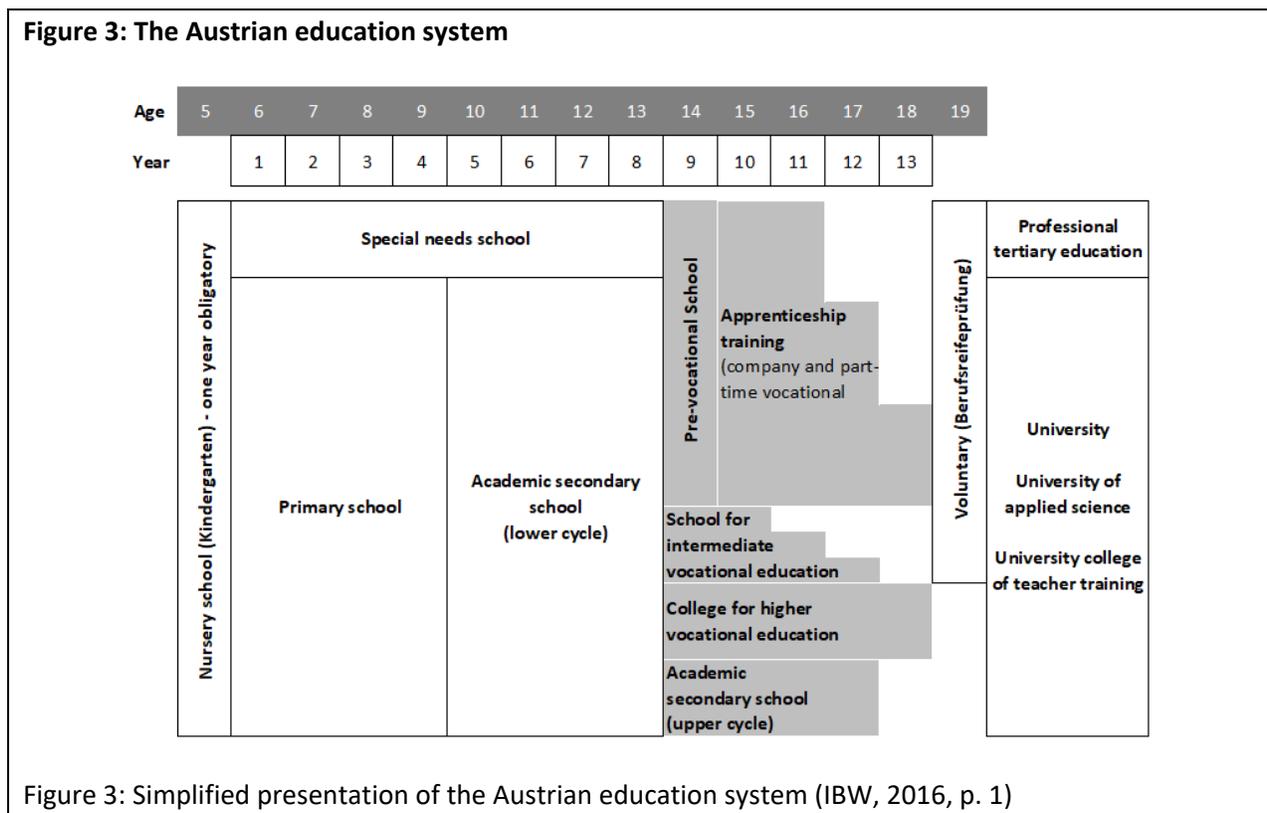


Figure 2: Presentation and differentiation of the fields of research and practices in business education and development (Ostendorf, 2017, p. 9)

The part of consumer education focusses on the economic and financial education of the entire population. In an increasingly insecure world, under the influence of new technologies, individuals are challenged to make decisions economically. In addition to the enormous flood of information and the possibility of generating new amounts of data at any time and any place, the actual time-period is characterized by commercial transactions on the internet or, for example, electronic business transactions. The need to create awareness of these outlined developments through education is linked to this part of business education. In addition, the focus is increasingly on the education of adults, and the measures are understood as a reaction to the dynamic changes of digital transformation in the labor market and as a way of shaping the future employment relationships. This is also a new way to put on a new value to lifelong learning. The research work in the field of school pedagogy is mainly concerned with teaching surrounded by new technologies. However, the content aspect as well as the teaching and learning objectives of business education must be also adapted and researched (e.g., core content in addition to profound specialist knowledge, setting of content priorities and subject design, anchoring of interdisciplinary thinking). One level above this is the level of school education management. In this context, a discourse on the equipment, the strategic positioning of vocational schools and colleges as well as a possible cooperation with partners from the economy and the further training of teachers in terms of content, didactics and media didactics are to be discussed. In the field of in-company education and training new occupational patterns, occupational fields and work tasks are discussed. The companies are challenged to qualify or retrain their employees, which is why didactical concepts are important to promote employability. An essential aspect for all areas of business education is the examination of future training and further training for educational staff. In addition, the design and structure of the vocational training system must be reviewed and discussed regarding digital transformation (Ostendorf, 2017).

Digital transformation and schools for business education in Austria

In Austria, every child’s education starts with four years at primary school. The first differentiation in the Austrian school system is at the beginning of the lower secondary level. Schoolchildren at that stage have a choice between two types of schools that last for four years each (see Figure 3).



For many of the Austrian schoolchildren, the first school year at the upper secondary level is also the final year of compulsory schooling. Then they can decide between a vocational (VET) and a general education pathway. Both forms are virtually equal in terms of student numbers (Stock et al., 2019). VET programs are provided within the framework of apprenticeship training (dual system) at VET schools (Berufsbildende Mittlere Schulen = BMS) and VET colleges (Berufsbildende Höhere Schulen = BHS). Successful completion of an academic school (Allgemeinbildende Höhere Schule = AHS) or VET colleges (Berufsbildende Höhere Schulen = BHS) provides students with higher education entrance qualifications and hence access to universities.

About 78% of the 16 year old teenagers are part of the vocational school system in Austria. This shows the importance of vocational training for Austria compared to the European countries. The young people are either in a dual or full-time school education (Schrack, 2018). The school types are oriented

among external aspects like the current requirements of the job market and the economy. This is the reason, why schools cooperate with companies from the economy, associations, or state institutions to prepare their students to shape the future through innovations and skills. Because digital transformation has an influence on both professional and private life and is thus increasingly being discussed, it is also an object of reflection and design in vocational education training. The didactic principle of vocational schools is therefore based on actuality and the response to different practical and theoretical qualification requirements originating from the economy (Bronnhuber, 2016). A decade earlier, there were efforts to orient schools to new information and communication technologies. Even back then, the focus was on the further development of young people and the design of learning opportunities geared to current practical requirements such as the use of information and communication technology. Only the focus of schools has shifted over time. In this respect, Euler (2017) notes that occupational profiles have always changed, some have disappeared, and others have been added. Today, the main challenge is to remain flexible in the design and focus of vocational education and training, to respond to changes and to take account of new trends and new social demands in institutional, curricular, and didactical terms. Within the frame of reference of digital transformation, for example, learning provision must be adapted to meet changing requirements and qualification profiles as well as skill requirements (Euler, 2017). The possibility of stimulating and supporting learning processes with new technologies and innovative methods should not be neglected and seen as an opportunity for the design of teaching and learning offerings. There is also the possibility of using digital media (e.g., tablets) to shape work processes in the future, which is why this should also be considered in the design of training (Gerholz & Dormann, 2017).

One point of school development in the context of facing the digital transformation can be found in the Digitization Master Plan of Austria. This plan is intended to help schools to adapt teaching and learning in times of digital transformation. The goal is to respond to the changes linked to the increasingly digitized world and to integrate its effects step-by-step into Austria's education system. To achieve this goal, the government defined three points which have to be revised and integrated in the development of the school system (BMBWF, 2018):

- (1) Teaching and learning content
- (2) Education, further education and training of teachers
- (3) Infrastructure and modern school administration

The rethinking of current (1) teaching and learning content is reflected in the required revision of existing curricula. It is important to recognise the new necessary skill equipment for fulfilling digitally changed working tasks and implement it into the curriculum. A basic understanding of questions of digital transformation should be created at all school levels. The teaching and learning processes will be accompanied by digital tools. Initially, (2) in-service and permanent trainings of teachers should be offered and carried out in schools. In these meetings of teachers, a new framework of curricula should be created and applied. The third aspect (3) relates to the technical infrastructure of the schools and the use of digital end devices. The new technologies should be available nationwide. In addition, there is a focus on simplifying school administration through helpful programs and tools and the provision of a service portal for digital schools (BMBWF, 2018).

The digital transformation does not only affect the design of teaching and learning processes. There is also an effect on the people who participate in them. A key cohort that is also facing changing demands is the teaching staff. Teachers must deal with new technologies and must develop new skills in dealing with the digitalization. Many of the teachers believe that new information and communications technology and ongoing digitization enrich the school system and hold a great potential for designing lessons. For example, a study conducted by Bitkom (2015) pointed out that 95% of teachers are open-minded about new media and support using new technologies in class. Only 5% of teachers see something negative in this digital change. The handling and use of new media in learning processes must therefore be promoted in addition to the skill requirements for teachers which have always been predominant and is summarized under media-related competence. A breakdown into media education, media didactics and information technology facets provide more precise information about the partial aspects of media-related skills. It should be emphasized that professional, methodological, social and personal skills (Peterßen, 2005) are still of great importance and should be promoted. A network of these skills, which are required for the first time, should be strived for. In addition to this, the ability to reflect and criticize, to include motivational and emotional factors in the classroom, promote empathy or the ability to design media should of course be promoted (Schultz-Pernice et al., 2017; Verein Industrie 4.0 Österreich, 2017). The development of knowledge in the field of computer science is becoming more and more important and is now a basic part of the general education of teaching staff. In addition, it is more important to promote problem-solving skills, innovativeness, and creativity in the use of digital media. All the above-mentioned skills must be placed in the context of the subject specifics in order to address both general and subject-related didactic objectives (Schultz-Pernice et al., 2017).

There is also a change in the teachers' understanding of their personal role. Students can download concrete detailed information on any subject on the internet (e.g., via YouTube videos). This opens the opportunity to deepen content in such a way that the students become experts in some cases and acquire more highly differentiated knowledge than their teachers. The learning materials on the web are also getting of higher quality and are freely accessible to learners. It is much more difficult for teachers to develop subject expertise compared to world knowledge on the web. For this reason, teachers should not see themselves only as knowledge mediators. They should step in the role of an advisor or a coach. Teachers must design new exercises and hand it to their students. Then the students solve the exercises independently with digital aids. The students thus acquire knowledge independently and try to apply this knowledge to the problems they face. In the classroom there is more room for reflection and exchange as well as for consolidation and application of knowledge. The 'flipped classroom teaching and learning arrangement' can be cited as an example of the change in the teacher's understanding of their role. The term 'flipped or inverted classroom' is translated as reverse teaching and implies that "events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (Lage et al., 2000, p. 32). Teaching with this concept, which is not new but has been awakened (Walvoord & Anderson, 1998; Lage et al., 2000), brings some changes for the teachers. The changed understanding of roles implies that the learners are given freedom, that the focus is on the learners, that the selection of content is goal-oriented and that they are coached and accompanied in class (Kamsker & Slepcevic-Zach, 2018).

Conclusion and further work of research

Digitization – or, more precisely, the digital transformation – also confronts business education with new issues, both at all levels of education and in organizations. It is getting apparent that the relationships as well as the understanding of roles of individuals (whether they are teachers and learners or colleagues) are subject to a process of change. The forms of organization and work are also affected by the changes brought about by digital transformation.

However, in some cases, the issues are not entirely new questions, but rather questions that have already been dealt with, and which require a new answer. This can concern both problems of how to design learning-friendly teaching with new media or innovative IT applications and questions that address the development towards a learning organization in an increasingly digitally transforming world of work and everyday life. Dealing (as positively as possible) with changes in an increasingly volatile, uncertain, complex, and ambiguous world is, and remains a central issue for future business education research. Therefore, the digital transformation represents a central object of reflection for the educational institution of schools, especially for vocational schools. Not only the didactic questions on the use of digital media and methods, but also the didactic facets of learning objectives and content are to be discussed. For the selection of learning objectives and content in business education, it would be desirable to use the curricular principal of situation. Wilbers (2012) outlines that the selection of teaching and learning objectives and content based on the changed working tasks of businesspeople is one characteristic of vocational education in the commercial-administrative sector. A major challenge of the VET school system is the flexible design and setting of priorities of the educational offers, the response to current processes of change as well as the institutional, curricular, and didactic consideration of social demands and drivers (Kamsker & Slepcevic-Zach, 2019).

In addition, it is important to prepare students for the mentioned changed qualification and skill requirements and to achieve an acquisition of competences in this regard through a consistent education system and a networking of vocational education at the secondary level with scientific vocational education at the tertiary level. It is necessary to discuss the coordination between universities, colleges, and schools as to which priorities should be set and which entry requirements students need for the transition to the tertiary education system.

The trend towards higher qualification predicted by the literature suggests that the motivation to obtain a degree at a higher level of qualification will increase. This will rise the number of students. With the urge to achieve higher qualifications, the aim for pupils is to get the qualification for university entrance. An in-depth general education should be the basis for a later specialisation in the subject areas or fields of study of interest at university. For this reason, it can be assumed that the number of students at general secondary schools will continuously rise, whereas the development of student numbers at VET schools and colleges will stagnate and the development curve will slowly turn downwards (Benedik et al., 2020). This means that especially VET schools (BMHS) are faced with the challenges of providing a modern, attractive educational offer. They must distinguish themselves from academic schools (AHS) in the educational competition to arouse interest in a VET school among students.

Due to the increasing demand from business practice to build workers who can transfer the acquired knowledge into practice, vocational education, and training in particular faces the challenge of designing teaching and learning in a practice-oriented way (Mohr & Mohr, 2017). Based on the already existing curricular anchoring of practice phases, project work and internships, didactic considerations that leads to a transfer between theory and practice should be discussed.

Furthermore, the exemplification of a culture of digitality (Stalder, 2017) is important. Changed forms of communication, a changed interaction in the digital space, the handling and use of new technologies as well as changed forms of knowledge and learning must be exemplified and taught to the pupils. Suitable teaching and learning settings must be considered, whereby it should be noted at this point, based on the results on the changed teaching and learning formats, that understanding digital transformation does not necessarily mean switching to online teaching. It is necessary to adapt the methods and media to the respective educational goals and content.

The aim of this paper was to present important issues and problems for further development of schools in business education in a digital age. First, the general challenges for VET schools should be outlined to discuss didactic, curricular, and administrative aspects in further steps. For this reason, the broad research field of the digital transformation of vocational education and training was discussed on a rather superficial level within the framework of a literature-based analysis. The didactic design of teaching and learning settings with content about the digital transformation and new media as well as new technology, the generation of technical framework conditions at schools and teacher training can therefore be seen as suggestions for further research projects. In addition, the literature review will form the basis for further empirical research projects on the digital transformation of VET schools.

However, despite all the requirements and willingness to change or to try to react to the changes, business education must also always ensure its own positioning. It should not be forgotten that, in the final analysis, it is always about the development of the learners – personal and professional.

References

- Abel, J. (2018). *Kompetenzentwicklungsbedarf für die digitalisierte Arbeitswelt*. Forschungsinstitut für gesellschaftliche Weiterentwicklung. https://www.fgw-nrw.de/fileadmin/user_upload/FGW-Studie-I40-09-Abel-komplett-web.pdf
- Adermon, A., & Gustavsson, M. (2015). Job Polarization and Task-Biased Technological Change: Evidence from Sweden, 1975–2005. *Journal of Economics*, 117(3), 878–917.
- Ahrens, D., & Gessler, M. (2018). Von der Humanisierung zur Digitalisierung: Entwicklungsetappen betrieblicher Kompetenzentwicklung. In D. Ahrens & G. Molzberger (Eds.), *Kompetenzentwicklung in analogen und digitalisierten Arbeitswelten. Gestaltung sozialer, organisationaler und technologischer Innovationen* (pp. 157–172). Springer. [https://doi: 10.1007/978-3-662-54956-8](https://doi.org/10.1007/978-3-662-54956-8)

- Arntz, M., Gregory, T., & Zierahn, U. (2016a). *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis* (OECD Social, Employment and Migration Working Paper, 189). OECD Publishing.
- Arntz, M., Gregory, T., Jansen, S., & Zierahn, U. (2016b). *Tätigkeitswandel und Weiterbildungsbedarf in der digitalen Transformation* (ZEW-Gutachten und Forschungsberichte). Zentrum für Europäische Wirtschaftsforschung GmbH. <https://www.econstor.eu/bitstream/10419/148159/1/872916693.pdf>
- Arnold, R., & Pachner, A. (2011). Konstruktivistische Lernkulturen für eine kompetenzorientierte Ausbildung künftiger Generationen. In T. Eckert, A. von Hippel, M. Pietraß & B. Schmidt-Hertha (Eds.), *Bildung der Generationen* (pp. 299–308). VS Verlag für Sozialwissenschaften.
- Arnold, D., Arntz, M., Gregory, T., Steffes, S., & Zierahn, U. (2016). *Herausforderungen der Digitalisierung für die Zukunft der Arbeitswelt*. Zentrum für Europäische Wirtschaftsforschung.
- Autor, D. (2013). The “task approach” to labour markets: an overview. *Journal for Labour Market research*, 46, 185–199.
- Baethge, M., Solga, H., & Wieck, M. (2007). *Berufsbildung im Umbruch. Signale eines überfälligen Aufbruchs*. Friedrich Ebert Stiftung. <http://doku.iab.de/externe/2007/k070228f09.pdf>
- Balsmeier, B., & Wörter, M. (2019). Is this time different? How digitalization influences job creation and destruction. *Research Policy*, 48(8), 62–73.
- Bartel, A. P., & Sicherman, N. (1998). *Technological change and the skill acquisition of young workers*. National Bureau of Economic Research.
- Becker, W., & Botzkowski, T. (2019). Auswirkungen der Digitalisierung auf das Geschäftsmodell mittelständischer Unternehmen: Eine unternehmensgrößen-, branchen- und geschäftsmodelltypabhängige Analyse. In W. Becker, B. Eierle, A. Fliaster, B. Ivens, A. Leischnig, A. Pflaum & E. Sucky (Eds.), *Geschäftsmodelle in der digitalen Welt. Strategien, Prozesse und Praxiserfahrungen* (pp. 319–340). Springer Gabler.
- Benedik, O., Gumpoldsberger, H., Klem, S., Martinschitz, S., Mayerweck, E., Pauli, W., Peterbauer, J., Radinger, R., Reif, M., Riha, N., Salfinger-Pilz, B., Sommer-Binder, G., Speckle, C., Stüger, E., Trenkwalder, K., Wanek-Zajic, B., Wisbauer, A., & Zheng, J. (2020). *Bildung in Zahlen 2018/19*. Statistik Austria. http://statistik.gv.at/wcm/idc/idcplg?IdcService=GET_NATIVE_FILE&RevisionSelectionMethod=LatestReleased&dDocName=123148

- Bitkom (2015). *Digitale Schule – vernetztes Lernen. Ergebnisse repräsentativer Schüler- und Lehrerbefragungen zum Einsatz digitaler Medien im Schulunterricht*.
<https://www.bitkom.org/sites/default/files/pdf/noindex/Publikationen/2015/Studien/Digitale-SchulevernetztesLernen/BITKOM-Studie-Digitale-Schule-2015.pdf>
- BMBWF (2018). *Masterplan Digitalisierung*.
<https://www.bmbwf.gv.at/Themen/schule/zrp/dibi/mp.html>
- Bock-Schappelwein, J., Famira-Mühlberger, U., & Leoni, T. (2017). *Arbeitsmarktchancen Digitalisierung*. Österreichisches Institut für Wirtschaftsforschung.
https://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=60909&mime_type=application/pdf
- Bonin, H., Gregory, T., & Zierahn, U. (2015). *Übertragung der Studie von Frey/Osborne (2013) auf Deutschland* (Endbericht Nr. 57). Bundesministerium für Arbeit und Soziales. <https://www.econstor.eu/bitstream/10419/123310/1/82873271X.pdf>
- Braun, A., März, A., Mertens, F., & Nisser, A. (2020). *Rethinking education in the digital age*. Brussels.
[https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641528/EPRS_STU\(2020\)641528_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641528/EPRS_STU(2020)641528_EN.pdf)
- Bronnhuber, J. S. (2016). *Digitalisierung und Bildung. Eine erste Annäherung an die Digitalisierung im Bildungswesen mit Fokus auf die digitale Bildung an allgemeinbildenden und beruflichen Schulen*. http://dozenten.alp.dillingen.de/2.5/images/referat/digitale_bildung_20161206.pdf
- Brzeski, C., & Burk, I. (2015). *Die Roboter kommen (doch nicht?)*. <https://ingwb.de/media/1398074/ingdiba-economic-research-die-roboter-kommen.pdf>
- Dengler, K., & Matthes, B. (2018). *Wenige Berufsbilder halten mit der Digitalisierung Schritt. Substituierbarkeitspotenziale von Berufen*. Institut für Arbeitsmarkt- und Berufsforschung.
- Dengler, K., & Matthes, B. (2015). *Folgen der Digitalisierung für die Arbeitswelt. Substituierbarkeitspotenziale von Berufen in Deutschland*. Institut für Arbeitsmarkt- und Berufsforschung. <http://doku.iab.de/forschungsbericht/2015/fb1115.pdf>
- Dinges, M., Leitner, K.-H., Dachs, B., Rhomberg, W., Wepner, B., Bock-Schappelwein, J., Fuchs, S., & Horvath T. (2017). *Beschäftigung und Industrie 4.0. Technologischer Wandel und die Zukunft des Arbeitsmarkts*. Bundesministerium für Verkehr, Innovation und Technologie.
https://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=60906&mime_type=application/pdf
- Dosi, G., Piva, M., Virgillito, M., & Vivarelli, M. (2019). Embodied and Disembodied Technological Change: The Sectoral Patterns of Job-Creation and Job-Destruction. *IZA DP, 12408*, 1–18.

- Eichhorst, W., & Buhlmann, F. (2015). Die Zukunft der Arbeit und der Wandel der Arbeitswelt. *Wirtschaftspolitische Blätter*, 1, 131–148. https://www.wko.at/site/Wirtschaftspolitische_Blaetter/009_Eichhorst.pdf
- Euler, D. (2017). Erfolg macht (nicht) unantastbar! – Herausforderungen an eine zukunftsgerechte Berufsbildung. *Zeitschrift für Berufs- und Wirtschaftspädagogik*, 113(4), 533–541.
- European Commission (2020). *Digital Skills & Jobs*. <https://digital-strategy.ec.europa.eu/en/policies/digital-skills-and-jobs>
- Frey, C. B., & Osborne, M. A. (2013). *The Future of Employment. How susceptible are jobs to computerisation?* (Working Paper). Oxford University.
- Fürst, R. A. (Eds.) (2019). *Gestaltung und Management der digitalen Transformation. Ökonomische, kulturelle, gesellschaftliche und technologische Perspektiven*. Springer.
- Gerholz, K.-H., & Dormann, M. (2017). Ausbildung 4.0: Didaktische Gestaltung der betrieblich-beruflichen Ausbildung in Zeiten der digitalen Transformation. *bwp@ Berufs- und Wirtschaftspädagogik – online*, 32, 1–24. http://www.bwpat.de/ausgabe32/gerholz_dormann_bwpat32.pdf
- Goos, M., & Manning, A. (2003). *Lousy and Lovely Jobs: The Rising Polarization of Work in Britain*. Centre for Economic Performance.
- Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization routine-biased technological change and offshoring. *American Economic Review*, 104(8), 2509–2526.
- Goos, M., Manning, A., & Salomons, A. (2009). Job Polarization in Europe. *American Economic Review*, 99(2), 58–63.
- Hartmann, E. A., Apt, W., Shajek, A., Stamm, I., & Wischmann, Steffen (2019). Perspektiven: Industrie 4.0 – Hype oder echte Revolution? In G. Spöttl & L. Windelband (Eds.), *Industrie 4.0. Risiken und Chancen für die Berufsbildung* (pp. 49–73). wbv.
- Harwardt, M. (2019). *Management der digitalen Transformation. Eine praxisorientierte Einführung*. Springer Gabler.
- Heuermann, R., Engel, A., & Lucke, J. von (2018). Digitalisierung: Begriff, Ziele und Steuerung. In R. Heuermann, M. Tomenendal & C. Bressemer (Eds.), *Digitalisierung in Bund, Ländern und Gemeinden. IT-Organisation, Management und Empfehlungen* (pp. 9–50). Springer Gabler.
- Hirsch-Kreinsen, H. (2016). Digitalisierung und Einfacharbeit. *WSO Diskurs*, 12, 1–24.

- Hofer, H., Titelbach, G., & Vogtenhuber, S. (2017). Polarisierung am österreichischen Arbeitsmarkt? *Wirtschaft und Gesellschaft*, 43(3), 379–404.
- Kamsker, S., & Slepcevic-Zach, P. (2019). Lernen in einer digitalisierten Welt. In M. Stock, P. Slepcevic-Zach, G. Tafner & E. Riebenbauer (Eds.), *Wirtschaftspädagogik. Ein Lehrbuch* (pp. 301–339). Uni-Press.
- Kamsker, S., & Slepcevic-Zach, P. (2018). Digitalisierung im Unterricht begegnen – Anwendungsbeispiel eines möglichen Lehr-Lern-Arrangements. *Berufs- und Wirtschaftspädagogik – online, Spezial AT-1*, 1–25. <https://www.bwpat.de/ausgabe/wipaed-at1/kamsker-slepcevic-zach>
- Kern, H., & Schumann, M. (1985). *Industriearbeit und Arbeiterbewußtsein. Eine empirische Untersuchung über den Einfluß der aktuellen technischen Entwicklung auf die industrielle Arbeit und das Arbeiterbewußtsein*. Suhrkamp.
- Klammer, U. (2017). Arbeiten 4.0 – Folgen der Digitalisierung für die Arbeitswelt. *Wirtschaftsdienst*, 97(7), 459–476.
- Kleine Sextro, H., Sauer, D., & Albert, T. (2019). New Work – wie die Digitalisierung die Arbeitswelt verändert. Potenzial- und Risikoanalyse für produzierende Unternehmen. In H. Witte, R. Rauscher & M. Ryba, Lingener (Eds.), *Studien zu Management und Technik*. LIT.
- Krcmar, H. (2018). Grundlagen der digitalen Transformation. In G. Oswald & H. Krcmar (Eds.), *Digitale Transformation. Fallbeispiele und Branchenanalysen* (pp. 5–64). Springer.
- Laar, E. van, Deursen, A. J. A. M. van, Dijk, J. A. G. M., & Haan, J. de (2017). The relation between 21st-century skills and digital skills: a systematic literature review. *Computers in Human Behavior*, 72, 577–588.
- Lage, M., Platt, G., & Treglia, M. (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. *The Journal of Economic Education*, 31(1), 30–43.
- Lasi, H., Fettke, P., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business and Information Systems Engineering*, 6(4), 239–242.
- Mertala, P. (2019). Paradoxes of participation in the digitalization of education: a narrative account. *Learning, Media, and Technology*, 45(2), 179–192.
- Mohr, K. A. J., & Mohr, E. S. (2017). Understanding Generation Z Students to Promote a Contemporary Learning Environment. *Journal on Empowering Teaching Excellence*, 1(1), 84–94.
- Nagl, W., Titelbach, G., & Valkova, K. (2017). *Digitalisierung der Arbeit: Substituierbarkeit von Berufen im Zuge der Automatisierung durch Industrie 4.0* (Projektbericht). Institut für Höhere Studien.

- Ostendorf, A. (2017). Wirtschaftspädagogik 4.0 – Herausforderungen und Chancen einer digitalisierten Ökonomie für Wissenschaft und Praxis der Wirtschaftspädagogik. *wissenplus, Österreichische Zeitschrift für Berufsbildung*, 3, 6–10.
- Peneder, M., Bock-Schappelwein, J., Firgo, M., Fritz, O., & Streicher, G. (2016). *Österreich im Wandel der Digitalisierung*. Österreichisches Institut für Wirtschaftsforschung. https://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=58979&mime_type=application/pdf
- Perkin, N., & Abraham, P. (2017). *Building the Agile Business through Digital Transformation*. Kogan Page.
- Peterßen, W. H. (2005). *Kleines Methoden-Lexikon*. Oldenbourg.
- Schrack, C. (2018). Berufsbildung 4.0 – Digitalisierung und Industrie 4.0 in der österreichischen Berufsbildung. *Elektronik & Informationstechnik*, 135(1), 103–105.
- Schultz-Pernice, F., Kotzebue, L. von, Franke, U., Ascherl, C., Hirner, C., Neuhaus, B., Ballis, A., Hauck-Thum, U., Aufleger, M., Romeike, R., Frederking, V., Krommer, A., Haider, M., Schworm, S., Kuhbandner, C., & Fischer, F. (2017). Kernkompetenzen von Lehrkräften für das Unterrichten in einer digitalisierten Welt. *Merz Medien + Erziehung, Zeitschrift für Medienpädagogik*, 4, 65–74.
- Stalder, F. (2017). *Kultur der Digitalität*. Suhrkamp.
- Stock, M., Slepcevic-Zach, P., & Tafner, G. (2019). Wirtschaftspädagogik und berufliche Bildung. In M. Stock, P. Slepcevic-Zach, G. Tafner & E. Riebenbauer (Eds.), *Wirtschaftspädagogik. Ein Lehrbuch* (pp. 11–28). Uni-Press.
- Suta, C., Barbieri, L., & May-Gillings, M. (2018). Future Employment and Automation. *STUDI e RICERCHE*, 61, 17–43.
- Verein Industrie 4.0 Österreich (2017). *Ergebnispapier „Qualifikation und Kompetenzen in der Industrie 4.0“*. https://plattformindustrie40.at/wp-content/uploads/2016/03/WEB_Industrie4.0_Ergebnispapier-Qualifikation-und-Kompetenzen.pdf
- Walvoord, B., & Anderson, V. (1998). *Effective grading. A tool for learning and assessment in college*. Jossey-Bass.
- Wilbers, K. (2012). *Wirtschaftsunterricht gestalten. Lehrbuch*. epubli.