Article

Challenges of the Coronavirus Pandemic as an Opportunity for Sustainable Digital Learning in Vocational Education and Training (VET)

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Abstract: In addition to restrictions in training companies, vocational schools were also closed due to the coronavirus pandemic in Germany. After the unexpected first lockdown, it was the challenge of all those involved to draw lessons from the emergent weaknesses in the system and to prepare for further school closures. These preparations primarily involved shifting to digital learning platforms. This article uses a simple and easy to understand research design and focuses from a practical point of view on the results of a quantitative online survey conducted by the University of Applied Labour Studies Mannheim among 143 apprentices in southern Germany on the differences between the first and second school closures with regard to live communication with teachers, attention to apprentice concerns by the vocational school, access to digital devices, and the use of these devices. The results of the survey show that, according to the apprentices' assessments, the vocational schools were able to improve live communication as well as better attend to the apprentices' concerns between lockdowns. In addition, the apprentices were able to improve their own digital devices and competencies and, to a large extent, make up for deficits. They were better able to use digital devices and software during the second school closure compared to the first. Gender differences were observed. However, despite significant improvements, there is still a need to modernize and innovate, which should be considered in future digital developments at schools.

Keywords: apprenticeship; digitization; distance learning; school development

1. Introduction

In addition to the immediate health consequences, the coronavirus pandemic also triggered social and economic consequences due to the measures implemented to contain the virus. The closure of cultural and recreational facilities and businesses was accompanied by the closure of general as well as vocational schools and other educational institutions. In both the first temporary and unexpected school closure in Germany in spring 2020 and the second closure in December of the same year, students and apprentices were faced with the challenge of learning on their own from home and, if offered, participating in online classes.

This online learning required technical competence among teachers and access to digital equipment such as a computer, a laptop, or a tablet, and a sufficient Internet connection. Prior to the pandemic, this extensive digital equipment was not necessary for successful participation in face-to-face classes. After the start of the pandemic, digital devices were much needed but often not available to those in need, which included students and teachers, and which highlighted inequalities in access to digital equipment [1]. In the literature, it has generally been argued that longer periods without schooling, differences in digital equipment, and a lack of digital competencies have had an important role with regard to educational inequalities and that these were reinforced during the coronavirus pandemic not only in Germany [2] but also worldwide [3]. However, during the time

between those two closures, measures such as financial support for the digitization of the educational system in Germany were taken to improve the access to digital equipment and to prepare for additional school closures [4].

As the coronavirus pandemic continued with a second school closure lasting several months, the question arose as to what extent the apprentices as well as the German vocational schools have been able to overcome the challenges posed by the first school closure.

There are now numerous studies on pandemic-related school closures in general education schools. However, there has been little research focused specifically on apprenticeships, and few studies have focused on digital learning and school development. Studies with a similar focus as this article, but limited to the initial school closure in Germany, notably include the study by the German Federation of Trade Unions [5] on apprenticeship during the coronavirus pandemic, and a study by Biebeler and Schreiber [6].

The objective of this study, therefore, was to provide initial insights into how the organization of online learning has changed and the extent to which learning in vocational schools can benefit in the long term from the changes brought about by the coronavirus pandemic. Primary data in the project "Successful Start into Apprenticeship" (Erfolgreicher Start in die Berufsausbildung, EStarA) by the University of Applied Labor Studies (HdBA) at the Mannheim Campus were analyzed. The data retrospectively referred to the assessment of apprentices in southern Germany on their learning situation during the first and second school closures.

In this article, we first outline the theoretical background of the study on the basis of pivotal considerations regarding the requirements of digital learning as well as the equipment required and the use of digital devices and learning media. This is followed by a description of the data and data collection, including the special features that were considered when interviewing young people, as well as a presentation of the method of analysis used in this exploratory study. A report of the results is followed by a concluding discussion with practical implications. Finally, the limitations of the study are reported.

2. Theoretical Background and Current State of Research

2.1. The German Vocational Educational System

To understand the special situation of apprentices and their increased burden during the pandemic, the role of vocational education and training in the secondary sector of the German educational system is first to be described. After nine years of compulsory general education, young people in Germany can start vocational education and training even without a formal school-leaving qualification, either full-time at a school or as part of a dual apprenticeship in combination with employment in a company. This paper focuses exclusively on dual apprenticeships, which represent a complex system combining two learning spaces: the learning of theoretical knowledge at a vocational school and the learning of job-related knowledge at the workplace in a training company, which is highly functional [7]. This special form of vocational education and training enables context-related learning of relevant professional knowledge through hands-on experience. Theoretically explored learning content is applied directly in everyday professional life at the training companies, which promotes the learning process. In addition, the apprentices gain valuable practical work experience during their apprenticeship. Compared to full-time school-based training, in which practical content is only included in short internships, dual vocational education and training thus enables a complex, comprehensive learning process.

In an international comparison, Germany is one of the countries with the highest proportion of dual vocational education and training. This combination of theoretical and practical knowledge supports the transition into the labor market [8,9] because in Germany, apprenticeships are usually attended directly after graduation from general education schools. This aspect is of great importance for young people's career paths.

However, the low average age at which apprentices enter the program should also be seen as a challenge. Apprentices often still live in their parents' household and can only rely on their work and learning experiences from general education school when it comes

to structuring their learning process. Vocational education, however, requires learning theoretical knowledge that is directly linked to the occupation, which is why systematic support takes place in vocational schools that focus on specific occupational areas.

Furthermore, the apprentices as well as the companies are supervised by so-called chambers. One example of this is the Chamber of Handicrafts. On the one hand, it advises companies in the handicrafts sector, which, along with the industrial sector, has the highest number of apprentices in Germany [7], and on the other hand, it also supports the apprentices (e.g., exam preparation).

2.2. Learning Space and Support

Designing a personal learning space and creating the technical conditions are especially important for learning success during school closures. This is due to the fundamental changes to the learning framework: both the personal (through social distancing) and spatial dimensions (school vs. home) as well as material resources (technology), which are important determinants of the learning space [10], were affected by the pandemic-related restrictions. This was highlighted in a report by the European Commission's Joint Research Center following the first school closure, based on qualitative interviews with 105 students and their parents from 10 member states (Austria, Croatia, Denmark, France, Italy, Norway, Portugal, Romania, Slovenia and Spain). The report pointed to the difficulties students face in terms of learning space, which could be inadequate under restricted living conditions, as well as insufficient digital equipment or the lack of personal interaction [11]. Similar findings were presented in Indonesia, where teachers reported problems with Internet access and student support at the onset of school closures, despite available digital devices and online learning platforms [12,13].

Prior to the coronavirus pandemic, most learning for apprentices had taken place at a set location at a scheduled time and had not required special equipment. The vocational school had served as a learning space most of the time, but it was no longer available during the school closures.

Using data from the socioeconomic panel, a study in Germany showed that learning success was strongly dependent on the learning environment at home [14]. This was also confirmed by Helm et al. [15], who reported in an international meta-review that students from socially deprived and educationally disadvantaged families had experienced lower learning success during the pandemic. It was in this context that school-based support was an important determinant of successful learning during the coronavirus pandemic. A study from the U.S. shows how important non-academic support is in addition to learning support [16]. This illustrates the relevance of a contact person for students. The great importance of a viable educational relationship during school closures has been supported from different perspectives. From the perspective of parents as well as teachers and students themselves, frequent and continuous communication has a high impact on distance learning and a positive effect on learning success [17–19].

2.3. Digital Learning

In this article, "digital learning" refers to distance learning supported by technological means as occurred during the coronavirus pandemic and the resulting school closures.

There is not yet a clearly defined and distinct term in the research literature for this pandemic type of learning, which is why other forms of digital-based learning are initially used to define the concept for this paper. In this regard, Helm et al. [15] drew on similar existing concepts used in the German educational system such as homeschooling (i.e., parents adopt the role of teacher) and distance learning (i.e., responsibility remains with an organization, but learning takes place on one's own and independent of location) as well as homework practices, on which the domestic environment has a strong influence. Particularly important determinants for understanding digital learning in this coronavirus pandemic context, therefore, are the spatial flexibility provided, a transfer of responsibility, and the domestic environment.

Digital learning generally allows for additional informal learning, which offers a high degree of flexibility and individuality as compared to solely formal learning, since it is not bound to an institution and thus provides numerous advantages for the design of the learning situation [20]. These advantages are also quite relevant for vocational education and training [21]. Comprehensive meta-studies [22] have also shown that online learners perform even better than when in traditional face-to-face settings The analysis of 45 international studies comparing face-to-face learning with blended learning on the one hand and face-to-face learning with mere online teaching on the other hand shows that blended learning in particular leads to significantly better learning outcomes than face-to-face learning. A Japanese study shows that online learning can reduce the negative effects of pandemic school closures [23]. Nevertheless, international research show that disparities in technical access and in the use of technical devices need to be addressed to avoid the remote learning paradox where students who suffer the most from learning losses cannot participate in online instruction due to limited internet access [24]. Therefore, in online learning, good planning and institutional support structures are particularly important for success [25]. At the same time, the challenge to transmit and capture emotions via online platforms should be taken into account when it comes to digital learning [26].

Digital learning requires adequate technical equipment and digital competency, but social inequalities have been be observed [27,28]. Helm et al. [15] reported that a higher socioeconomic background increased the quality of technical equipment and digital literacy.

In addition to digital literacy (i.e., individual computer skills), self-management and time management (i.e., self-regulated learning) have also been shown to be essential requirements for successful distance learning [29]. Approximately one-third of students have difficulties with self-organization in distance education [15].

In this regard, a study from China also indicates that self-efficacy in using remote learning during the coronavirus pandemic supports academic performance, underlining the relevance of using digital tools for successful learning [30].

However, deficits in digital competences can be observed in the international literature among both students and teachers [31–35].

From a teacher's perspectives, students' lack of expertise, in addition to their lack of independence, challenges their abilities to participate in online learning activities [36]. In this context, maintaining communication with teachers who support students in their self-organization may be all the more important.

Gender differences in the field of digital learning have yet to be adequately investigated. Nevertheless, there have been indications that these differences exist and have had an influence on learning in distance education. For example, previous studies have shown that young males had higher digital literacy ratings than young females [37]. However, contrary to expectations, a recent study by Korlat et al. [38] from Austria showed no difference between genders in children in terms of their competency assessments regarding digital learning. This result was explained by the overall higher academic competency assessment of young women. For the intrinsic motivation in digital learning, a higher value among young females was observed [38]. These results were particularly relevant with regard to the development of gender inequality over the course of the coronavirus pandemic.

2.4. Digitization in the Course of the Coronavirus Pandemic

Dual vocational education and training in Germany is characterized by a particularly high proportion of subject-specific content that is closely linked to practical knowledge, and is therefore strongly affected by challenges in online implementation [34]. Digitization has already been cited in a 2018 study as the most important topic for the future-oriented design of vocational education and training [39]. Nevertheless, German general education schools were not prepared digitally for the pandemic-related school closures. There was a lack of equipment, teachers were on their own when it came to distance learning practices, and for the most part, communication was via e-mail [36]. Similar findings on the first

school closures were also reported by studies focusing on dual vocational education and training [5,6].

Before the coronavirus pandemic, the use of digital content by vocational schools was limited.

A survey of teachers at vocational schools in Switzerland showed gaps in the supply of digital devices and technological deficiencies, but at the same time, they viewed distance learning as an opportunity for their own digital education [40]. A German survey among teachers after the first school closure also indicates the need for qualification in ICT, which already existed before the coronavirus pandemic [41]. These findings are supported by a Spanish study that shows that parents and students as well as teachers already had a need for further training in digital literacy before the pandemic and that this need was intensified by the pandemic, as was the digital divide [42]. In a comparison between Germany, Austria, and Switzerland with regard to teachers' digital competency and digital equipment, the results of the school barometer showed that teachers in Germany rated both their competence and their equipment lower than teachers in neighboring countries [43]. The results of a survey among teachers in Italy [44] as well as a report about the situation in Latin America [45] and Indonesia [46] underline the necessity of teachers' digital skills and pedagogical knowledge in online settings.

At the beginning of the coronavirus pandemic, it also became apparent that not only the vocational schools but also the training companies [47] had made little use of the opportunities for digital learning and had rarely enabled people to work from home [6]. Although the disruption to apprentices in the workplace varies by occupation, it is clear that reduced social contact and less informal on-site learning have a negative impact on the apprentices' motivation [48].

Overall, digitization was low in the context of vocational training before and at the beginning of the pandemic, which was why the lockdowns further complicated the teaching of vocational training content. At the same time, this situation highlighted the importance of a functioning digital learning environment and the urgent need for action.

2.5. School Closures during the Coronavirus Pandemic

Distance learning in the first school closure in spring 2020 had to be implemented without any time for preparation. The lack of structure for online teaching required independent learning by apprentices, who had different ways of organizing their learning; while some coped well with the unexpected learning shift, others did not. These differences resulted from, among other things, the high heterogeneity among apprentice programs. Standardized concepts for distance learning did not exist and, depending on the vocational school, the proportion of analog or digital content varied [49,50]. Initially, self-organization played a key role for participation in digital distance learning, which requires high motivation and technical interest [51]. Teachers reported that self-organization, in particular, was one of the greatest challenges alongside the digital requirements [52]. However, a study from Greece shows that interactive digital activities such as online quizzes increase motivation in digital learning during the coronavirus pandemic [53].

In this context, close school support with regularly provided tasks promoted students' independent learning: a study in Germany based on data from approximately 900 students at general education schools showed that students' time spent on learning increased with the frequency of tasks assigned [17]. This finding was also supported by an analysis of the National Educational Panel in Germany, in which children's academic performance was strongly related to parents' perceived satisfaction with the care their children received from schools [54]. Another study illustrated that teachers' support, by being available to students and providing feedback, also directly influences student satisfaction [18]. This is also evident in the international research literature. Han et al. report from a Chinese survey of about 270,000 students at vocational schools that technical preparation of instruction together with comprehensive support are the most important prerequisites for successful online learning [55]. Consequently, although regular support and feedback that promotes

learning require a great deal of effort on the part of teachers, it is worth the effort in terms of motivation and self-organization in distance learning [19].

An analysis of the school barometer by Huber [56] showed a high variance in the response behavior of the surveyed teachers regarding the technical equipment of the schools for the first school closure. These findings, particularly at the beginning of the coronavirus pandemic, indicated the need for a large proportion of schools to modernize.

The differences in technical equipment can also be observed among teachers, depending on their affinity and prior knowledge of digital learning, which was perceived by both the teachers themselves and the students [56]. A study from Jordan [32] showed negative attitudes of vocational school teachers towards the use of digital learning formats. For students Helm et al. [15] report that approximately three-quarters had sufficient digital devices at home to cope with distance learning, although they assumed that students with insufficient technical equipment may have also been under-reported. At the same time, Huber [56] points out that, even if it only applied to a small proportion of overall students, inadequate equipment was the greatest handicap to participating in online instruction.

A study by Züchner and Jäkel [29] indicated that before school closures due to the coronavirus pandemic, 60% of students were able to use a computer and approximately half (52.6%) were able to use Microsoft Office programs and do research on the Internet (54.4%). Nearly 30% were able to work with a learning platform. In the representative JIMplus 2020 study, 80% of respondents reported having a personal computer or laptop; 29% a tablet; and 82% at least a smartphone for completing school tasks during the first school closure. Headsets (15%) and webcams (6%), however, had rarely been used, supporting the study's other finding that 16% of students had participated in videoconferences and that 11% had contact with teachers by phone. A fixed weekly class schedule was available to 6% of students. Most students received assignments via email [57].

Digital devices were not provided in the initial lockdown in Germany and had to be purchased at the student's own expense, leading to inequalities based on socioeconomic status [1] due to the simultaneous closure of public resources such as libraries [58]. Additional problems with participation in online classes arose from insufficient Internet capacity with many people working or being educated at home, especially in rural areas [59].

Gender differences were also observed, as males may be more likely to use computers at home [60] and reported better overall technical equipment with regard to online learning during the pandemic in an exploratory study by the HdBA during the first school closure in spring 2020 in southern Germany [41]. The study also showed for this particular target group that apprentices felt inadequately supported by their vocational schools and that their concerns were not satisfactorily addressed. Classes were often not held via live media and the technical equipment as well as the Internet connection were not sufficient, and females were found to have disadvantages [61].

Overall, existing inequalities had been further exacerbated by the first school closure at the onset of the pandemic. The first school closure was unexpected, whereas the second school closure from winter 2020 to April 2021 was anticipated due to the development of the coronavirus pandemic. Klein [62] argued that the first school closure exposed German schools' poor IT equipment and digital competence deficiencies and should have served as an opportunity for improvements. The IT competencies of teachers were also essential for the success of distance learning [29].

The period between summer and fall 2020 was used, at least in part, to prepare schools and students for future school closures.

The German Federal Government has invested a total of 600 million EUR to fund the expansion of IT infrastructure and also five billion euros for a special funding project for digitization in schools [4].

Nevertheless, due to the federal structure, there was no standardized regulation in Germany. At the conferences of the ministers of education and cultural affairs, many attendees insisted that face-to-face teaching had the highest priority despite growing concerns regarding the spreading coronavirus pandemic. Ultimately, the schools were

directed to close nationwide by the winter break period in 2020. As the Organization for Economic Cooperation and Development (OECD) [63] noted, although school closures were widespread globally until the second quarter of 2021, the situation had improved significantly compared to 2020. In this context, distance learning occurred in a hybrid form, combining synchronous digital learning units with asynchronous content provisions. A survey of vocational teachers from Indonesia indicates a strong preference for synchronous online classes or the use of video-based content for learning, but these methods also have the greatest challenges and require the most effort [64].

A survey of parents in Germany by Wößmann et al. [65] on the second school closure showed improvements in the activities of schools and teachers, as compared to the first school closure, particularly in online teaching and personal contact between students and teachers. During the second school closure, the use of learning platforms was possible for most students without issues and equipment with suitable hardware and a sufficient Internet connection was available for a large proportion of students. Furthermore, students were able to improve their digital skills so they could follow lessons in an online format.

Overall, there was a notable improvement in the structures of distance learning. At the same time, the phase between the first and second school closures was not sufficiently used to smooth the transition from face-to-face to online instruction for all types of students and schools. The changes perceived by apprentices between the first and second school closures are examined in more detail in the following analysis.

3. Data and Methods

3.1. Survey Design and Data Collection

Almost two-thirds of apprentices in Germany are under 20 years of age at the start of their vocational training and have a lower or intermediate secondary school leaving certificate [66]. Therefore, apprentices usually start training after nine years of school at approximately 16 years of age. This study was based on primary data from the EStarA project of the University of Applied Labor Studies in Germany. Our survey design made it possible to meet the special requirements when surveying our target group of apprentices. In order to achieve high data quality when interviewing adolescents, context effects should be avoided [67–69]; therefore, our survey was conducted in cooperation with selected chambers of handicrafts and chambers of commerce and industry in the counseling centers as a computer-assisted self-interview (CASI). The questions were also aligned with the adolescents' personal experience [67]. The online questionnaire allowed for graphical visualization of rating scales to further enhance response behavior among adolescents [70–73] and to increase digital natives' willingness to participate [74].

3.2. Respondents

The respondents were apprentices in vocational education and training (VET) in southern Germany. Since only apprentices from selected cooperating chambers were able to participate, the sample could not be considered representative for Germany. In addition to a privacy statement from the HdBA with a reference to the data protection officer, participants received display cleaners for their smartphones as incentives.

A total of 143 apprentices participated in the survey, which was conducted from October 2021 to January 2022. After a list-wise case exclusion based on the variables relevant for this study, 114 participants remained, 103 males (age: 17–44, mean: 20.8, SD: 3.7) and 11 females (age: 17–24, mean: 19.3, SD: 1.9). Despite the high age range, skewness (male: 3.4, female: 1.7) shows that most survey participants are young. A third gender-identification option was excluded from the analysis due to the low case number of 5 and inconsistent values. The low proportion of female respondents was likely due to the male-dominated occupational fields of the participating chambers and did not correspond to the proportion of females in dual vocational education and training in Germany.

According to the distribution in the Vocational Education and Training report [66], the majority of participants in the present study had a lower secondary school certificate at a

minimum age of 15, covering nine school years (*n* = 41, 36%) or an intermediate secondary school certificate usually at the age of 16, covering ten school years (*n* = 55, 48.2%). A university entrance qualification which comprises 12 or 13 school years and corresponds to a regular age of 18 to 19 was held by 18 participants (15.8%).

Of the participants, 48 (male: 41, female: 7) were in their third year of apprenticeship, 35 males in their fourth, 27 (male: 23, female: 4) in their second, and only 4 males in their first year. This distribution across the training years was due to the fact that, at the time of the survey, most of the participants were attending examination preparation courses for the completion of their apprenticeship at the chambers.

3.3. Measures

We evaluated retrospective apprentices' assessments of the support of the vocational school ("My concerns were taken seriously by the school during the first/second school closure.") and the use of live communication by the teachers ("The teachers used live communication (e.g., live chat) to communicate with the apprentices during the first/second school closure."). We also examined digital devices ("I had sufficient computer/laptop/tablet at home during the first/second school closure") and the use of digital devices ("I coped well with the technical requirements for online instruction during the first/second school closure").

In each case, two different items within a block of questions were used to assess differences between the first and second school closures. The quasi-metric rating scale ranged from 1 = "does not apply", 2 = "does rather not apply", 3 = "partly/partly", 4 = "rather applies" to 5 = "applies". The scales used for the relevant items can be found in the Appendix A in both the original German version and translated into English.

3.4. Analysis Method

To explore the extent to which the situation in vocational schools changed over the course of the pandemic, the information provided by apprentices at the two points in time of the first and second school closures was evaluated in pairs. The following research questions were examined:

1. From the apprentices' point of view, did the attentiveness of the vocational school improve between the first and second school closure?
2. Did live communication improve from the apprentices' perspectives?
3. Did the equipment with digital devices improve among the apprentices?
4. Did the apprentices' assessments of their own digital competence improve?
5. Were there gender differences?

Firstly, descriptive statistics and distribution measures (mean, standard deviation—SD, quartiles, median, outliers) were analyzed, which were also presented graphically using boxplots. Since we wanted to consider differences between females and males in terms of their digital equipment and competencies, these variables were also presented and grouped by gender. Secondly, one-tailed paired *t*-tests were used to analyze whether there were statistically significant improvements in vocational schools between the first and second school closures. In this regard, the analyzed variables were checked for their normal distribution.

4. Results

Table 1 summarizes the mean differences between the first and second school closures.

Figure 1 shows the differences in the ratings of the organization of the vocational school between the two school closures. The apprentices had to indicate to what extend the statements "My concerns were taken seriously by the school during the first/second school closure" applied on a scale as described above. They rated the attentiveness to their concerns by the vocational school in the first school closure at an average of 2.5 with a standard deviation of 1.2 scale points. The rating for the second school closure showed an improvement to a mean of 2.8 (SD = 1.2). However, a higher variability in the distribution

was observed. For the first school closure, at least a quarter of the respondents indicated that their concerns were not satisfactorily addressed. The second school closure shows a shift in the distribution to the upper range of the scale through the median and quartile boundaries. The *t*-test results showed that the mean differences were statistically significant at the 1% level. Therefore, the vocational schools' attention to apprentice concerns statistically improved significantly between the first and second pandemic-related school closures, with the effect sizes using Cohen's d [75] indicating a medium effect (0.3).

Table 1. Differences between first and second school closures.

Items	Mean	SD	pΔ *t*-Test	Cohen's d
Attentiveness of vocational school				
First school closure	2.544	1.153	<0.001	0.339
Second school closure	2.807	1.226		
Live communication	3.289	1.419		
First school closure	3.904	1.190	<0.001	0.447
Second school closure				
Digital devices	3.868	1.386		
First school closure	4.088	1.266	0.005	0.246
Second school closure				
Digital competence	3.325	1.436		
First school closure	3.789	1.265	<0.001	0.503
Second school closure				

pΔ shows the significance of a one-tailed paired *t*-test (first/second, *n* = 114).
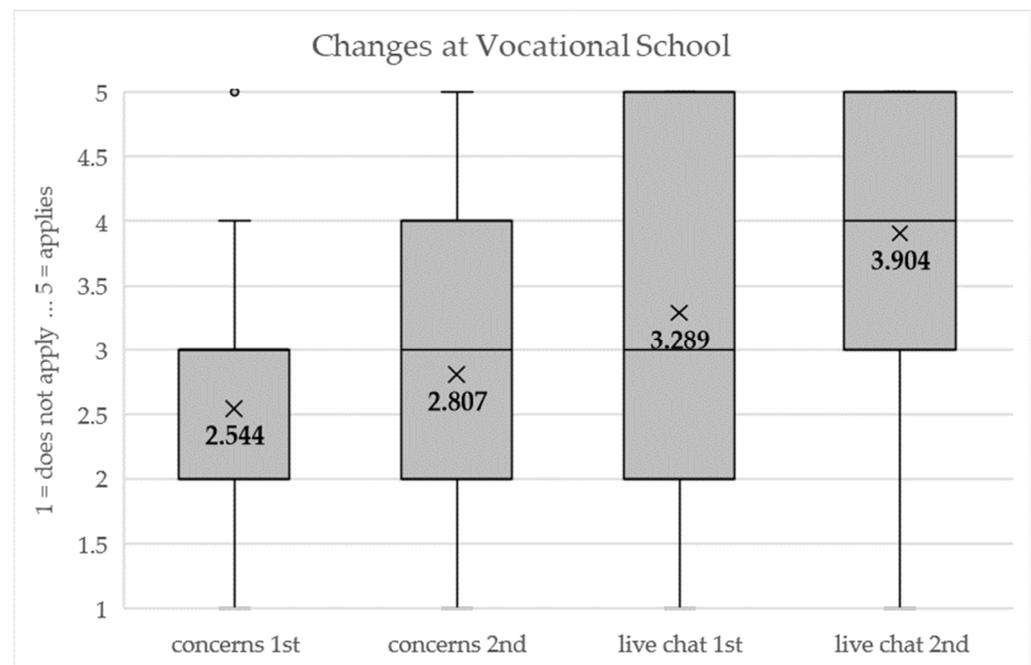

Figure 1. Changes at vocational school.

The same pattern was observed for live communication by the school as for the first variable examined. Here, the mean score for the first school closure was 3.289 (SD = 1.419), and for the second school closure was 3.9 (SD = 1.2). Furthermore, the median rose from a value of 3 to 4 and the variability of the assessments also reduced overall. The results of the *t*-test showed that the improved mean differences were statistically significant at the 99% level, with the effect size using Cohen's d indicating a medium-to-strong effect (0.4).

With regard to digital equipment, an improvement was likewise observed. The mean value for the first school closure was 3.9 (SD = 1.4). For the second school closure, the mean value was 4.1 (SD = 1.3). Accordingly, the digital equipment of the apprentices statistically improved significantly ($p < 0.005$) by 0.2 scale points in the second school closure, with Cohen's d showing a weak effect size (0.2).

The digital equipment of male apprentices changed only slightly from the first to the second school closure (Figure 2). The situation for female apprentices was more differentiated, with higher variability in the first school closure. When interpreting the results, it must be noted that the case number of women is very small. Due to the small number of female apprentices (m: 103, f: 11), the gender differences were not analyzed using a *t*-test. However, the mean value for the second school closure increased to 4.1 while the variability was reduced. We attributed these results to female apprentices being provided with better access to digital devices during the second school closure than at the beginning of the coronavirus pandemic.
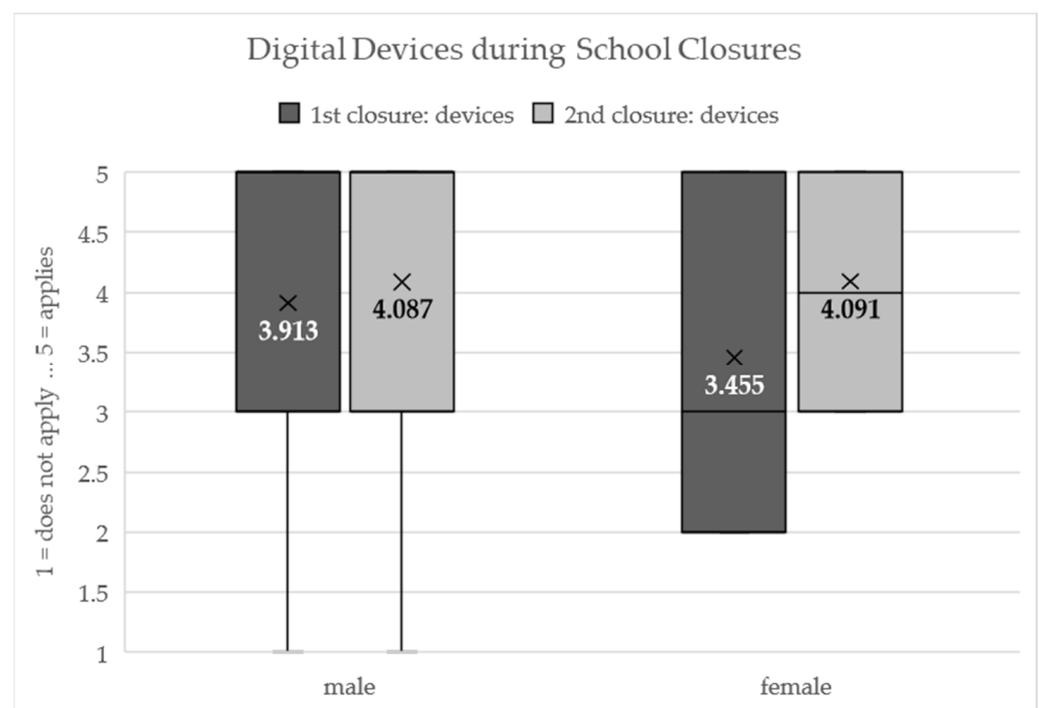

Figure 2. Digital devices during school closures by gender.

Again, for both genders, the score for "coping with digital devices" improved from a mean of 3.3 (SD = 1.4) for the first school closure to a mean of 3.8 for the second school closure (SD = 1.3). The apprentices' use of digital devices statistically improved significantly ($p < 0.001$) by 0.5 scale points in the second school closure. Cohen's d showed a strong effect size (0.5).

Coping with digital devices showed a mean value of 3.340 for male apprentices at the first school closure (Figure 3). This variable also showed an improved assessment for the second school closure with a mean value of 3.7. Variability also decreased. The median was unchanged at 4. Consequently, male apprentices' coping with digital devices improved between the first and second school closures. For female apprentices, the mean increased much more noticeably from 3.2 to 4.2, and the variability also decreased. The median also increased from 3 to 4. Overall, it was concluded that coping with digital devices for female apprentices had improved significantly.
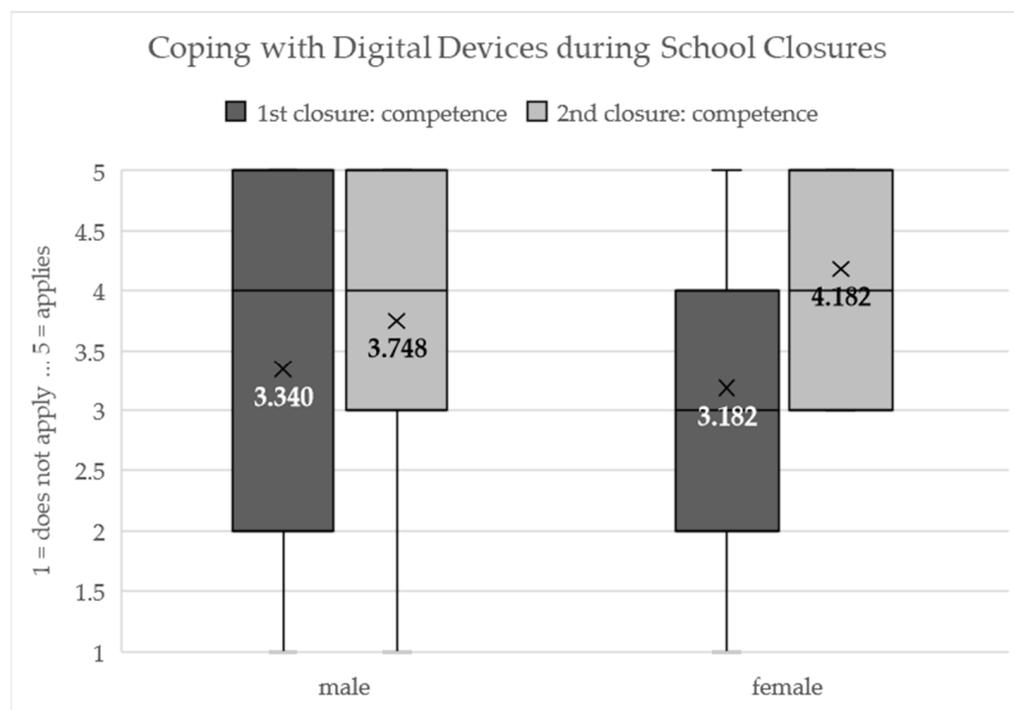
Figure 3. Coping with digital devices during school closures by gender.

5. Conclusions

5.1. Summary

The results of the survey showed statistically significant improvements in all areas in the before and after comparison between the two school closures. Both attentiveness of vocational school and live communication were rated better by survey participants for the second school closure. This suggested that appropriate measures were implemented by the schools of the surveyed students in summer 2020 to improve communication between those teachers and those students in preparation for the second school closure. For students, both their access to digital equipment and their assessments of their own digital competence improved significantly. Here, we can postulate that students may have used the time between the school closures to better adjust to a second distance learning period. The improved communication with the schools was perceived positively by the apprentices, which confirmed the results from previous studies that reported positive effects from improved communication on students' learning experiences [17–19].

The results of the comparison between the first and second school closures show that the female surveyed apprentices were poorly equipped with digital devices, especially at the beginning of the coronavirus pandemic, and show deficits in terms of their digital technical competence. A comparison between women and men is not possible without any doubt due to the unequal ratio of the number of participants (11 women, 103 men).

However, female apprentices appeared to have remedied this deficiency by the second school closure. In the present study, we assumed that males were more likely to use personal computers in their free time [60] and were, therefore, better equipped with technology than females at the onset of the coronavirus pandemic. At the same time, at least for the second school closure, the results of Korlat et al. [38] were supported: Both the digital equipment and the assessments on coping with digital devices in females in the context of digital learning were equal to the assessments of men. Here, we concluded that the overall higher intrinsic school motivation [76,77] as well as the higher motivation in digital learning environments shown in other studies [78,79] led to a digital catch-up process for female apprentices after the first school closure.

5.2. Discussion

5.2.1. Practical Implications

Although the results of this study showed a clear improvement with regard to digitization in dual vocational education and training, further effort is needed. There is no ideal situation, especially when there is still a great deal of heterogeneity in the types of equipment and the access to digital devices. In addition, although the apprentice assessments improved, much progress can still be achieved. A key prerequisite for reducing educational inequality, which has been exacerbated during the coronavirus pandemic, is that all students should have equal access to digital devices and be empowered to work with them [36]. With regard to the gender differences discussed in the research literature, it should be emphasized that access to digital devices is important for the realization of equal opportunities [1,58,60]. Even though gender differences cannot be reliably demonstrated due to the small convenience sample in this paper, the results nevertheless show hints that confirm the recommendations for action to reduce gender inequalities for sustainable education.

The implementation of live communication must also be further improved, and all students should have access, as these are essential to ensure that students can participate in lessons regardless of their location. In this context, beyond the mere transfer of information, it is also important to consider the motivational and emotional aspects as well as students' living situations in order to promote sustainable learning [26,56]. As the coronavirus pandemic caused a sudden interruption of the usual school and work routine of the apprentices and changed the communication channels as well as the roles of all actors in VET, there has to be a strategy for support beside the learning content [24]. The results of this paper have exemplified that communication between vocational schools and apprentices has made progress. Nevertheless, there is further potential for improvement.

Züchner and Jäkel [29] summarized that learning activities are supported by exchanges with teachers and classmates as well as family members. Apprentices must be empowered to use digital media to learn in a self-organized way. Teaching these digital competencies will be a key task for vocational schools in the coming years. In addition, it must be kept in mind that self-organized learning is associated with a decrease in social interactions and that particularly vulnerable groups, such as apprentices with non-German mother tongues, fear a deterioration in academic performance [61]. Consequently, in order to teach the learning content to as many apprentices as possible despite distance learning, personal contact with teachers is essential, especially when problems and concerns arise [36].

Based on the findings of the school barometer in Germany, Austria, and Switzerland, Huber [56] concluded that a comprehensive digitization initiative would be necessary during pandemic-related restrictions for sustainable school and personnel development, whereby the competencies of the teaching staff should be promoted in the long term in order to create a differentiated teaching and learning provision. In particular, he emphasized the complex interplay between innovation, sustainability, and optimization (ISO strategy), which are essential for successful development.

Eickelmann [80] emphasized four relevant objectives of successful digital learning: the use of digital media, the support of subject-specific learning, new forms of teaching, and the promotion of digital literacy. New technologies must be developed to make learning successful in the long term. To employ digitization for educational purposes during the coronavirus pandemic [36], vocational schools should further expand their current use of digital tools to support learning and motivation such as interactive elements e.g., like online-quizzes [53] or apps and learning-videos [28] that can be used flexibly in both space and time. This was underlined by the policy recommendations of the European Commission's Joint Research Center report, which emphasized digital upskilling, innovative pedagogical approaches, and equal access to digital devices for all students [11]. These recommendations are vital to avoid by all means the afore mentioned remote learning paradox [24] and to stop the increased educational disparities caused by the school closures and sudden introduction of digital lessons. However, target-oriented concepts should be developed to counteract

issues caused by competing hardware and software products and to thus ensure successful educational processes based on pedagogical and didactic premises [56]. Based on the need to impart digital competences to apprentices, further training courses for teachers and company training staff will be particularly relevant in the future, as they have not been sufficiently offered or attended in recent years [32,35,81,82].

In dual vocational education and training, training companies are an important source of information for apprentices, in addition to vocational schools. The use of digital media as part of vocational training varies greatly and depends on the sector. Although some companies have introduced digital media during the coronavirus pandemic [6], there is still much progress to achieve in order to provide apprentices with optimized digital support during the coronavirus pandemic and beyond.

5.2.2. Limitations and Future Research

The present study has some methodological problems, which is why it should be considered an exploratory survey. The selective sampling due to the cooperation with only a few chambers resulted in a participant population that was not fully representative. Furthermore, due to the selection of respondents by the chambers, the sample had a low proportion of women, which skewed the results. This affected the significance of the *t*-tests, and inferential statistics were not unconditionally possible. Therefore, only descriptive statistics with mean differences could be reported. A third variable control to reduce unobserved heterogeneity was not possible due to the small number of cases. Consequently, a robust hypothesis test was also not possible. As a result, no inference can be drawn about individuals outside the sample. The results can only be interpreted as a case study and considered as a reference point for future studies.

Since this was a retrospective query of the first and second school closures and not based on longitudinal data, memory bias was likely an issue for respondents [83].

Future research should strive for a representative survey of apprentices in order to obtain more robust data. Ideally, collecting panel data that documented the development of schools on a longitudinal basis should be considered. This would allow for more complex analyses since, as already discussed, numerous factors are relevant for the success of digital development.

Appendix A

Jetzt geht es um die Organisation der Berufsschule.
Bitte geben Sie jeweils an, inwieweit die Aussagen auf Sie/Ihre Berufsschule zutreffen.

	trifft nicht zu	trifft eher nicht zu	teils/ teils	trifft eher zu	trifft zu	kann ich nicht beurteilen
Meine Sorgen wurden während der **ersten Schulschließung** von der Schule ernst genommen.	○	○	○	○	○	○
Meine Sorgen wurden während der **zweiten Schulschließung** von der Schule ernst genommen.	○	○	○	○	○	○
Die Lehrerinnen und Lehrer nutzten während der **ersten Schulschließung** Live-Kommunikation (z.B. Video-Chat), um sich mit den Schülerinnen und Schülern auszutauschen.	○	○	○	○	○	○
Die Lehrerinnen und Lehrer nutzten während der **zweiten Schulschließung** Live-Kommunikation (z.B. Video-Chat), um sich mit den Schülerinnen und Schülern auszutauschen.	○	○	○	○	○	○

Now it's about the organization of the vocational school.
Please indicate in each case to what extent the statements apply to your vocational school.

	does not apply	does rather not apply	partly/partly	rather applies	applies	don't know
My concerns were taken seriously by the school during the **first** school closure.	○	○	○	○	○	○
My concerns were taken seriously by the school during the **second** school closure.	○	○	○	○	○	○
Teachers used live communication (e.g., video chat) during the **first** school closure to interact with apprentices.	○	○	○	○	○	○
Teachers used live communication (e.g., video chat) during the **second** school closure to interact with apprentices.	○	○	○	○	○	○

Figure A1. Vocational school: original German scale with English translation.

Jetzt geht es darum, wie sie Ihre technische Ausstattung und den Umgang damit einschätzen.
Bitte geben Sie jeweils an, inwieweit die Aussagen zum gegebenen Zeitpunkt auf Sie zutreffen.

	trifft nicht zu	trifft eher nicht zu	teils/ teils	trifft eher zu	trifft zu	kann ich nicht beurteilen
Ich hatte während der **ersten Schulschließung** zu Hause ausreichend Computer/Laptop/Tablet.	○	○	○	○	○	○
Ich hatte während der **zweiten Schulschließung** zu Hause ausreichend Computer/Laptop/Tablet.	○	○	○	○	○	○
Ich kam während der **ersten Schulschließung** gut mit den technischen Anforderungen für den Online-Unterricht zurecht.	○	○	○	○	○	○
Ich kam während der **zweiten Schulschließung** gut mit den technischen Anforderungen für den Online-Unterricht zurecht.	○	○	○	○	○	○

Next, it's about how they feel about your technical equipment and how to use it.
Please indicate in each case to what extent the statements apply to you at the given time.

	does not apply	does rather not apply	partly/partly	rather applies	applies	don't know
I had sufficient computer/laptop/tablet at home during the **first** school closure.	○	○	○	○	○	○
I had sufficient computer/laptop/tablet at home during the **second** school closure.	○	○	○	○	○	○
I coped well with the technical requirements for online classes during the **first** school closure.	○	○	○	○	○	○
I coped well with the technical requirements for online classes during the **second** school closure.	○	○	○	○	○	○

Figure A2. Digital devices: original German scale with English translation.

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