Vorwissenschaftliche Arbeit

Digital distance learning during the Covid-19 pandemic – A model for the future?/ Digitales Lernen während der Corona-Pandemie – Ein Modell für die Zukunft?

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Abstract

The findings from a survey among 171 senior students at BRG VBS 14 are empirically analysed in order to answer three research questions: How did students experience digital distance learning during the COVID-19 pandemic? What elements of digital distance learning worked well and which need to be improved? What conclusions can one draw for the digital school of the future?

Overall, students' experience with distance learning varied. Especially younger pupils or those pupils who already struggled with school before the pandemic, experienced an increase in stress and workload. Nonetheless, many believed they learned less than in a traditional school environment. The main obstacles for students were not external but student-related factors such as a lack of motivation, focus issues or struggles with self-organization. On the other side, students also experienced some advantages of distance learning: the greatest ones were flexible self-determination and individually designed schedules.

The majority of students answered that they would like to preserve certain aspects of distance learning in the future. Moodle, a digital learning platform that supports traditional teaching and PowerPoint presentations instead of handwritten class notes, have proven to be particularly beneficial.

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1 Introduction

The Covid-19 pandemic caused schools in many countries to switch teaching to digital distance learning. For students, this was a new situation to cope with. Some digital teaching methods worked well; some may even be kept in the future when regular school operations can resume. However, the new way of learning also presented challenges for many students.

With the help of an investigation at my high school, BRG VBS 14, I wanted to find out which digital forms of teaching have proven to be successful, where there is room for improvement, and where the limits of digital teaching lie. The main focus was on the perspectives of the children and adolescents. Spatially, I focused on Austria, or to be more precise, on BRG VBS 14 in Vienna.

My main research questions were:

- How did students experience distance learning?
- What elements of distance learning worked well and which need to be improved?
- What conclusions can one draw for the digital school of the future?

More information about the research questions formulated above is provided in chapter 3. To further examine these questions, an empirical analysis of a survey was undertaken which I conducted at BRG14. The survey was analysed descriptively and by using Spearman's rank correlation coefficient (see chapter 3.5.).

In chapter 2, an overview of different types of factors that influenced subjective learning outcomes of distance learning which could be found in previous studies is provided. In chapter 3, the questionnaire and the methodology are explained and more information on the research questions is presented. In chapter 4, the results of the survey are analysed descriptively and also with the help of Spearman's rank correlation coefficient. In chapter 5, conclusions about the future of digital distance learning are drawn.

2 Literature review

Online distance learning is a new, but quickly growing field in educational research. Several existing studies have examined different aspects determining how students experienced the distance learning period. There appear to be three categories of factors (Helm, Huber and Loisinger 2021, 1):

- The **system factors** include regulations that were outlined by the government or the respective schools. They also take into account how teachers adapted to the changes and how well they were able to transfer their knowledge to their students.

- The **student factors** describe an individual's ability to adapt to the new circumstances. This includes a student's capability of independently organizing their day, staying motivated and concentrated and coping with the difficult situation in their own.

- Finally, the **environmental factors** consider a student's socioeconomic status, wealth (equipment of digital devices), and family situation.

2.1 System factors

Especially in the beginning of the distance learning period, students, parents, and teachers often criticized the absence of a uniform teaching concept that could have been provided by the government or school. In turn, teaching practices often varied from teacher to teacher, which posed a challenge for students who had to adapt not only to one, but to multiple new teaching methods (Goetz 2020, 6-7). An example for this is the usage of various digital meeting-services: One teacher may have preferred Zoom, whereas another teacher liked staying in contact with students via MS Teams, a third one used Google Classroom and a fourth favoured Skype. Adolescents had to keep up with their teachers' predilections, which sometimes turned out to be difficult.

Also, teaching materials that teachers had used and reused in the previous years were often not compatible with online teaching. This was one reason why some students described the online teaching as "boring and unengaging" (Dhawan 2020, 8). The

difficulties of adjusting already existing materials to fit for online teaching also varied by subject. While it was relatively easy to teach online in natural scientific, mathematic, and humanistic subjects, subjects like music, art or PE were only partly adaptable (Goetz 2020, 9). Studies show that about 20 % of pupils state that the quality of teaching has decreased after the transition to digital (Breitenbach 2021, 9).

Generally, neither students nor teachers, neither parents nor schools were prepared for an event that could cause the schools of an entire country to be closed. Therefore, there was a "low-level preparedness" among all parties regarding the usage of online tools (Dhawan 2020, 8).

Furthermore, another big problem was the lack of communication between teachers and students, which also resulted in a decrease of possibilities to ask questions during classes. In "Lernen trotz Corona" (Brandhofer, et al. 2020, 6), the authors described the situation as follows: A lesson does not only include teaching in a classroom, but also maintaining a relationship with students: with the students themselves (in the classroom or the corridor) and their parents (during office hours, on the phone) and also with colleagues (in the conference room, during team teaching, in the corridor). For these interactions to take place, they now have to be organized and transferred into a virtual space; in the school building, these interactions take place automatically due to certain routines (Brandhofer, et al. 2020, 6).

When a student was assigned to do a worksheet in class, asking a question was possible by simply raising a hand. However, when the student experienced difficulties while going through a worksheet alone at home and also did not see the teacher face-to-face when handing it in, chances were that the student never asked anyone to explain the problem. Instead, the student may have just copied the answer of another student or from the internet. To ask the teacher a question, the student would have had to write an email to the teacher and subsequently possibly take part in an extra-meeting, which overall was rather cumbersome and time consuming and therefore in many cases did not happen (Goetz 2020, 13-15).

However, not only the lack of interaction between teachers and students, but also between students and their colleagues turned out to be an important factor. This was

evident not only at an educational level, but also at a psychological level. For one, students did not automatically get the opportunity to chat with the students seated next to them about their weekend plans etc, but also, it was harder for students to ask their seatmates for help if they did not understand something in class (Goetz 2020, 8). According to Breitenbach (Breitenbach 2021, 9), "the diminished contact among students, which could not be compensated by online communication or the use of social media, was perceived as particularly problematic.".

Summing up, when focusing on system factors, it could be observed in the literature that for distance learning to be effective and successful, there must be clear guidelines provided by the government or school in order to keep things organised and unified. Teachers should have learning materials prepared that are compatible with online teaching and are as diversified and as engaging as possible. Researchers have found that regular online meetings were useful to maintain contact between students and teachers and to provide students with a possibility to ask questions and keep up with their colleagues.

2.2 Student factors

Students perceived the distance learning period quite differently: While some were happy with the new-found freedom of organizing the day according to their own preferences, others found it rather hard to concentrate on their work or separate their working time from their spare time. (OECD 2020, 7)

Motivation is one of the main student factors that determined how well distance learning worked for a student. Motivation can be divided into two parts: intrinsic and extrinsic motivation. Karl Lahmer (Lahmer 2018, 87) described extrinsic motivation as follows: An extrinsically motivated person does or desires one thing to achieve something else with it. This means that a student could not directly influence their level of extrinsic motivation, since extrinsic motivation can be induced by parents or teachers, for example. However, what a student could influence was their level of intrinsic motivation, which can be defined as follows: An intrinsically motivated person does or desires a thing for its own sake and not to achieve something else with it. (Lahmer 2018,

87). Some adolescents could motivate themselves more easily intrinsically than others when it comes to school-related topics, so some students had what one could call a "head start" in that matter. Those pupils that had a hard time finding motivation for what they had to do for school within themselves were less likely to describe the distance learning period as a positive time. (Baber 2020, 286)

Another factor was a student's ability to stay focused even after hours of staring at screens. In their paper "Attempts, Successes, and Failures of Distance Learning in the Time of COVID-19" (Dietrich, Kentheswaran and Ahmadi 2020, 5), Dietrich, Kentheswaran and Ahmadi described this issue as follows: "[…] other students had difficulty in paying attention to a screen for more than an hour (inattention could lead to a breakup in the classes and a decrease in motivation) […]". They also mentioned that looking at screens over long periods may have caused headaches among some students:

> Several educators reported some health consequences of spending most of the daytime focusing on screens during videoconferences, such as headaches, which may also be experienced by students. This may affect concentration and the ability to react promptly during distance classes (Dietrich, Kentheswaran and Ahmadi 2020, 7).

During in-person-teaching before the pandemic, laptops may have been used from time to time, but it was a rarity to use them for several hours straight, especially without a proper break between lectures (Dietrich, Kentheswaran and Ahmadi 2020, 5). However, if used correctly, children could also benefit from using laptops for learning:

> A review of the evidence suggests that a moderate use of digital technology, especially watching age appropriate, high-quality programming, may promote certain cognitive and social benefits. In addition, "co-viewing" (i.e. engaging in screen time with a parent or caregiver) can enhance infant attention and their propensity to learn from on-screen content. (OECD 2020, 18)

Something that some students very much enjoyed was planning and organizing their own day. However, other pupils struggled with finding time to do their work or deliberately separating working time from free time. It also may have been hard for some students to incorporate physical activity or time for family and friends into their schedule. Therefore, some students struggled with maintaining a healthy work-life-balance. The differentiation between leisure and work time was complicated by the lack of physical distance at home. Usually, adolescents went to school to learn and then

relaxed at home, however due to the pandemic, studying and resting had to take place within the same space. This made it harder for students to switch from working mode into recreational mode, which for some meant having a hard time to focus on studying and for others meant not being able to calm down and enjoy their free time (Huber and Helm 2020 , 40-41) (Brandhofer, et al. 2020, 3-4).

Lastly, some students reported to have a hard time working and studying independently. In their study titled "Impacts of the COVID-19 Pandemic on Life of Higher Education Students: A Global Perspective", Aleksander Aristovnik, Damijana Keržič, Dejan Ravšelj, Nina Tomaževič and Lan Umek stated that:

> "[…] studying isolated online at home can bring about many challenges, e.g. lack of motivation and a need for higher self-discipline and self-initiative, which means that one has to adapt his/her studying habits efficiently in order to minimize the stress and the feeling of work overload. (Aristovnik, et al. 2020)"

Therefore, they suggested that students who lacked the ability to work independently tended to be more stressed and felt overwhelmed with their tasks (Huber and Helm 2020).

In summary, when considering all of the information provided above, distance learning seems to be more suitable for students that are able to motivate themselves (and potentially also receive motivation from the things and people around them), separate productive time from free time, plan their day wisely and then implement the plan, work independently and stay concentrated over long periods of time, even while looking at screens.

2.3 Environmental factors

There were also limitations concerning the work environment and the housing situation, that may have influenced a student's success during the distance learning period. However, studies suggested that the environmental factors were often less significant than the student- and system factors, especially in developed countries (Breitenbach 2021).

Some students' parents or siblings played an active role in helping and supporting when problems arise, whereas other students' families could or did not do so. This was often the case with pupils from socioeconomically (highly) disadvantaged families. During the distance learning period, it was often harder for teachers to support students individually. Accordingly, teacher support was greatly reduced, and the support of parents and/or siblings as "substitute teachers" became much more important. Therefore, the quantity as well as the quality of parental or fraternal support had an impact on how well students performed during the distance learning period (Huber and Helm 2020).

Shivangi Dhawan (Dhawan 2020) named "distractions" as one of the main weaknesses of distance learning. The availability of technical devices like phones, TVs or gaming consoles, noisy flatmates or attention seeking pets may represent distractions that would not be present while at school (Bork-Hüffer, et al. 2021). Heinrich, Darling-Aduana, Good and Cheng (Heinrich, et al. 2019) said that they "[…] saw many student behaviors that suggested a lack of engagement in the learning process, such as texting on cell phones, searching other websites, and distracting fellow students."

According to Bork-Hüffer, Kulcar, Brielmair, Markl, Immer, Juen, Walter and Kaufmann (Bork-Hüffer, et al. 2021), "Spatial confinement, lack of physical space for learning, and lack of sufficiently quiet learning environments are other factors that negatively influenced distance learning." Similar to the parental support, students with a weak socioeconomic background tended to have a less suitable working space. However, only a minority (6 %) of students said that they could not study at home because of their housing situation (Baier and Kamenokowski 2020).

Some students were also affected by a lack of technical devices at home. In some cases, they had to share their devices with their parents or siblings, who also had to work from home; in other cases, no devices were available at all. This posed a challenge for students, who sometimes were unable to participate in online meetings or had to work at night time. Devices that were needed may have included a laptop, a headset, and a microphone, but also well-functioning Wi-Fi was crucial. Some teachers were unable to stay in touch with certain students due to their poor Wi-Fi connection. This resulted in

some students not receiving tasks and not studying for a rather long period of time, which widened the gap between more and less privileged students (Brandhofer, et al. 2020, 6, Dhawan 2020, Goetz 2020, Breitenbach 2021).

Concluding, students with families that were able and willing to help when technical, emotional, or intellectual problems arose experienced fewer difficulties during the distance learning period. Also, it was important for students to have a silent and motivating working environment and the necessary resources.

3 Research questions and methodology

The goal of this chapter is to provide a discussion of the main research questions and to develop a methodology to answer these questions. The methodology used was an empirical analysis of data collected from a survey, which I conducted among senior students at BRG14 in the summer semester 2021. The results from the survey are analysed in the following chapter.

The survey was targeted at upper-secondary students of BRG14 and was conducted between June 22, 2021, and July 10, 2021. The original version of the questionnaire was written in the German language (see Appendix). The questionnaire was designed to address the following three main research questions:

- How did students experience distance learning?
- What elements of distance learning worked well and which need to be improved?
- What conclusions can one draw for the digital school of the future?

All three questions had the ultimate goal to clarify whether distance teaching and learning would still be relevant in the future, even though the pandemic might eventually come to an end and also to determine what elements of distance learning and teaching would remain relevant. Below, the three questions were explained further and related to the questionnaire.

3.1 How did students experience distance learning?

The first goal of the questionnaire was to learn about students' experience with distance learning. The aim of this research question was to identify what changed for students during the distance learning period in comparison to the time before distance learning was introduced and to determine what factors influenced the students' experience most. In order to evaluate each aspect of distance learning, it was important to know what elements were used and to also consider how frequently each element was used.

However, the research question did not only cover the changes that teachers had to implement, but also the school-related alterations in students' lifestyles.

Important aspects of this question may have been: In what ways did teachers have to adapt their teaching methods? Which new forms of teaching were introduced? How widely were they adopted? What changed for students and how did the changes affect them? How did a day in distance learning look different from an ordinary day at school with classroom teaching? To what extent did help from parents, siblings, and other caregivers become more important during distance learning?

3.2 What elements of distance learning worked well and which need to be improved?

The second aim of the questionnaire was to determine what elements of distance learning worked for students (and teachers) and which ones turned out to be non-functional. In other words, the elements that were defined in the section above should be evaluated by their functionality and practicality. This, again, includes system, student, and environmental factors. Adolescents were encouraged to state their opinion, assess the changes that distinguish classroom teaching from distance learning, and ultimately provide suggestions for improvement.

The main research question covered the following aspects: Did students find the usage of certain online tools helpful for their learning process? What were upsides and downsides of regular teaching and what were upsides and downsides of distance learning? What were the major problems with distance learning? Did students struggle with the organization of distance learning? Was it problematic that they were not in regular contact with their teachers and classmates? Did they struggle with the material taught? Were there problems with the novelty of learning independently? Which of these problems had the biggest impacts? Were there problems with resources such as laptops, headsets or microphones or a stable Wi-fi connection? Was there an adequate working environment? Were they able to seek for help when problems occurred?

3.3 What conclusions can one draw for the digital school of the future?

Lastly, the aim of the questionnaire was to identify elements of distance learning that might also be useful in the future when the pandemic is over, and schools can go back to pre-pandemic teaching. Without a doubt, neither teaching before the pandemic nor teaching during the pandemic was perfect, but both teaching styles had certain benefits. Now that a great number of people have tried out both styles of teaching and learning, there could exist a major new opportunity to combine both methods and use the benefits of both approaches to develop a new style of teaching suitable for the post-pandemic period. The underlying hypothesis was that a combination of face-to-face learning and distance learning would be the best solution. Did students agree with this statement?

Parts of this research question are: What positive aspects of distance learning could be transferred to face-to-face learning? How could the best parts of both worlds be combined? Taking into account what people know about analogue learning and what they have learned about digital distance learning, what is the new "best format of learning and teaching"?

3.4 Questionnaire

In this section, I relat the research questions explained above to the corresponding sections of the questionnaire. The full questionnaire (German version) can be found at the end of this paper (see Appendix). At the time the survey was conducted, Viennese students were taught face-to-face. However, in the respective school year, distance learning for students of the upper secondary in Vienna had taken place between 3 November 2020 and 8 February 2021, followed by a phase of hybrid teaching (students were divided into two groups, each group was in school two days a week, the remaining three days were distance learning-days) between 8 February and 17 May 2021 (Andraschko, et al. 2020, 2021).

In the first section of the questionnaire, the questions were targeted to uncover basic facts (questions one to four), but also to find out about the students' general attitude towards school. The second and third question particularly focused on the socioeconomic situation of the student (or their parents) participating in the survey.

1. *What grade are you in?*
   - ○ *5.*
   - ○ *6.*
   - ○ *7.*
2. *What is the highest education your 1st caregiver (e.g., mother or father) has completed?*
   - ○ *No degree*
   - ○ *Secondary school*
   - ○ *Apprenticeship*
   - ○ *Secondary vocational school (HASCH, ...)*
   - ○ *AHS - Matura*
   - ○ *BHS - Matura (HAK, HTL etc)*
   - ○ *University, University of Applied Sciences*
   - ○ *Not specified*
3. *What is the highest education your 2nd caregiver (e.g. mother or father) has completed?*
   - ○ *No degree*
   - ○ *Secondary school*
   - ○ *Apprenticeship*
   - ○ *Secondary vocational school (HASCH, ...)*
   - ○ *AHS - Matura*
   - ○ *BHS - Matura (HAK, HTL etc)*
   - ○ *University, University of Applied Sciences*
   - ○ *Not specified*
4. *How much do you like going to school in general?*
   - ○ *1 (very much) - 5 (not at all)*
5. *How easy or difficult is school for you in general?*
   - ○ *1 (very easy) - 5 (very difficult)*

Box 1

In the next section, students were asked to subjectively evaluate the distance learning period (question six). In addition, they were encouraged to compare distance learning

to their regular classroom lessons. The students were asked to rate their experience in three categories: stress (question seven), gain of knowledge (question eight) and quantity of work (question nine). The main research question that was being addressed in this section is: "How did students experience distance learning?"

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6. *How well did distance learning work last year compared to regular school?*
   - *1 (much better) - 5 (much worse)*
7. *How stressful did you find the distance learning phase?*
   - *1 (not stressful at all) - 5 (very stressful)*
8. *How much knowledge did you gain during distance learning compared to normal school?*
   - *1 (much more) - 5 (much less)*
9. *How much work did you have to do during distance learning compared to normal school?*
   - *1 (much less) - 5 (much more)*

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Box 2

In the subsequent part, students were asked what forms of distance learning were used in their classes (question ten) and how they rated their practicality (question eleven). The examined areas included digital worksheets and reading materials, textbooks and other books, audios, videos, video conferences, Moodle and special educational software. The main research questions addressed in this section were: "How did students experience distance learning?" and "What elements of distance learning worked well and which need to be improved?"

10. Which of the following media were frequently used for distance learning?

☐ *Digital worksheets and reading materials*

☐ *Textbooks and other books*

☐ *Audios*

☐ *Videos*

☐ *Video conferences*

☐ *Moodle*

☐ *Special educational software (for example virtual lab experiments, vocabulary, ...).*

☐ *Other:*

11. Which of the following media do you find particularly helpful for distance learning?

☐ *Digital worksheets and reading materials*

☐ *Textbooks and other books*

☐ *Audios*

☐ *Videos*

☐ *Video conferences*

☐ *Moodle*

☐ *Special educational software (for example virtual lab experiments, vocabulary, ...).*

☐ *Other:*

Box 3

In question twelve, students were asked to tick all boxes corresponding to their personal biggest hindrances for distance learning. Contrary to that, in question thirteen, students indicated the advantages of distance learning. The research question that was being addressed in this part was: "Which elements of distance learning worked well and which need to be improved?"

12. What have been the biggest obstacles for you in distance learning?

☐ Lack of motivation
☐ Difficulty working independently
☐ Problems with time management
☐ Difficulty separating school from free time
☐ Concentration problems when working in front of a screen for long periods of time
☐ Too much and too difficult material
☐ Unclear organization of distance learning
☐ Missing/ poor learning materials
☐ Too monotonous lessons
☐ Too little experience with distance learning
☐ Too few opportunities to ask questions
☐ Too little exchange with teachers
☐ Too little exchange with classmates
☐ Too little support at home (for example from parents, siblings, …)
☐ Too many distractions at home
☐ No personal workplace
☐ Too poorly equipped with digital devices
☐ Too poor Internet connection
☐ Too much screen-time
☐ There were no problems
☐ Other:

13. What did you like about distance learning?

☐ I can better determine my own daily schedule
☐ Learning at my own pace
☐ I can choose my own place and time of learning
☐ Improving my computer skills
☐ Audios/videos I can repeat as many times as I want
☐ More written materials, less transcripts
☐ More variety in learning materials
☐ I can concentrate better at home than at school
☐ Nothing
☐ Other:

Box 4

The following part of the questionnaire focused on the future development of distance learning. Students were asked to what extent they viewed distance learning as a model for the future (question fourteen) and to explain their answer further in an 'open

answer'-box (question fifteen). In question sixteen, the interviewees were asked to specify what elements of distance learning they would like to keep in the future. The focus of this section lay on the main research question: "What conclusions can one draw for the digital school of the future?"

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14. *Should there be more instruction using digital media/learning platforms after the Covid19 pandemic?*
    - ○ *Yes*
    - ○ *In certain areas*
    - ○ *No*
15. *What is your main reason for answering the question above about whether more digital instruction should be used?*
    - → *Open answer*
16. *What forms of digital instruction would you like to keep in the future?*
    - ☐ *Moodle as a central platform for assignments, materials, and submissions*
    - ☐ *Videos that explain required prior knowledge again*
    - ☐ *Videos that explain difficult content again*
    - ☐ *Digital materials with additional interesting information*
    - ☐ *PowerPoint slides instead of blackboard transcripts*
    - ☐ *Worksheets, graphs, etc. in digital form instead of on paper*
    - ☐ *Assignments that use technology (for example, making a video/audio file)*
    - ☐ *Online meetings for work groups instead of face-to-face meetings*
    - ☐ *Other:*

Box 5

Ultimately, students were offered one last open answer box (question seventeen) to write about whether teachers had already adopted certain elements of distance learning for their teaching. Once again, the main research question addressed in the last part was: "What conclusions can one draw for the digital school of the future?"

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17. *Do you have subjects that are still using new digital forms of teaching even though the lockdown is over? Which subjects? What forms of teaching?*
    - → *Open answer*

Box 6

The factors from chapter 2, system factors, student factors and environmental factors, were also taken into account when the questionnaire was created. In questions four through nine, students were asked to answer questions about school and distance learning in general. To answer these questions, students may have primarily considered system and student factors, however environmental factors may have also played a role specifically in the questions about distance learning. In questions ten and eleven about instruction materials used for distance learning, the main factors to be considered were system factors. In question twelve, students were asked to name the biggest difficulties that they encountered in the distance learning period. The answer options were sorted by student-related ("Lack of motivation" to "Concentration problems […]"), system-related ("Too much and too difficult material" to "Too little exchange with classmates") and environment-related ("Too little support at home" to "Too much screen-time"). The same scheme applied to question fourteen, again with response options that could be categorized as student factors ("I can better determine my own daily schedule" to "Improving my computer skills"), system factors ("Audios/videos I can repeat as many times as I want" to "More variety in learning materials") and environmental factors ("I can concentrate better at home than at school"). Questions fourteen and fifteen, which deal with the future of distance education, could again only be answered if all three types of factors were considered. Question seventeen discussed what forms of digital teaching students would like to keep in the future and in this case, the most important factors were system factors. In the final question students were asked to list subjects and forms of teaching that were being used by their teachers after the end of the distance learning period. Again, system factors were the most relevant factors to consider.

3.5 Correlation analysis

For the analysis of the data collected in the survey, I conducted both a descriptive analysis and an examination of correlations between subjective learning outcomes and learning factors. For the descriptive analysis, I provided an overview of the results of the survey for each question or variable and present the findings by using charts. For the

correlation analysis, I investigated possible relationships between two variables. To do so, I used Spearman's Rank Correlation Coefficient.

> The Spearman rank correlation coefficient is computed between the ranks of two variables […]. The computation of the Spearman rank correlation coefficient (rs) is the same as the Pearson correlation coefficient, but rank values are used instead of the actual values (Frapporti, Linnartz and Vriend 1991).

Spearman's rank correlation coefficient was used to determine the strength of a link between two sets of ordered categorical data. To take one example from the survey, the correlation between a student's evaluation of distance learning on a scale from one to five and the frequent (=1) or not frequent (=0) use of video conferences in teaching was considered. Finding correlation of ranks between these two variables could indicate, for example, that more frequent use of video conferences was associated with a higher evaluation of distance learning (University of Texas: Statistics + Data Sciences 2015, Boer, Schober and Schwarte 2018, Frapporti, Linnartz and Vriend 1991).

The rank correlation coefficient r_s between two ordered categorical variables x and y with sample size n is defined as the ratio of the covariance of the variables divided by the product of the standard deviations. (University of Texas: Statistics + Data Sciences 2015, Frapporti, Linnartz and Vriend 1991).

$$r_s = \frac{cov(x, y)}{\sigma(x) * \sigma(y)}$$

To calculate the rank correlation coefficient, one can use the formula below. One first has to obtain the means of the two sets of variables whose correlation shall be tested. Next, for each of the two variables one has to subtract the mean from the value of each observation to obtain the deviations from the means. Then, for each observation, one multiplies these deviations from the means for both variables, summed up across all observations and divided by n. The value obtained is the numerator in the formula below and corresponds to the covariance between the two variables. Next, the denominator has to be determined. It equals the product of the standard deviations of the two variables. To calculate the standard deviation for one variable, one has to take the square root of the sum of the squared deviations of each observation from the mean divided by n.

$$r_s = \frac{\left(\frac{1}{n}\right) * \sum_{i=1}^{n}(x_i - \bar{x}) * (y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 * \left(\frac{1}{n}\right)} * \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2 * \left(\frac{1}{n}\right)}}$$

The result of the formula for calculating the rank correlation coefficient always lies in an interval between - 1 and + 1. The further the result is away from zero and the closer it is to 1 or - 1, the stronger the correlation (1 being a perfect positive correlation and - 1 being a perfect negative correlation). A value close to zero suggests that there is little to no correlation between the two variables.

3.6 Limitations

It should be noted that finding correlation between two variables does not necessarily imply a causal relationship. Even though the data analysis may have suggested a strong correlation, the two factors examined may actually be causally unrelated. The outcome could be a coincidence or other factors may have influenced the results. A deeper examination of the relationship between two variables may be necessary to show causation (Boer, Schober and Schwarte 2018).

Additionally, only 171 students took part in the survey. These students were all enrolled in the same high school, therefore tended to live in similar areas and come from similar socio-economic backgrounds. They were also in the same age range. Furthermore, it could not be guaranteed that all students were 100% honest with their answers. Therefore, the students surveyed could not represent all high school students in Vienna or even students in Austria in general, since there was too little data to draw reliable conclusions of this scope.
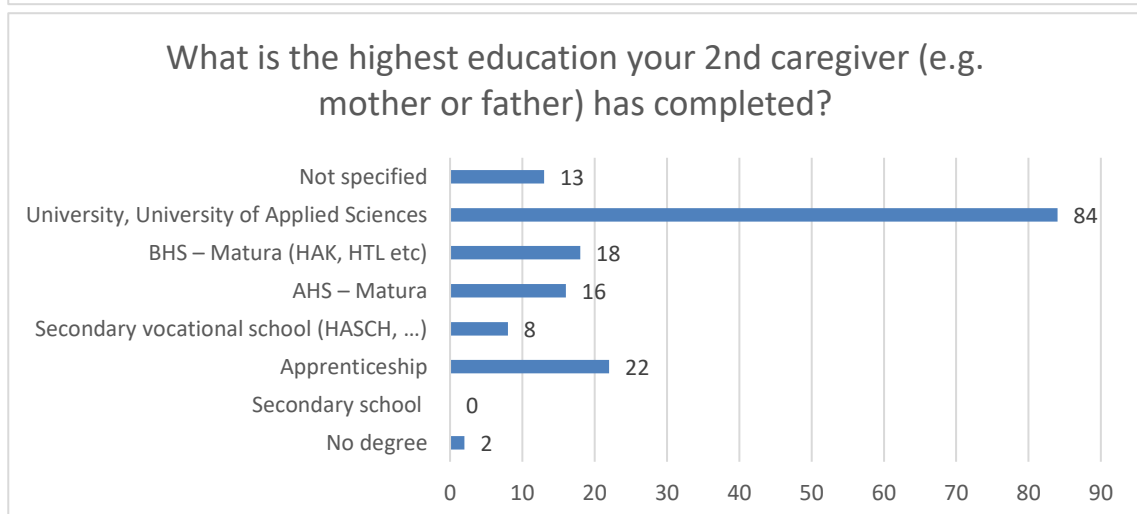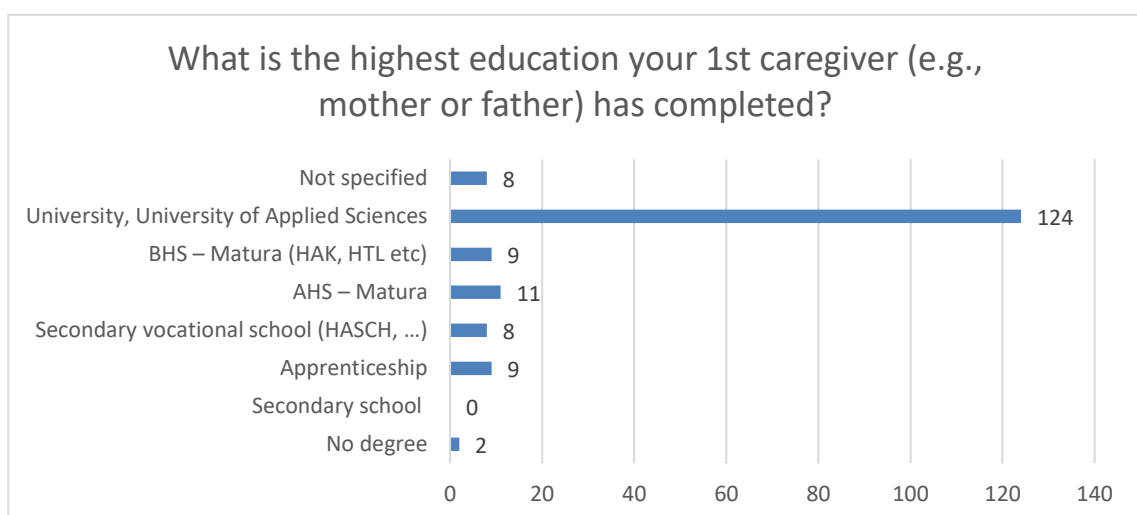
Moreover, the Spearman rank correlation coefficient could only detect and measure linear correlations, but some sets of data may have correlated in a different way, quadratically or exponentially, e.g. Therefore, a number close to zero may not always have indicated a lack of correlation in general, but rather a lack of linear correlation (Boer, Schober and Schwarte 2018).

4 Empirical data analysis

4.1 Descriptive analysis

The data analysed was collected in the survey described in section 3.4. In total, 171 students participated in the survey, of which 61 were in 5th grade, 67 were in 6th grade and 43 were in 7th grade.

As can be seen in graphs 1 and 2 below, the vast majority (72.5 %) of the students' parents have completed university. It must be noted that this educational composition is not representative for Austrian society. According to "Statistik Austria", only 8.1 % of Austrians aged 16 or older in 2008 have completed university and a combined 61.1 % have either completed secondary school or an apprenticeship (Stöger 2012, 35).

What is the highest education your 1st caregiver (e.g., mother or father) has completed?

Category	Value
Not specified	8
University, University of Applied Sciences	124
BHS – Matura (HAK, HTL etc)	9
AHS – Matura	11
Secondary vocational school (HASCH, …)	8
Apprenticeship	9
Secondary school	0
No degree	2

What is the highest education your 2nd caregiver (e.g. mother or father) has completed?

Category	Value
Not specified	13
University, University of Applied Sciences	84
BHS – Matura (HAK, HTL etc)	18
AHS – Matura	16
Secondary vocational school (HASCH, …)	8
Apprenticeship	22
Secondary school	0
No degree	2

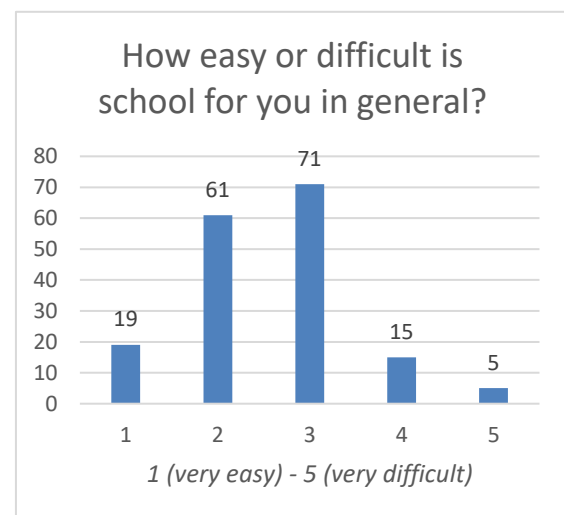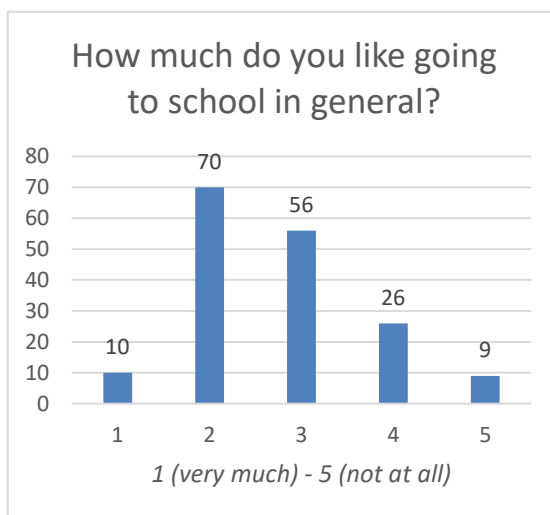*Graph 1 & 2*   Total: 171 students

When asked about how much students enjoyed going to school on a scale of one to five (one meaning they like it very much, 5 meaning they do not like it at all), most students answered saying they felt rather positive (5.8 % + 40.9 %) or neutral (32.7 %) about going to school (graph 3). The mean of their answers was 2.731.

Students were also asked about how difficult they found school to be in general on a scale of one to five (one being very easy and five being very difficult). Most of students' answers lay between one and three (88.3 %), with the mean being 2.567 (graph 4). Concluding, many students found school rather easy or neither particularly easy nor particularly hard.

How much do you like going to school in general?	How easy or difficult is school for you in general?
80 – 70 – 60 – 50 – 40 – 30 – 20 – 10 – 0 — 1: 10, 2: 70, 3: 56, 4: 26, 5: 9	80 – 70 – 60 – 50 – 40 – 30 – 20 – 10 – 0 — 1: 19, 2: 61, 3: 71, 4: 15, 5: 5
1 (very much) - 5 (not at all)	*1 (very easy) - 5 (very difficult)*

Graph 3 & 4   Total: 171 students

In the subsequent question, students were asked to rate their distance learning experience in comparison to regular face-to-face teaching on a scale from one to five (one meaning distance learning was much better than regular school and five meaning it was way worse). The answers students gave (depicted in graph 5) were relatively evenly distributed with a slight trend towards higher scores with a mean of 3.275. In conclusion, a clear majority of students stated that distance learning did not work as well as regular in-class teaching.

In response to the question, "How stressful did you find the distance learning phase?" (graph 6) students gave answers that tended to range from "fairly stressful" (33.3 %) to "very stressful." (26.9 %). Again, students had to rate the level of stress on a scale from one to five, one being not stressful and five being very stressful. The mean of the

answers given by the students was 3.515. Concluding, students found the distance learning phase to be fairly stressful.

How well did distance learning work last year compared to regular school?

1 (much better) - 5 (much worse)

How stressful did you find the distance learning phase?

1 (not stressful at all) - 5 (very stressful)
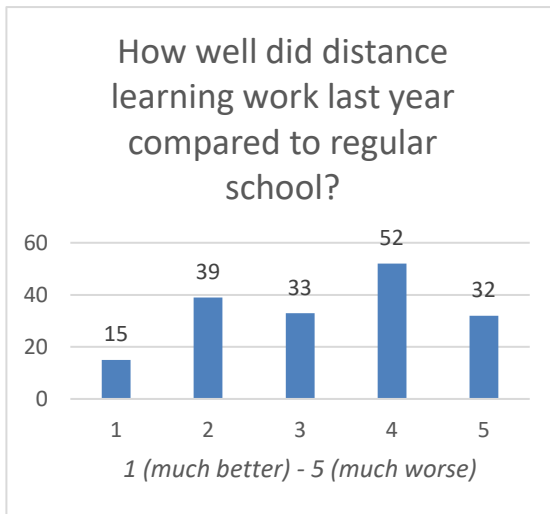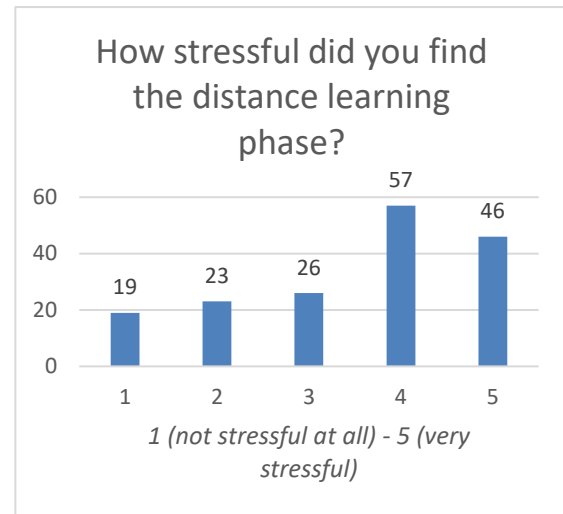
Graph 5 & 6   Total: 171 students

The next question (graph 7) was about the amount of knowledge students gained during the distance learning period in comparison to face-to-face learning. Again, a scale from one to five, one meaning that students learned more and five meaning that students learned less, was used to represent the opinion of the students. Here, the mean of the students' answers was 3.649, meaning that they gained less knowledge on average during distance learning in comparison to regular school.

For the following question, students were asked to compare how much work they had to do during the distance learning period and during face-to-face teaching stages. Again, there was an unmistakable trend towards the higher end of the spectrum (one meaning that students had to do much less work at home than at school, five meaning the opposite), with 83% giving answers between 3 and 5. Therefore, students found that distance learning required a bigger effort (graph 8).

How much knowledge did you gain during distance learning compared to normal school?

1 (much more) - 5 (much less)

How much work did you have to do during distance learning compared to normal school?

1 (much less) - 5 (much more)
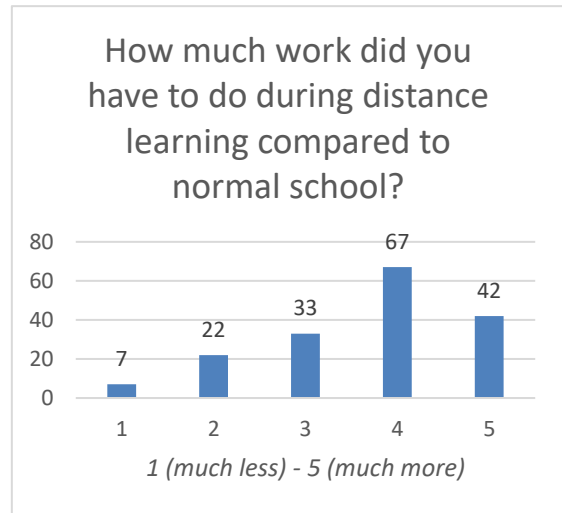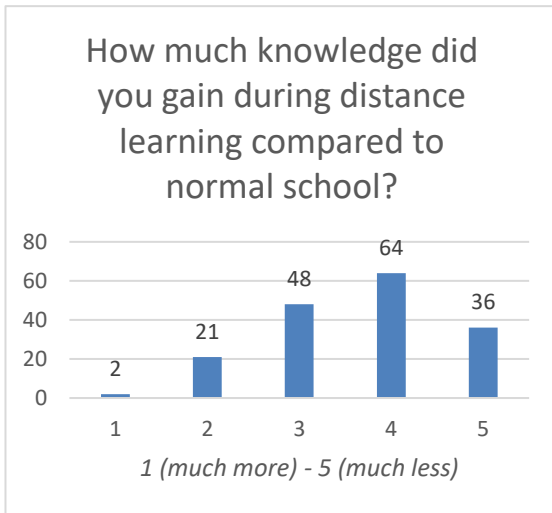
Graph 7 & 8   Total: 171 students

In the next two questions, students were asked to indicate what media were frequently used (graph 9) during distance learning and also to state what media they found especially useful (graph 10). The two most-used media were Moodle (169 ≙ 98.8 %) and video conferences (162 ≙ 94.7 %), followed by digital worksheets and reading materials (122 ≙ 71.3 %) and textbooks and other books (117 ≙ 68.42 %). The clear winner when it came to what media students perceived to be particularly useful for distance learning was Moodle (120 ≙ 70.2 %), an online course management system and learning platform. It was followed by video conferences (79 ≙ 46.2 %), videos (69 ≙ 40.4 %), textbooks and other books (61 ≙ 35.7 %) and digital worksheets and reading materials (60 ≙ 35.1 %).

Which of the following media were frequently used for distance learning?

Which of the following media do you find particularly helpful for distance learning?
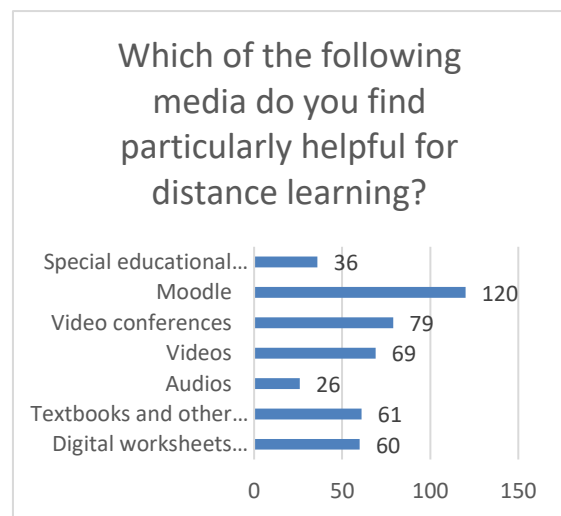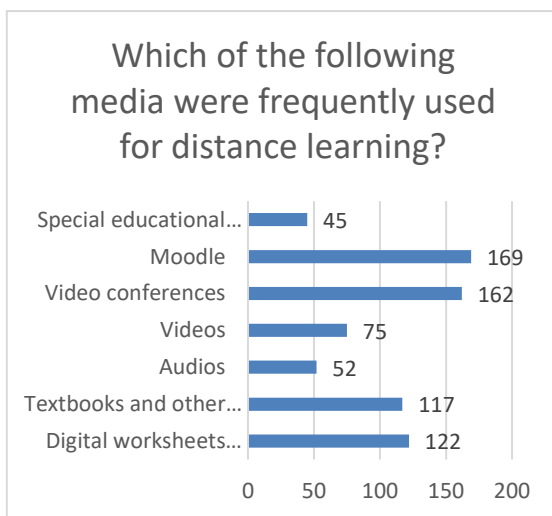
Graph 9 & 10   Total: 171 students

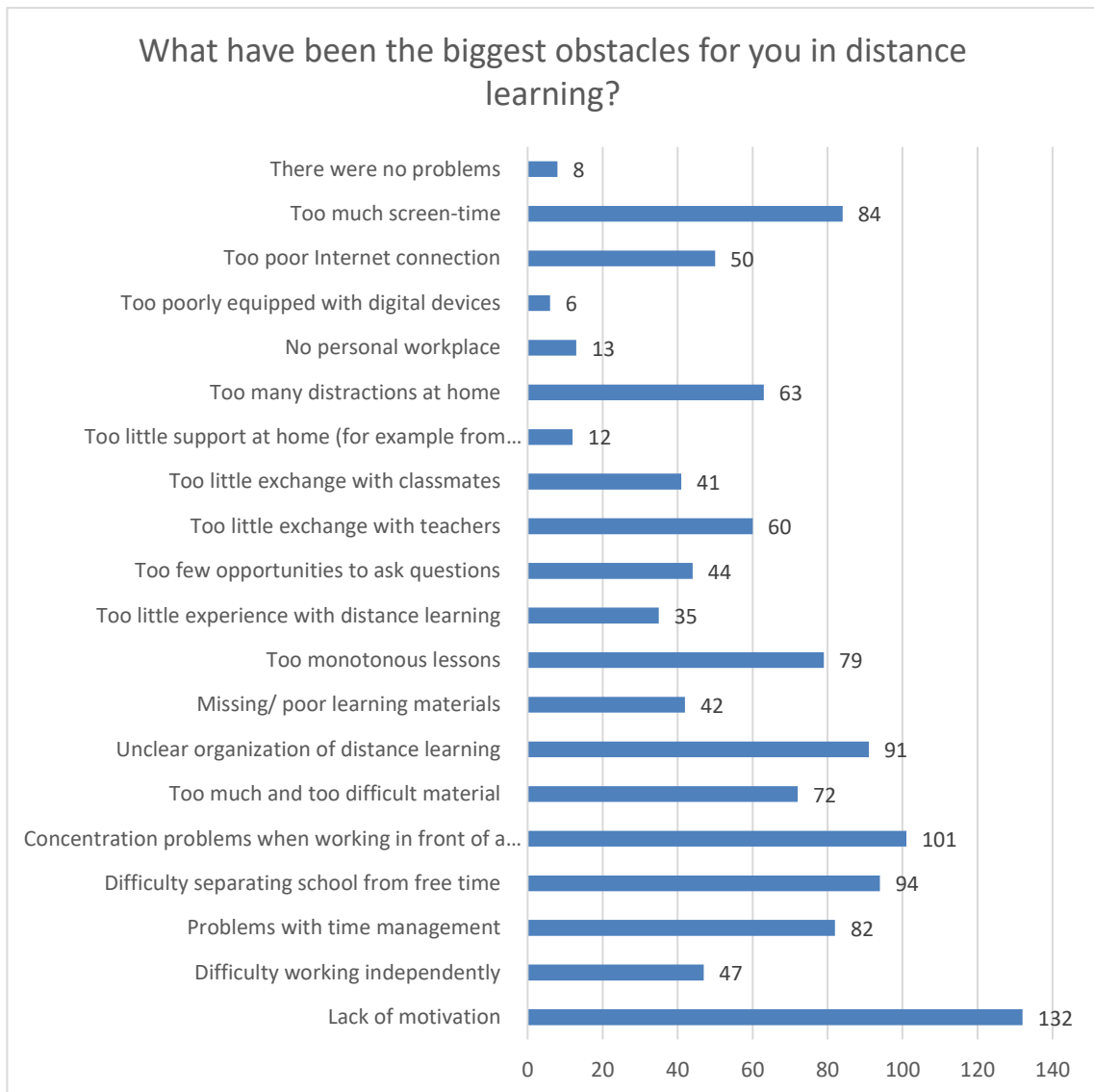Next, students were asked to indicate what they perceived to be the biggest obstacles for distance learning (graph 11). Most of the students surveyed felt that a lack of motivation (132 ≙ 77.2 %) was the biggest obstacle for distance learning. Concentration problems when working in front of a screen for long periods of time (101 ≙ 59.1 %), the difficulty of separating school from free time (94 ≙ 55 %) and an unclear organization of distance learning (91 ≙ 53.2 %) were the next most common difficulties. The factors that were moderately significant were too much screen time (84 ≙ 49.1 %), problems with time management (82 ≙ 48 %), too monotonous lessons (79 ≙ 46.2 %), too much and too difficult material (72 ≙ 42.1 %), too many distractions at home (63 ≙ 36.8 %), too little exchange with teachers (60 ≙ 35.1 %), poor internet connection (50 ≙ 29.2 %), difficulties working independently (47 ≙ 27.5 %), too few opportunities to ask questions (44 ≙ 25.7 %), missing/ poor learning materials (42 ≙ 24.5 %), too little exchange with class mates (41 ≙ 23.9 %) and too little experience with distance learning (35 ≙ 20.5 %). The less significant obstacles seemed to be no personal workspace (13 ≙ 7.6 %), too little support at home (12 ≙ 7 %), and a lack of equipment (6 ≙ 3.5 %). Eight people (4.7 %) stated that there were no problems, however only three of them stated the latter as their only answer, the other five also considered other factors to be obstacles for distance learning.

When calculating the means for obstacles that could be categorized as "student factors", "system factors" or "environmental factors", the results were rather interesting: System factors (58 ≙ 33.9 %) and environmental factors (45.6 ≙ 26.7 %) both totalled around 50, while student factors added up to 91.2 (53.3 %). This suggested that student factors were the most influential factors when it came to obstacles and problems with distance learning.

What have been the biggest obstacles for you in distance learning?

Obstacle	Value
There were no problems	8
Too much screen-time	84
Too poor Internet connection	50
Too poorly equipped with digital devices	6
No personal workplace	13
Too many distractions at home	63
Too little support at home (for example from…	12
Too little exchange with classmates	41
Too little exchange with teachers	60
Too few opportunities to ask questions	44
Too little experience with distance learning	35
Too monotonous lessons	79
Missing/ poor learning materials	42
Unclear organization of distance learning	91
Too much and too difficult material	72
Concentration problems when working in front of a…	101
Difficulty separating school from free time	94
Problems with time management	82
Difficulty working independently	47
Lack of motivation	132

Graph 11   Total: 171 students

In the next question, students were asked about the benefits of distance learning (graph 12). What students liked the most was the freedom to plan their day according to their own preferences (118 ≙ 69 %) and the liberty to choose the place and time at which the learning took place (111 ≙ 64.9 %). Next came the autonomy to choose their own pace of learning (78 ≙ 43.3 %), the opportunity to repeat videos and audios as often as needed (66 ≙ 38.6 %), the increased use of written materials contrary to student having to copy everything themselves (47 ≙ 27.5 %), the improvement of students' computer skills (36 ≙ 21.1 %), a higher level of concentration at home (32 ≙ 18.7 %) and a bigger variety of learning materials (10 ≙ 5.8 %). 12 people (7 %) stated that there were no benefits to distance learning, one of which also stated the determination of their own daily schedule as an advantage to distance learning.

What did you like about distance learning?

Category	Value
Nothing	12
I can concentrate better at home than at school	32
More variety in learning materials	10
More written materials, less transcripts	47
Audios/videos I can repeat as many times as I want	66
Improving my computer skills	36
I can choose my own place and time of learning	111
Learning at my own pace	78
I can better determine my own daily schedule	118
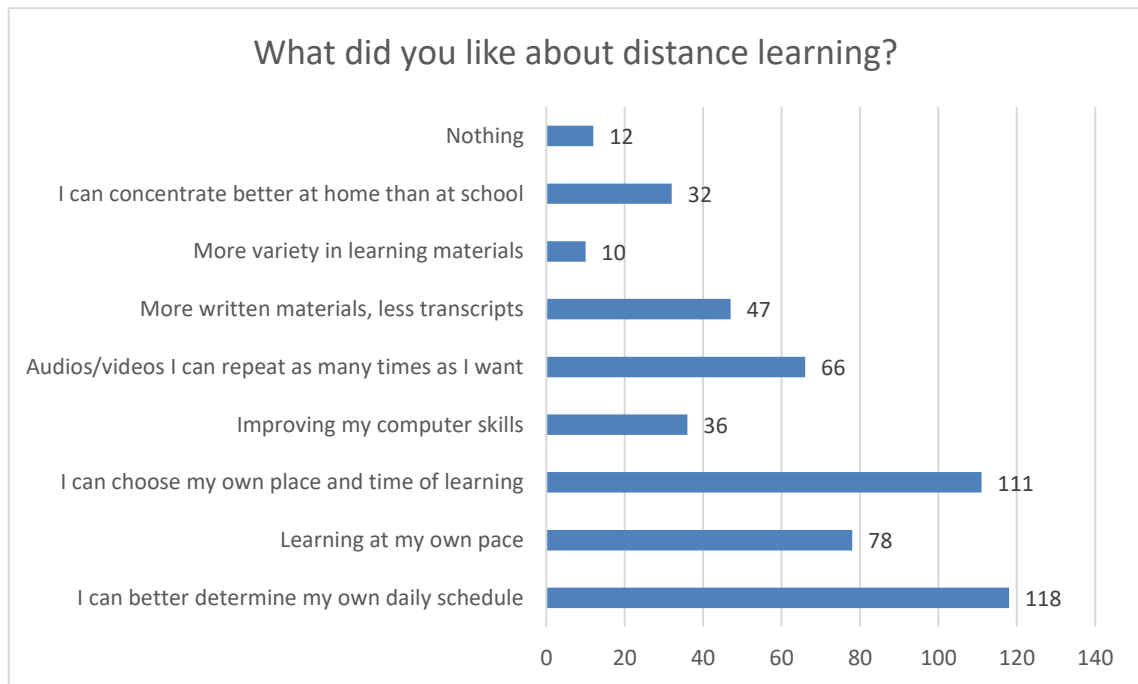
Graph 12   Total: 171 students

In the subsequent question, students were asked whether they thought that there should still be instruction using digital media or learning platforms after the pandemic has ended (graph 12). The majority of students answered that they would like to be taught using digital media in certain areas (111 ≙ 64.9 %). Students advocating (28 ≙ 16.4 %) or opposing (32 ≙ 18.7 %) the use of digital media/ learning platforms were a clear minority and their numbers were roughly balanced. So generally speaking, students seemed to be in favour of a mixture between digital learning and face-to-face teaching.

Should there be more instruction using digital media/learning platforms after the Covid19 pandemic?

Category	Value
No	32
In certain areas	111
Yes	28
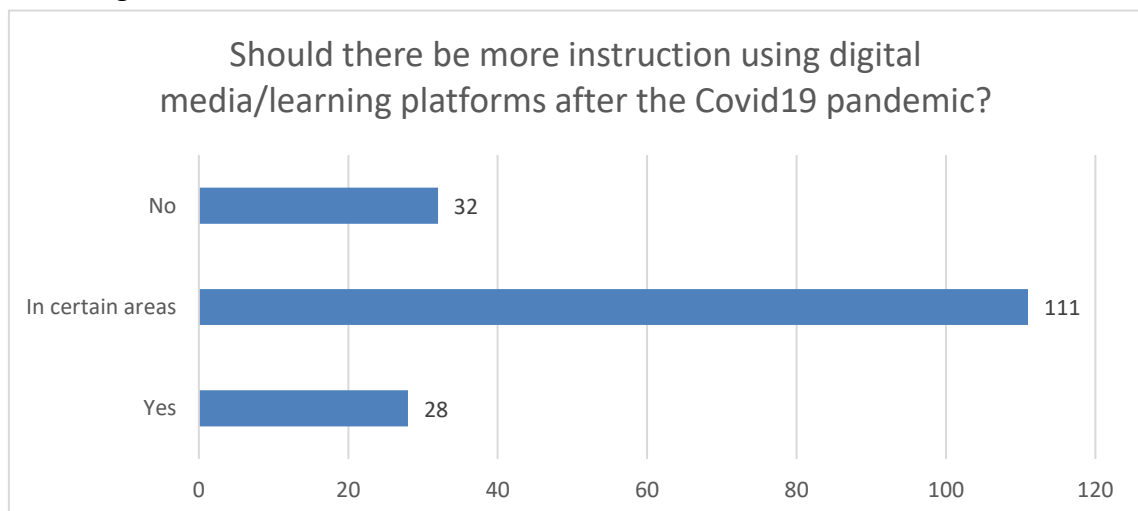
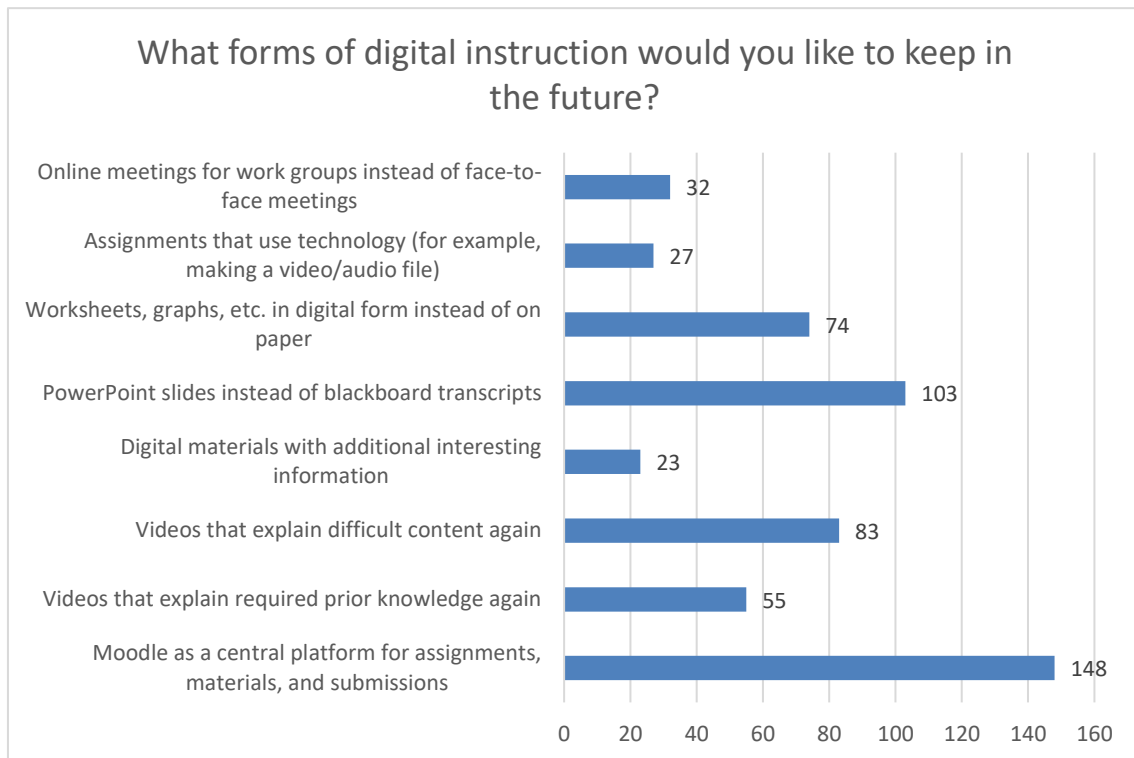*Graph 13*   Total: 171 students

In the next question, students were asked to state the main reason(s) for their answer to the previous question. The most prominent reasons were that students felt that for some subjects, distance learning/ learning with the help of digital media could easily replace face-to-face learning, but distance learning was not compatible with other subjects and also, students were often appreciative of less printed paper and more digital worksheets that they could access any time in any place. Many also mentioned that in their opinion digital learning was, at least to a certain extent, the future of schools. Some students stated that they had experienced a lack of motivation, organization and concentration during distance learning, however others stated that they had experienced this the exact opposite way, they had appreciated the freedom to plan their schedule individually and they had felt more concentrated and motivated at home. Some students stated that they had felt lonely at home due to not seeing their friends and colleagues every day. Some mentioned that if a student was sick and unable to go to school, they were still be able to access all the material that had been discussed online.

In the next question, students were asked to specify what forms of digital instruction they would like to keep in the future (graph 14). Almost every student participating in the survey stated that they would like to have Moodle as a central platform for assignments, materials and submissions (148 ≙ 86.5 %). The second most common answer was that students wanted to keep PowerPoint slides instead of blackboard transcripts (103 ≙ 60.2 %). 83 students (48.5 %) wanted to keep videos that explain difficult content, 74 students (43.3 %) wanted to keep worksheets, graphs, etc. in digital form instead of on paper, 55 pupils (32.2 %) wanted to keep videos that explain required prior knowledge, 32 (18.7 %) students wanted online meetings for work groups instead of face-to-face meetings, 27 (15.8 %) wanted to have assignments using technology in the future and 23 students (13.5 %) wanted to keep digital materials with additional interesting information.

What forms of digital instruction would you like to keep in the future?

Category	Value
Online meetings for work groups instead of face-to-face meetings	32
Assignments that use technology (for example, making a video/audio file)	27
Worksheets, graphs, etc. in digital form instead of on paper	74
PowerPoint slides instead of blackboard transcripts	103
Digital materials with additional interesting information	23
Videos that explain difficult content again	83
Videos that explain required prior knowledge again	55
Moodle as a central platform for assignments, materials, and submissions	148

Graph 14   Total: 171 students

In the final question, students were asked to state if they had subjects that were still using new digital forms of teaching even though the lockdown was over and to specify which subjects and what forms of teaching those were. About one fifth of the students surveyed stated that teaching with digital media did not continue after the end of the lockdowns. 80 % of the students, however, stated that some digital methods were retained. Moodle and online files that replaced printed handouts or worksheets were, for example, tools that were mentioned most often. Also, some teachers started using PowerPoints instead of writing on the blackboard. Several teachers showed their students videos to introduce them to new topics.

The use of Moodle and PowerPoint became established in all types of subjects equally. Also, according to the students, online files were often used in nearly every subject. The subjects that were most mentioned were maths, English and physics.

To conclude, the students surveyed liked going to school and did not experience major difficulties there. They rated distance learning worse than regular face-to-face school, since they experienced more stress, they had to work more but still felt that they gained less knowledge. Nearly all students stated that they frequently used Moodle and took

part in video conferences. The students' favourite online tool for distance learning was Moodle. Most students stated that a lack of motivation was the biggest obstacle for distance learning. Generally, "student factors" were the biggest obstacles for most students, whereas there were fewer problems that could be categorized as "system factors" or "environmental factors". The greatest benefit of distance learning was the freedom to determine one's own schedule. Most students felt that digital distance learning should still take place in the future in certain subjects but was not compatible with other subjects. Students would appreciate the continuation of Moodle as a central platform for assignments, materials, and submissions and also PowerPoints that can be put on Moodle instead of them having to copy what teachers write on the board. Many teachers actually have integrated the latter into their teaching routines.

4.2 Correlation analysis

In the correlation analysis, the relationships between subjective learning outcome variables and other learning factors were examined. As subjective learning outcomes, the following variables were considered:

- *Perception of distance learning (DL): How well did distance learning work last year compared to regular school?*
  - *1 (much better) - 5 (much worse)*
- *Stress: How stressful did you find the distance learning phase?*
  - *1 (not stressful at all) - 5 (very stressful)*
- *Knowledge: How much knowledge did you gain during distance learning compared to normal school?*
  - *1 (much more) - 5 (much less)*
- *Workload: How much work did you have to do during distance learning compared to normal school?*
  - *1 (much less) - 5 (much more)*

The learning factors were derived from the other questions of the survey as described below. The analysis of correlation was conducted using Spearman's rank correlation coefficient as explained in chapters and The result of the calculation to determine Spearman's rank correlation coefficient is always a number between -1 and +1. The further away the number is from zero, the more significant is the correlation between the two variables examined. For my set of data, I set the critical threshold of significance to $r_s \leq -0.15$ or $r_s \geq 0.15$. The Spearman correlation tests provided by the statistical software package R suggest that within this range the correlation coefficients were significant at the 95 % level. This means that with high probability, the correlation found between two variables was not random.

First, the relationships between learning outcomes and some general factors, more specifically the student's school level, how much they liked school and how easy they found school were described. An overview of the results is being provided in the table below (table 1). For starters, the relation between a student's perception of distance learning and the general factors above were examined. The strongest correlation could be observed between a student's perception of how hard school is and how much they liked distance learning with a correlation value of r_s=0,161. This means that students

who found school to be harder also tended to not like distance learning. There were no significant correlations between a student's perception of distance learning and their school level or whether they liked going to school. Stress correlated strongly negatively (r_s=-0.269) with a student's school level, meaning that younger students were more likely to experience stress. Also, the level of stress and how hard a student found school correlated positively with an r_s-value of 0.172, meaning that students who found school hard were more likely to experience stress. The gain of knowledge of a student correlated rather strongly positively with how hard they found school (r_s=0.247). This means that students who found school to be harder tended to have gained less knowledge during the distance learning phase. Their school level and how much a student enjoyed going to school did not correlate significantly with their gain of knowledge. A negative correlation with an r_s-value of -0.186 between a student's school level and workload could be observed. Therefore, younger students were likely to perceive their workload to be bigger than older students. Workload did not correlate significantly with the other two variables mentioned earlier.

	Perception of DL	Stress	Knowledge	Workload
School level	-0,066	-0,269	0,015	-0,186
Likes/dislikes school	-0,013	0,092	0,073	0,051
Finds school easy/hard	0,161	0,172	0,247	0,001

Negative r_s: Higher grade and more positive attitude towards school is associated with better subjective learning outcomes

Table 1

Next, the correlations between the subjective learning outcome variables and the frequency of use of the tools that can be seen below in Table 2 were examined. None of the tools, including digital worksheets, textbooks, audios, videos, video conferences, Moodle and special learning software correlated highly with a student's perception of distance learning. However, it can be noted that all the correlations had a negative sign except for the correlation between digital worksheets and the perception of distance learning, leading to the conclusion that worksheets contributed least to a student's positive perception of distance learning or being a reason why a student did not perceive distance learning positively.

There were also only non-significant correlations between the frequency of use of the tools named above and a student's level of stress. Again, it was perhaps noteworthy that all r_s-values were positive except for the ones that described the correlation between stress and the use of Moodle as well as stress and the use of special learning software, leading to the conclusion that these two tools contributed least to a student's degree of stress.

The most significant correlations of this category could be observed between a student's gain of knowledge (1 meaning that a lot of knowledge has been gained, 5 meaning the opposite) and the frequency of use of the tools named before (0 meaning the tool was not frequently used, 1 meaning the opposite). The strongest negative correlation existed between the gain of knowledge and the use of textbooks with r_s=-0,224, meaning that textbooks contributed to a bigger gain of knowledge. There was also a negative correlation with the frequent use of videos and video conferences (r_s=-0.167). A positive significant correlation could be observed between knowledge and digital worksheets (r_s=0.152), meaning that digital worksheets did not contribute to the gain of knowledge.

There were no significant correlations between a student's workload and the frequency of use of the tools named previously.

Frequent use of:	Perception of DL	Stress	Knowledge	Workload
Digital worksheets	0,103	0,107	0,152	-0,038
Textbooks and other books	-0,114	0,105	-0,224	0,056
Audios	-0,108	0,001	-0,145	0,054
Videos	-0,103	0,043	-0,167	0,031
Video conferences	-0,103	0,043	-0,167	0,031
Moodle	-0,062	-0,084	0,024	-0,023
Special educational software	-0,093	-0,069	-0,016	-0,007

Negative r_s: More frequent use is associated with better subjective learning outcomes
Table 2

In this section, the relationships between the school levels, students were in and their biggest obstacles for distance learning were examined. The results can be viewed in table 3. It could be observed that younger students tended to experience difficulties with the amount and the level of difficulty of the tasks they were given (r_s=-0.234). They were also likely to lack the ability to work independently (r_s=0.193), to maintain a work-

life-balance (r_s=-0.172) and they also tended to feel like they had too few opportunities to ask questions (r_s=-0.165). In the meantime, older students were more likely to find lessons very monotonous (r_s=0.172). They were also more likely to not obtain a personal adequate workspace. The obstacles "Lack of motivation" and "Concentration problems in front of screens" were the two obstacles that were named the most often – it can be observed that younger as well as older students struggled with these problems more or less equally. A conclusion one can draw from the results of the correlation analysis is that younger students especially struggled with obstacles that could be categorized as student factors, moderately with system factors, and less with environmental factors.

Obstacles	School level
Lack of motivation	-0,117
Difficulty working independently	-0,193
Problems with time management	-0,146
Difficulty separating school from free time	-0,172
Concentration problems in front of screens	-0,026
Too much and too difficult material	-0,243
Unclear organization of distance learning	0,092
Missing/ poor learning materials	-0,009
Too monotonous lessons	0,172
Too little experience with distance learning	-0,044
Too few opportunities to ask questions	-0,165
Too little exchange with teachers	-0,057
Too little exchange with classmates	0,056
Too little support at home	-0,087
Too many distractions at home	-0,030
No personal workplace	0,152
Too poorly equipped with digital devices	-0,101
Too poor Internet connection	-0,001
Too much screen-time	0,056
No Obstacles	-0,116

Negative r_s: Obstacle is associated with lower grade

Table 3

In table 4, the correlations between the subjective learning outcomes and students' biggest obstacles were illustrated. The first thing that stood out was that all r_s-values were positive or very close to zero except for the r_s-value that described the correlation between the student's gain of knowledge and the inexistence of obstacles with an r_s-value of -0.282.

The strongest positive correlation with a student's perception of distance learning could be observed with problems with time management (r_s=0.437), the difficulty of working independently (r_s=0.397) and a lack of motivation (r_s=0.340), meaning that these were the obstacles that most contributed to a student's negative perception of distance learning. Other rather strong correlations could be observed between the perception of distance learning and too little experience with distance learning (r_s=0.301), too poor internet connection (r_s=0.279), too little support at home (r_s=0.202), difficulties separating school from free time (r_s=0.201), concentration problems in front of screens (r_s=0.200), too difficult or too much material (r_s=0.181), an unclear organization of distance learning (r_s=0.181) and too many distractions at home (r_s=0.180). The strongest correlations could be categorized as student factors, suggesting that they had the biggest influence on a student's overall perception of distance learning.

The subjective learning outcome "stress" correlated most strongly with too difficult and too much material (r_s=0.476), concentration problems in front of the screen (r_s=0.371), problems with time management (r_s=0.344) and difficulty working independently (r_s=0.319). Therefore, these factors seemed to add most to a student's level of stress. Additional stronger correlations could be observed between the amount of stress a student experienced and the difficulty separating school from free time (r_s=0.299), a lack of motivation (r_s=0.285), too few opportunities to ask questions (r_s=0.272), too little experience with distance learning (r_s=0.268), too much screen time (r_s=0.229), too poor internet connection (r_s=0.206), too many distractions (r_s=0.202), as well as too little devices (r_s=0.157) and too little support (r_s=1.155) at home. Again, the biggest contributors to stress in distance learning seemed to be student factors.

When examining the correlations between knowledge and the different kinds of obstacles that can be seen in Table 4, it can be observed that the strongest positive correlations existed between knowledge and too monotonous lessons (r_s=0.379), the difficulty to work independently (r_s=0.336) and a lack of motivation (r_s=0.335), suggesting that the presence of these factors most decelerated a student's gain of knowledge. Significant positive correlations apart from those could be found between knowledge and too many distractions at home (r_s=0.296), too poor internet connection

(r_s=0.292), missing or poor learning materials (r_s=0.275), an unclear organization of distance learning (r_s=0.249), difficulties to maintain a work-life balance (r_s=0.235), too few opportunities to ask questions (r_s=0.214), as well as too much and too difficult material (r_s=0.176), no personal workspace (r_s=0.171), too poor equipment of digital devices (r_s=0.168), too little support at home (r_s=0.166) and finally too little exchange with teachers (r_s=0.158). Students who stated that there were no obstacles were likely not to have experienced a decrease in their gain of knowledge during the distance learning phase (r_s=-0.282). In this category, the averages of the r_s-values per category were roughly equal, meaning that student, system and environmental factors mattered equally.

Ultimately, the correlations between a student's workload and the different obstacles was investigated. The workload correlated most strongly with too much and too difficult material with an r_s-value of 0.345, meaning that this obstacle contributed most to a bigger workload. More obstacles that correlated rather strongly positively with workload were too much screen time (r_s=0.234), too poor internet connection (r_s=0.224), problems with time management (r_s=0.215), difficulties with working independently (r_s=0.195) and separating school from free time (r_s=0.189), a lack of motivation (r_s=0.166), too little exchange with classmates (r_s=0.154) and too poor equipment of technical devices (r_s=0.150). The strongest correlations could be observed between workload and student factors, however in general, the correlations between obstacles and workload tended to be weaker than the correlations between obstacles and the other learning outcomes.

Obstacles	Perception of DL	Stress	Knowledge	Workload
Lack of motivation	0,340	0,285	0,335	0,166
Difficulty working independently	0,397	0,319	0,336	0,195
Problems with time management	0,437	0,344	0,235	0,215
Difficulty separating school from free time	0,201	0,299	0,146	0,189
Concentration problems in front of screens	0,200	0,371	0,138	0,148
Too much and too difficult material	0,181	0,476	0,176	0,345
Unclear organization of distance learning	0,181	0,117	0,249	-0,085
Missing/ poor learning materials	0,116	0,085	0,275	-0,084
Too monotonous lessons	0,119	0,135	0,379	0,053

Too little experience with distance learning	0,301	0,268	0,076	0,108
Too few opportunities to ask questions	0,056	0,272	0,214	0,074
Too little exchange with teachers	0,039	0,159	0,158	-0,003
Too little exchange with classmates	0,115	0,138	0,076	0,154
Too little support at home	0,202	0,155	0,166	0,076
Too many distractions at home	0,180	0,202	0,296	0,050
No personal workplace	0,157	0,132	0,171	0,032
Too poorly equipped with digital devices	0,015	0,157	0,168	0,150
Too poor Internet connection	0,279	0,206	0,292	0,224
Too much screen-time	0,096	0,229	0,062	0,234
No Obstacles	-0,040	0,049	-0,282	0,062

Positive r$_s$: Obstacle is associated with worse subjective learning outcomes

Table 4

Concluding, students that had a positive perception of distance learning were likely to find school rather easy and to not struggle with student factors such as problems with time management, difficulties when working independently or a lack of motivation. Younger students and students that found school hard were more likely to experience stress during distance learning. Stress was often accompanied by obstacles that can be categorized as student factors, such as concentration problems in front of screens, but also with system factors such as too much and too difficult material. Students that found school easier were less affected by a decrease in their gain of knowledge during distance learning. Textbooks, videos and videoconferences were helpful tools for the gain of knowledge, whereas digital worksheets or reading materials had a negative influence. A student's gain of knowledge was equally affected by student factors (e.g. problems with time management), system factors (e.g. too monotonous lessons) and environmental factors (e.g. too many distractions at home). Younger students were more likely to feel that their workload increased during the distance learning phase. The workload correlated most strongly with the obstacle "too much and too difficult material", however the highest mean of r$_s$-values could be found in the category "student factors".

5 Conclusions – Distance learning as a model for the future?

5.1 How did students experience distance learning?

Students had very different experiences during distance learning: Some liked it better than remote teaching, others preferred face-to-face teaching, nonetheless, on average students tended to lean towards preferring in-class teaching. Teachers sometimes encountered difficulties because their pre-pandemic teaching approaches were incompatible with online learning. They had to get creative and come up with new ideas, learn new skills and acquire a new teaching styles. Numerous new tools were introduced into day-to-day teaching, the most important ones being Moodle, video meetings and digital worksheets However, peer-to-peer learning was mainly missing throughout the remote learning period. Also, students were now in charge of organizing their own schedules and keeping up a positive mindset. Some students had problems with distance learning because they did not receive the same support at home as they did at school. Some students' caregivers were less familiar with the material taught than others, putting them at a disadvantage in comparison to their peers. Students, especially younger pupils or adolescents who struggled with school in general, experienced an increase in stress and workload while feeling they learned less than before the pandemic.

5.2 What elements of distance learning worked well and which need to be improved?

The obstacle that most students encountered was a lack of motivation. This might be attributed to the absence of peers and the monotony of school days at home. Additionally, issues with attention while working in front of a screen for a longer period of time made it hard to stay focused during videoconferences or when working on online tasks. Some students also had difficulty distinguishing between school and free time and thus maintaining a healthy work-life balance. When breaking down all obstacles

students encountered into student factors, system factors and environmental factors, the student factors have by far the highest mean value out of the three categories. Students also mentioned feeling lonely at home, suggesting that they may be in favour of continuing education using digital tools but not of remaining at home for months on end and being taught only online.

However, not all aspects of distance learning were evaluated negatively. Most students regarded the ability to choose their own timetables based on their tastes and requirements as the most significant benefit of distant learning. They could also choose their place and time of learning, which gave them the freedom to individualize their learning routines. Students could learn at their own pace, meaning that those who struggled to understand a topic did not have to move on and learn at the same pace as their classmates, but could instead focus on the difficulties until they were resolved. On the other hand, underchallenged students could get their work done more quickly and use the remaining time to pursue their interests outside of school. Additionally, students could repeat audios and videos provided to them by their teachers as often as they needed or wished, giving students a second chance to understand something by listening to it or watching it again. Students especially appreciated Moodle, as it helped them to maintain an overview of the work they had to do and to stay organized. They also appreciated PowerPoint slides instead of blackboard transcripts and to be handed worksheets in digital form instead of printed on paper which helped them to maintain order and to have them available whenever and wherever they needed them.

5.3 What conclusions can one draw for the digital school of the future?

It seems the COVID19 pandemic has accelerated the movement toward digital tools to the point that it's already reaching schools now, instead of a few years down the road. Digitalization in schools will likely continue to happen – the COVID-19 pandemic acted as a jumpstart for the movement. Most students that took part in the survey I conducted at BRG VBS 14 stated that they would appreciate some elements of distance learning to be implemented into teaching after the end of the pandemic. The most common

element requested was Moodle because of its functionality as a platform which makes it easy to stay organized. Also, teachers shared their PowerPoint slides, meaning own notes didn't have to be taken, resulting to stay more focused on the topic. Students often mentioned that employing digital teaching into teaching routines is only beneficial in certain subjects but rather obstructive in others. The subjects that could benefit most from retaining digital elements, according to students, are Math, English and Physics. The "new best form of teaching" cannot be generalized for everyone, as everyone has different needs and preferences, however most students agree that it is neither only frontal teaching nor distance learning. For many students, the "new best form of teaching" would likely include elements of both teaching styles.

6 Appendix

6.1 Questionnaire

Fragebogen "Digitales Lernen während der Corona-Pandemie – Ein Modell für die Zukunft?"

Dieser Fragebogen bezieht sich auf die Distanzlehre im Schuljahr 2020/21.

1. *In welcher Klasse bist du?*
   - *5.*
   - *6.*
   - *7.*
2. *Was ist die höchste Ausbildung, die deine 1. Bezugsperson (z.B. Mutter oder Vater) abgeschlossen hat?*
   - *Kein Abschluss*
   - *Hauptschule*
   - *Lehre*
   - *Berufsbildende mittlere Schule (HASCH, …)*
   - *AHS – Matura*
   - *BHS – Matura (HAK, HTL etc)*
   - *Universität, Fachhochschule*
   - *Keine Angabe*
3. *Was ist die höchste Ausbildung, die deine 2. Bezugsperson (z.B. Mutter oder Vater) abgeschlossen hat?*
   - *Kein Abschluss*
   - *Hauptschule*
   - *Lehre*
   - *Berufsbildende mittlere Schule (HASCH, …)*
   - *AHS – Matura*
   - *BHS – Matura (HAK, HTL etc)*
   - *Universität, Fachhochschule*
   - *Keine Angabe*
4. *Wie gerne gehst du allgemein in die Schule?*
   - *1 (sehr gerne) – 5 (nicht gerne)*
5. *Wie leicht oder schwer fällt dir die Schule allgemein?*
   - *1 (sehr leicht) – 5 (sehr schwer)*
6. *Wie gut hat die Distanzlehre im Vergleich zur normalen Schule im letzten Jahr funktioniert?*
   - *1 (viel besser) – 5 (viel schlechter)*
7. *Wie stressig hast du die Phase der Distanzlehre erlebt?*

- o *1 (gar nicht stressig) – 5 (sehr stressig)*
8. *Wieviel Wissen hast du während der Distanzlehre im Vergleich zu normaler Schule erworben?*
    - o *1 (viel mehr) – 5 (viel weniger)*
9. *Wie groß war der Arbeitsaufwand bei der Distanzlehre im Vergleich zu normaler Schule?*
    - o *1 (viel kleiner) – 5 (viel größer)*
10. *Welche der folgenden Medien wurden häufig für die Distanzlehre genutzt?*
    - ☐ *Digitale Arbeitsblätter und Lerntexte*
    - ☐ *Schulbücher und andere Bücher*
    - ☐ *Audios*
    - ☐ *Videos*
    - ☐ *Videokonferenzen*
    - ☐ *Moodle*
    - ☐ *Spezielle Lernsoftware (zum Beispiel für Labor-Experimente, Vokabeln, …)*
    - ☐ *Sonstige:*
11. *Welche der folgenden Medien findest du besonders hilfreich für die Distanzlehre?*
    - ☐ *Digitale Arbeitsblätter und Lerntexte*
    - ☐ *Schulbücher und andere Bücher*
    - ☐ *Audios*
    - ☐ *Videos*
    - ☐ *Videokonferenzen*
    - ☐ *Moodle*
    - ☐ *Spezielle Lernsoftware (zum Beispiel für Labor-Experimente, Vokabeln, …)*
    - ☐ *Sonstige:*
12. *Was waren für dich die größten Hindernisse bei der Distanzlehre?*
    - ☐ *Fehlende Motivation*
    - ☐ *Schwierigkeit, selbstständig zu arbeiten*
    - ☐ *Probleme mit dem Zeitmanagement*
    - ☐ *Schwierigkeit, Schule von Freizeit zu trennen*
    - ☐ *Konzentrationsprobleme bei langem Arbeiten vor dem Bildschirm*
    - ☐ *Zu viel und zu schwerer Stoff*
    - ☐ *Unklare Organisation des Distanzunterrichts*
    - ☐ *Fehlende/ schlechte Lernmaterialien*
    - ☐ *Zu monotoner/ eintöniger Unterricht*
    - ☐ *Zu wenig Erfahrung mit Distanzunterricht*
    - ☐ *Zu wenige Möglichkeiten, Fragen zu stellen*
    - ☐ *Zu wenig Austausch mit den Lehrer*innen*
    - ☐ *Zu wenig Austausch mit den Mitschüler*innen*

☐ *Zu wenig Unterstützung zu Hause (zum Beispiel von Eltern, Geschwistern, …)*

☐ *Zu viele Ablenkungen zu Hause*

☐ *Kein eigener Arbeitsplatz*

☐ *Zu schlechte Ausstattung mit digitalen Geräten*

☐ *Zu schlechte Internetverbindung*

☐ *Zu viel Screen-time*

☐ *Es gab keine Probleme*

☐ *Sonstige:*

13. *Was hast du am Distanzunterricht gut gefunden?*

☐ *Ich kann meinen Tagesablauf selbst besser bestimmen*

☐ *Lernen in meinem eigenen Tempo*

☐ *Ort und Zeit des Lernens kann ich mir selbst aussuchen*

☐ *Verbesserung meiner Computer-Kenntnisse*

☐ *Audios/ Videos kann ich beliebig oft wiederholen*

☐ *Mehr schriftliche Unterlagen, weniger Mitschriften*

☐ *Mehr Vielfalt bei den Lernmaterialien*

☐ *Zuhause kann ich mich besser konzentrieren als in der Schule*

☐ *Nichts*

☐ *Sonstiges:*

14. *Soll auch nach der Corona-Pandemie mehr Unterricht mit digitalen Medien/ Lernplattformen stattfinden?*

o *Ja*

o *In bestimmten Bereichen*

o *Nein*

15. *Was ist der Hauptgrund für deine Beantwortung der Frage oberhalb, ob mehr digitaler Unterricht stattfinden soll?*

→ *[Open answer]*

16. *Welche Formen von digitalem Unterricht möchtest du in Zukunft beibehalten?*

☐ *Moodle als zentrale Plattform für Aufgaben, Materialien und Abgaben*

☐ *Videos, die erforderliche Vorkenntnisse noch einmal erklären*

☐ *Videos, die schwierige Inhalte noch einmal erklären*

☐ *Digitale Materialien mit zusätzlichen interessanten Informationen*

☐ *PowerPoint-Folien statt Tafelmitschriften*

☐ *Arbeitsblätter, Graphiken etc in digitaler Form statt auf Papier*

☐ *Aufgaben mit Technologieeinsatz (zum Beispiel Anfertigung eines Videos/ Audiofiles)*

☐ *Onlinemeetings für Arbeitsgruppen statt persönlichen Treffen*

☐ *Sonstige:*

17. *Hast du Fächer, in denen noch immer neue digitale Lehrformen verwendet werden, obwohl der Lockdown vorbei ist? Welche Fächer? Welche Lehrformen?*

→ *[Open answer]*

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