

# Appendix

Table 3: General perception of digital learning environments (DLE)

Category		
	Subcategory	Example / Anchor Quotation
<b>Advantages of DLE</b>		
	<b>Self-paced Learning</b>	<i>'I guess I prefer self-paced learning (...). I remember I wasn't that successful as a high school student'. (student 7)</i>
	<b>Sensory Modalities</b>	<i>'It helps to have the contents presented to different sensory modalities (...). Things become easier to memorize (...). You read a text, see a picture with it (...)'. (student 3)</i>
	<b>Accessibility</b>	<i>'It's great that you can freely choose your learning environment and also plan your time schedule independently (...). I can choose when to do what and feel much more self-determined'. (student 1)</i>
	<b>Communication:</b> Immediate feedback	<i>'You receive immediate feedback. You enter your guess (...) and the system tells you whether you were wrong or right. (...). You can re-try without being graded right away. You get a chance to learn from your mistakes'. (student 8)</i>
	<b>Communication:</b> Data sharing	<i>'Data sharing became much easier through platforms such as Dropbox, Whatsapp and the like'. (student 1)</i>
	<b>Communication:</b> Fast exchange of learning materials	<i>'I think I observe a tendency towards sharing more information among students, even with strangers (...). For example, a document with an overview of all toxins or bacteria (...). There is a tendency to share it faster (...). It is perceived much easier and more practicable than sharing it individually with only some students'. (student 1)</i>
	<b>Communication:</b> Fast and location-independent communication	<i>'I have a lot of friends living in different areas of Germany and also spread out all over the world. Social networks offer the opportunity to still stay in touch'. (student 8)</i>
	<b>Communication:</b> Arrange meetings	<i>'It became much easier to arrange meetings with other students (...). Everyone has their phones with them, you can reach everyone immediately'. (student 2)</i>
	<b>Communication:</b> Fast contact with teachers	<i>'It's easier to write an e-mail from home (...). I have the feeling that it is easier to write an email than to approach them in person, because you can re-phrase your message several times to finally find the most correct and respectful wording'. (student 1)</i>
<b>Disadvantages of DLE</b>		
	<b>Information overload</b> Confusing user interface	<i>'Platforms are often packed with too much information and too many functions (...) because the creators wanted to make sure to meet everyone's needs (...). What results is unfortunately often a confusing user interface'. (student 3)</i>
	<b>Information overload</b> Getting lost	<i>'Such an overload of information that you get bogged down in details (...) and eventually get distracted'. (student 4)</i>
	<b>Communication:</b> Less face-to-face conversations	<i>'On the bus you notice that only very few people talk to each other and you notice that same thing during lunch break at university (...). Almost everyone is on their phones'. (student 4)</i>
	<b>Communication:</b> Less personal attendance at university	<i>'I often don't really need to attend classes anymore (...). Shortly before the exam, I download all the material and realize 'gosh, that's a lot of stuff to learn!'. (student 5)</i>

	<b>Communication:</b> Spending too much time online	<i>'You already spend a lot of time in front of the computer for your studies (...). With the progression of digital learning environments, there might be even less 'real' social interaction'. (student 8)</i>
	<b>Communication:</b> Vague / unspecific wording	<i>'Unprecise wording (...)- the online instructions leave too much space for interpretation'. (student 8)</i>
	<b>Legal issues:</b> Lack of regulations	<i>'There are no rules or laws to digital learning environments'. (student 8)</i>
	<b>Legal issues:</b> Less responsibility	<i>'You take less responsibility of your learning material (...). Everything is available online anyways'. (student 2)</i>
	<b>Technical issues:</b> Lack of support systems	<i>'I am sure I uploaded everything in the right way (...). However, there is no support system, no contact for support'. (student 2)</i>
	<b>Technical issues:</b> Dysfunctional Platform	<i>'It's extremely annoying when the platform doesn't work the way it's supposed to'. (student 9)</i>

## Guided interview questionnaire

### Sociodemographic data (to be filled in by the interviewer)

1. Age  
\_\_\_\_\_ years
2. Field(s) of study  
\_\_\_\_\_  
\_\_\_\_\_
3. Current semester  
\_\_\_\_\_ semester
4. Gender  
☐ male    ☐ female

### Questions on digital learning environment

1. How do you understand digital learning environment (DLE)?
2. Why do you think DLE could be useful?
3. Why do you think DLE could be harmful?
4. How much time per day could you imagine to spend in such a DLE? How much time do you already spend in DLEs?
5. Where do you see the biggest problems in dealing with DLEs?

6. What do you think – does increasing digitalisation have an influence on social contacts?
7. What do you think – does the increasing digitalization have an influence on your contact to lecturers?
8. If there was a digital assistant (DA) supporting you with your studies – what would it have to look like?
9. If there was a DA supporting you with your studies – which properties would it need to have / not have?
10. If you have ever been overstrained or overstimulated within a DLE – why was that?

### **Questions on stress in studies**

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1. If you feel exhausted in your position as a university student – why is that?
2. Which situations in your student life do sometimes ask too much of you?
3. Which situations in your student life do you perceive as especially frustrating?
4. Which situations in your student life provide you security?
5. In which moments (in studies or daily life) can you renew your energy?

### **Questions on potential burn-out**

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1. In which situations do you feel “burned out”? In which situations or DLEs do you feel “burned out”?
2. Which aspects of your student life (from the day of enrolment at University) do you still value or enjoy?
3. In which aspects of studying did you lose interest compared to the time of your enrolment at University?
4. What drives you in your studies?

Table 4: Stressors within DLE

Category		
	Subcategory	Example / Anchor Quotation
<b>Study-related stressors</b>		
	<b>Performance:</b> Examinations	<i>'So there's always a lot of stress (...). When you have to write several exams in a very short period of time and it is not just learning by heart (...). Especially in the MINT subjects, it's all about gaining a deeper understanding of the contents and that simply takes time'. (student 8)</i>
	<b>Performance:</b> Learning format	<i>'It's all about studying; writing exams (...). It's hard to find the motivation sometimes. I much prefer to actively contribute to a project of my interest, develop something new and exciting! Instead I simply have to hammer in facts and learn things by heart'. (student 8)</i>
	<b>Performance:</b> Exercise sheets / Time pressure	<i>'Some subjects also have very extensive exercise sheets (...). It is just not feasible to complete them within a week'. (student 10)</i>
	<b>Performance:</b> Performance pressure	<i>'Officially, if you have failed an exam twice, you will have to wait for one year to repeat it (...). One could probably still find an individual solution with the professors, but the official rules are still stressing us out'. (student 4)</i>
	<b>Performance:</b> Time pressure	<i>'When I realize I would like to sit down calmly and complete my tasks, but (...) there are so many things to do and I just don't know where to start'. (student 4)</i>
	<b>Performance:</b> Lack of empathy for students	<i>'Every professor seems to think that their subject is the most important (...) and students could invest even more time preparing for it (...). It is stressful to receive this as a subtle message in all classes'. (student 4)</i>
	<b>Performance:</b> Miscommunication	<i>'You tried your best to properly phrase your sentences (...). Then they are still not picked up the intended way by the other person'. (student 11)</i>
	<b>Management:</b> Time management	<i>'I don't have enough time to complete my assignments in a way that I would like to hand them in (...), more elaborated. But I feel I just don't have enough time'. (student 4)</i>
	<b>Management:</b> Task overload	<i>'There are too many different tasks to complete at the same time or in parallel (...). I often get the feeling that I don't have enough time to work everything through in a meaningful way'. (student 4)</i>
	<b>Management:</b> Regulatory affairs	<i>'It is hardly possible, to complete my studies in time (...). People seem to expect it anyways (...). Considering the obligatory internships, it is difficult to set up a time schedule to complete my masters within 4 semesters as expected (...). Even if I tried, it would still take me longer'. (student 4)</i>
<b>Personal stressors</b>		
	<b>Performance:</b> Comprehension difficulties	<i>'I was lucky enough to be navigated through the topic by the assistant professors (...). I know some of them personally (...). However, I still did not pass the exam, I was simply too nervous and did not read the tasks carefully enough'. (student 8)</i>
	<b>Performance:</b> Lack of motivation	<i>'I get distracted by other things that catch my attention, things of interest, so I feel I am spending my time wisely or in a meaningful way'. (student 3)</i>
	<b>Management:</b> Personal time management	<i>'I personally do have some troubles regarding time management (...). I simply don't know where to start best (...). In the end I always choose those assignments I find easiest (...). Maybe it would be more clever to focus on difficult tasks that need your full attention first'. (student 10)</i>
	<b>Management:</b> Personal living conditions	<i>'Besides my masters, I have a side job (...). A fellow student of mine has to work more than 20 hours part-time besides his studies and has a family of his own (...). Compared to that, my work load is doable (...): job, household and private appointments'. (student 5)</i>

Table 5: Preventive factors within DLE

Category		
	Subcategory	Example / Anchor Quotation
<b>Study-related PF</b>		
	Study motivation	<i>'Life-long learning, always getting to know more (...). To me, it is extremely exciting to learn something new'. (student 1)</i>
	Study interest	<i>'I am interested in every detail in the field of natural science (...). That's what I find so exhilarating'. (student 1)</i>
	Constructive feedback	<i>'When I receive direct feedback (...) - that is what motivates me and justifies my efforts'. (student 3)</i>
	Personal progress	<i>'Then you notice 'ok, I got that, I worked that out all by myself'. (student 1)</i>
	Self-determination	<i>'There was no certain plan to hold on to, instead I had the opportunity to develop my own ideas'. (student 2)</i>
	Support by teachers	<i>'One math professor offered such an elaborated reference list (...). He wanted us to find the according literature right away (...). That was really encouraging, I felt supported by him'. (student 12)</i>
	Augmented expertise	<i>'It feels good to say 'I really understood this and I am now qualified to do it all by myself in the future'. (student 5)</i>
	Interest	<i>'The motivation for my studies was that I was really interested in science (...). I was so eager to get access to science, to that scientific environment'. (student 5)</i>
	Meaningfulness	<i>'When I have accomplished some task and I feel my contribution was a meaningful one (...). In my internship, for example, I helped develop a program which has now been adapted in the field of radiology and my name is cited whenever someone talks about the method – that gives me confidence that I am on the right way'. (student 8)</i>
	Academic degree	<i>'The academic degree. To have it on paper, the academic degree'. (student 5)</i>
<b>Personal PF</b>		
	Organisation	<i>'When I start preparing on time (...). It helps me stay calm'. (student 12)</i>
	Social contacts	<i>'Hanging out with friends or your girlfriend (...), visiting the campus open-air (...). So that university is not only associated with workload, but also with having a good time'. (student 5)</i>
	Leisure time	<i>'Volleyball, twice a week and sometimes also competitions on weekends (...). I really need sports in my free time to recharge my batteries (...)'. (student 6)</i>

Table 6: Personal digital assistant (PDA)

Category		
	Subcategory	Example / Anchor Quotation
<b>Desired functions of a PDA – ‘Must Haves’</b>		
	Digital secretary	<i>‘I most likely it should be some kind of digital secretary (...) that manages your times, dates, deadlines, etc., so that you don’t need to keep them in mind’. (student 4)</i>
	Attractive Design	<i>‘Concerning the avatar, (...) if you choose a human character for example and it appears to be a woman. Then some people might complain that they would rather like to talk to a man. Or they prefer short hair over long hair. (...). Maybe you should rather chose a non-human avatar’. (student 5)</i>
	Simple Operability	<i>‘Very simple shortcuts on the computer keyboard (...). That makes it easier to switch between different windows’. (student 1)</i>
	Individualization	<i>‘I would suggest an option for every user to decide individually how often they want to have updates run on their systems, may it be every couple of hours or once a day. That should be up to the user’. (student 3)</i>  <i>‘I want an option to turn the system on and off. Everybody is different. The need for support also depends on the semester you are in. If I know that I only have one subject, I can handle it myself’. (student 11)</i>
	Communication	<i>‘It would also give students the opportunity to direct questions (...), e.g. questions about the lecture (...) to the teacher through the system’. (student 1)</i>
	Support and Wiki function	<i>‘An opportunity to ask the system questions (...), a support system or a window that pops up where you can enter your questions (...). Maybe an external link to some kind of wiki page where you can do further readings would also be great’. (student 5)</i>
	Study Mode	<i>‘It should be possible to switch the device to some kind of study mode (...), so it hinders you to access certain apps or only lets through very important information while you are studying’. (student 6)</i>
	Time Management	<i>‘There should be an integrated time manager (...). It should help you schedule your learning plan, when there is for example an exam in two months (...). Voluntary online exams would probably be helpful too’. (student 7)</i>
	Exam Registration	<i>‘An exam registration function (...) and a notification as soon as your results are online’. (student 7)</i>
	Recording function	<i>‘It would be great if you could tell the digital assistant ‘please record this and that lecture’, so you can listen to it later on’. (student 5)</i>
	Reminder Function	<i>‘A reminder function is fundamental to every e-learning tool. You should be reminded of your own study plan and deadlines you set for yourself. That would be essential’. (student 8)</i>
	Calendar function	<i>‘You should be reminded of dates to hand in certain assignments or exam dates (...). Sometimes you just lose track of that or you can’t remember the exact date and time’. (student 6)</i>
	Prioritise Information	<i>‘There should be a filter (...), so you are only confronted with the information and workload relevant for you’. (student 3)</i>
<b>Possible drawbacks of a PDA – ‘No Gos’</b>		
	Unwanted reminders	<i>‘There should be an on and off function (...). It would sometimes drive me crazy if I got a reminder every week, ‘bling’, ‘remember that you have to hand your work in today’ (...). Especially, if it is something like ‘you need to hand your work in in 5 minutes’ but you live one hour away (...). I would freak out’. (student 11)</i>  <i>‘When it reminds you too often. Or you just can’t turn it off’. (student 6)</i>

	Data security	<i>'The problem is, the system might have to know everything about my plans, so that it doesn't remind me of unnecessary things or tasks, I have already complete (...). I don't know if I want to put all my private information into that system'. (student 2)</i>
	Constant availability	<i>'If there are too many irrelevant messages, or if there are too many message in general (...). You shouldn't have to be available 24/7 or constantly addressed by it'. (student 3)</i>
	Unwanted commands	<i>'A machine commanding you to start studying (...). You learn best when you start independently (...) and not because the system tells you what to do. That would be a 'no-go' and would cause resistance in many students'. (student 8)</i>
	Control	<i>'Decisions should always be in the user's hands (...). It shouldn't hide any information that is considered irrelevant by the system - all information, everything should be seen by the user, the system should have no power to decide something for you'. (student 3)</i>