ADAPTATION AND LATENCY IN TIMES OF CRISIS - CHANGES IN IT IN HIGHER EDUCATION

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Abstract

Germany, end of March 2020: The start of the lecture period in North Rhine-Westphalia has been postponed. The Rector of the Heinrich Heine University Düsseldorf (HHU) wrote in a circular e-mail: “Not on 6 April, but ... only on 20 April will the courses of the 2020 summer semester begin. The Rectorate of the HHU welcomes the decision and is working together with the faculties on the design of the new semester plans”. This uncertain situation made it necessary to completely rethink teaching for the following semester and to organise it digitally online. Apart from many uncertainties, everyday life consisted of a number of challenges and also of new opportunities in a large experimental field of digitisation of teaching. Where can you find help? How can communication with students take place? Such and similar questions were absolutely at the centre of attention and accompanied throughout the entire 2020 summer semester.

The Centre for Information and Media Technology (ZIM) of the HHU searched in all different directions and compared which solutions were used by other universities and what capabilities were provided by different services. As well as establishing a new videoconferencing service, a variety of measures were implemented to support distance learning. Many existing services were expanded, not only to improve availability and performance, but also to add staff to support training and counselling. Tutorial videos have been produced and new support formats, such as the e-learning consulting hours in Rocket.Chat were highly appreciated by the lecturers. Problem solutions for VPN and WLAN or help with computer problems could only be offered by e-mail or telephone. Course rooms and PC workstations were also closed for the time being.

The disruption of the crisis promoted many newly conceived formats and concepts, such as the integration of the chat into courses or the more extensive provision of lecture recordings, much was tried out and discarded, rethought and redesigned. The students positively emphasised the possibility of being able to rework lecture content at their own pace via screencasts and recordings. The experience gained from lectures that were streamed live also led to a considerable acquisition of skills for online courses by both teachers and students. In addition to didactic and collaborative experiences, all stakeholders involved were able to gain insights into which organisational measures are suitable for good personnel support for live streaming lectures and that synchronous lectures with over 1,000 participants are technically possible with video conferencing tools such as Webex.

The experience gained was used at various levels and is a useful basis for planning the current winter semester and beyond. Inter-university online events, quickly offered a lively exchange of information on current plans, but also on initial findings. The different experiences were supplemented by surveys among teachers, students and in the area of infrastructure. In addition to the new formats, aspects of hybrid events, both online and on site, are currently being lived out. As well as developing the infrastructure, building up experience and skills among students and university staff, the university is also generally developing as a learning organisation in the form of double-loop learning.

Keywords: Adaptation, Changes in IT, Disruption, Double-Loop Learning.
1 INTRODUCTION

Heinrich Heine University Düsseldorf (HHU) is a large campus university centrally located in the capital of North Rhine-Westphalia (NRW) in the Federal Republic of Germany. A total of 35,000 students are enrolled in the five faculties[1]:

- Faculty of Medicine,
- Faculty of Mathematics and Natural Sciences,
- Faculty of Humanities,
- Faculty of Economics and
- Faculty of Law.

It is characteristic of HHU that almost all of its departments are located on one large campus and not spread out over the city, as is common at many other universities in Germany. Traditionally, HHU is also considered a commuter university by many students and employees from the surrounding area due to its location and transport connections.

At HHU, as a classical face-to-face university, e-learning has been used for many years by the Centre for Information and Media Technology (ZIM) and the associated Multimedia Centre (MMZ) to support teaching-learning processes. For example, the learning management system (LMS) ILIAS, the video-on-demand platform HHU Mediathek for streaming learning video, and various services for lecture recordings in lecture halls as well as screencast and learning video recordings.

The use of e-learning was accompanied by a digitalisation strategy[2] and basic considerations as well as assessments of e-learning applications. These include, for example, whether lectures should be recorded and delivered online asynchronously, and if so, how.

In order to navigate lecturers and learners safely through the new situation of learning under lockdown, the ZIM in cooperation with the MMZ has tackled numerous measures to ensure that distance learning at HHU can take place successfully in short term.

A few experiences with videoconferencing already existed to a very small extent from previous years. Especially for communication in research and working groups and not yet for communication with students. As a service provider, the German Research Network (DFN) offers the Pexip variant DFNconf and Adobe Connect as a nationwide central virtual classroom solution for all German universities. Due to the very high demand for video conferencing at short notice, these platforms were not prepared for the new requirements, neither in terms of licensing nor performance, and could not cope with the large number of participants in lecture streams.

After determining necessary and sufficient criteria and various software tests, as well as after lively exchange within the networked university communities and with other players, a decision was made by the rectorate in favour of the Webex video conferencing service by Cisco.

Likewise, asynchronous learning with video recordings, among other things, was greatly expanded in the times of crisis. The classic e-learning advantages, that students can work on the video resources at their individual learning pace, pause, rewind and fast-forward, as well as watch them again several times for exam preparation, were contrasted in each case by considerations of whether the internet connection of the HHU and the students at home is sufficiently fast and stable for the provision and retrieval of online teaching-learning materials.

The approach HHU has taken in the area of digital technologies and resources for teaching-learning processes under COVID19, crisis and lockdown conditions in online and distance learning is outlined below. Subsequently, results of technical measures and guidance as well as usage behaviour and experiences are described. Conclusions are drawn on how the HHU organisation has learned in times of crisis. Recommendations for action and further points of reference are given.

2 METHODOLOGY

Amidst pandemic in summer semester of 2020, the task and challenge of HHU’s IT and e-learning departments was to manage an exponential increase in the use of IT infrastructures. And to make decisions in a short time, and under uncertainty and frequently changing environment, to expand tools, utilities and services and to respond to support requests and learning media needs of the teaching staff in a timely manner. Before the pandemic, e-learning was already utilized in a variety of ways, from LMS to lecture recordings, learning videos, and many others, but such measures, which were
realised through the HHU's e-learning support fund or the NRW Fellowships for innovative teaching projects, were mainly implemented by 'pioneers'. There was a low level of acceptance of e-learning across the board, as there may have been fears among lecturers that it would replace face-to-face teaching. Before the changes in working methods, cooperation and collaboration in the HHU organisation are discussed in more detail in the following section, characteristic phases of university teaching in the lockdown are to be presented as a model in a timeline (Fig. 1).

![Timeline lockdown phases.](image)

Phase 1 Shock time: Expresses itself in postponing the start of the semester in the hope of being able to play for time. Further measures regarding online teaching are not tackled at first. At HHU, this phase may have been relatively short.

Phase 2 First plans: Increased enquiries about video conferencing systems and exploring the opportunities. During tests with teachers in mid-March 2020, the existing videoconference solutions collapsed under the increased load.

Phase 3 Acceptance: Lecturers realised that the pandemic will not disappear within a week. ZIM stabilises the platforms by upscaling and outscaling the systems, especially VPN, network connection, ILIAS, HHU Mediathek. Selection of Webex as video conferencing solution without major discussion (expert decision).

Phase 4 Adaptation: Only on the basis of the stabilised systems do the teachers’ behaviour change. They convert teaching to online. Tutorials and information services (Wiki) are made available relatively quickly or, for example, the interdepartmental e-learning consultation hour is set up.

Phase 5 Plateau: Training by a contracted service provider takes place on Webex. Committed lecturers are increasingly developing interesting teaching-learning formats with a mix of tools. The exchange in the communities and the networking at the peer level are rapidly gaining momentum.

Phase 6 Hope: For a quick return to the status quo, teachers act very pragmatically across the board, adapt their teaching quickly (or not). Less conceptual, didactic-structural adaptation of teaching, but rather emergency remote teaching.

Phase 7 Resignation: Lecturers come to terms with the fact that the COVID19 situation will last longer. Due to the need for planning security for the semester, lecturers now prefer online teaching to heavily restricted face-to-face or hybrid teaching.

Phase 8 Development: The rudimentary concepts of emergency remote teaching from the summer semester are overhauled and now also conceptually adapted – also on the basis of the practical experiences from the summer semester. The very high effort for hybrid teaching is greatly underestimated.

Phase 9 Future: The spectrum of lecturers diverges widely between those who would rather roll back all changes and those who would like to perpetuate e-learning opportunities on the basis of the experiences gained.
All phases of the pandemic are characterised by situational behaviour stakeholders and the organisation in terms of structural aspects. This is because the form of cooperation at the organisational level changed during the Corona crisis.

To overcome the crisis, an agile way of working was practised. In this context, agile does not mean that hierarchies and silos were formally dismantled or that specific agile process models or tools were explicitly introduced[3]. Rather, an ad-hoc agilisation in the organisation unfolded. The agile approach was exemplified and at least not prevented by the management level, in line with the principles of the agile manifesto[4]:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

There was increased communication across departmental boundaries and status groups. Specialists and working levels were closely included in decision-making.

Due to the urgency of the situation, decisions were made faster and in shorter coordination cycles in specialised task forces. The focus was on limited and short-term goals (on sight – adapted to the current and volatile situation) and measures that could be implemented quickly. This led to minimal solutions in the sense of a minimal viable product[5].

- What is missing? → A video conferencing solution (Webex).
- What needs to be prioritised and stabilised? → Bandwidth external connection, ILIAS, HHU Mediathek, VPN

In addition, decision-making often overrode existing regulations or failed to follow formal pathways, such as simplified procedures for procurements, overriding data protection and higher education policy bodies, and lower barriers through higher value thresholds in tenders.

It is still vague how this approach will play out in the post-Corona period. Especially in terms of sustainability of the measures provided (e.g. staff and technology), re-standardisation of solutions to achieve medium- to long-term efficiency gains (e.g. standardisation of media technology and platforms), and re-engagement of gatekeepers and stakeholder groups (e.g. data protection of Webex).

However, decisions were communicated quickly and transparently. The majority of students rated HHU's information policy on the regulations changed due to Corona as "rather good" to "very good" (60.5%, see internal university evaluation among students (n=2,701), evaluation period 22 June 2020 to 05 July 2020). The management actively sought contact with those affected by the decisions and obtained feedback.

The communication was accompanied by the following measures:

- Jour Fixe between the rectorate and the student council
- Online e-learning consultation hour
- Lecturers’ and students’ survey

Due to the high frequency of meetings of the decision-making bodies, it was possible to react quickly to feedback and thus readjust the measures. At the working level, new tools were adapted just as quickly, especially Kanban boards, in order to establish coordination and transparency in the teams and to prioritise work packages.

It was problematic for many students and lecturers that the helpdesk, which could only be reached by telephone and e-mail, could no longer be visited in person. In order to support students with computer workstations, 80 laptops were distributed to needy students as permanent loans via the HHU General Students' Committee (AStA).

For the new format of the e-learning consultation hour, it proved advantageous that the open source chat tool Rocket.Chat was already available as a service at HHU's ZIM. HHU had this advantage in terms of speed over other neighbouring universities, but the level of awareness among students and lecturers was rather modest. In a sprint, the format of the e-learning consultation hour was conceived and developed in one week in the middle of Corona March at the MMZ and launched on 20 March 2020. Initially, the consultation hours were optimised three times a week and accompanied by a parallel videoconference to coordinate the moderators. The announcement was made via the
COVID19 wiki of the ZIM[6], which is a good example of collaborative work and adaptation of the structure based on the increasing content, but also via the COVID19 information website of the HHU and existing social media channels. The exchange and cooperation were expanded by using changing moderation teams, also to expand the advisory spectrum beyond individual subjects and offers. From the very beginning, the intention was not only to provide support and clarify questions about e-learning, but also to show a good practice example for the use of Rocket.Chat at the university by presenting and encouraging useful functions (search, threads, social awareness, etc.) and areas of application of Rocket.Chat channels for teaching-learning processes in a clear and immersive way in the e-learning consultation hour.

In particular, ZIM and MMZ very quickly created handouts and tutorials on e.g. Webex, lecture recording or how to integrate videos into the learning management system based on feedback from users, also from the e-learning consultation system, and made them available in the HHU Mediathek. The HHU tutorials were all made available quickly, while others were sometimes very professionally created. This is about the well-known problem “Do you need it perfect, or by Tuesday”.

However, these digital tools were also used to rapidly establish the ability of IT staff to work in the home office and to quickly remove hurdles. On the organisational level, virtual daily stand-ups were partly carried out in some departments for a limited period of time.

3 RESULTS

To classify the process for dealing with uncertainties triggered by the COVID19 pandemic, the Cynefin model[7] is useful. The model distinguishes the four categories simple, complicated, complex and chaotic in relation to systems and their interrelationships. In this model, simple interrelationships are handled by patent remedies and complicated interrelationships can be handled by expert knowledge. If the contexts become complex or even chaotic, either a more experimental approach is recommended or decisive action with subsequent readjustment is emphasised. Many measures, structures, assistance and also large parts of communication in 2020 were characterised by very high uncertainty in the run-up and were initially implemented through expert knowledge, in many cases very experimentally and often also through decisive actions. These complex or chaotic contexts had to be administered very quickly by try, observe, react or act, observe, react, taking agile values into account.

With the abovementioned agile framework, very short informal communication channels between the lecturers on the one hand, and the service units on the other, became possible. Short-term service offers, support and service requests or counselling offers and needs were and still are a great challenge. Through focus and cooperation, where everyone has moved closer together, and through the openness of the university management, which has supported measures partly steering, partly accompanying in equally short but formal ways, the first possibilities for an almost complete online semester have been created.

3.1 Technical measures and advice

Many platforms have been technically upgraded to meet the demands of increased online usage. In many cases, the improvement of the virtual server infrastructure (more memory and more processing power) led to rapid success. For example, due to the sharp increase in usage from about 2,000 to over 15,000 users, the Confluence wiki as a central knowledge management system and collaboration platform could be expanded by upgrading the servers. A large part of the new information and especially the instructions for using the tools were made available in this wiki, as was the COVID19 wiki of the ZIM[6], which contains a collection of possibilities for distance education through constant expansion.

The ILIAS learning platform experienced an eightfold increase in traffic at the start of the 2020 online summer semester, with a peak of 8,000 parallel sessions on 20 April (Fig. 2), which brought the platform to a standstill. For comparison, in the 2019/20 winter semester of attendance (Nov 2019 to Jan 2020), access numbers were typically around 1,000 parallel sessions. Under Corona conditions, access numbers dropped somewhat after the peak in the following and the load was more evenly distributed across the usage periods. In the online semesters, the access numbers levelled off at 3,000 (from Apr 2020) and 5,000 (from Oct 2020) (Fig. 2).
An optimised caching in September 2020 contributed to the stabilisation of ILIAS, which improved the speed and response time of the system. The performance of ILIAS was once again significantly increased by a newly installed cluster with, among other things, higher database utilisation through optimised load balancing, spawning of processes and managing of ports, which was converted at the beginning of November 2020 with a downtime of less than one day. The complaints from lecturers about the slow speed of ILIAS, which had been frequent in the past, died down and no longer played a role in the support offices.

On the video-on-demand platform HHU Mediathek, which had already been available and established since 2013, there was a 19-fold increase in the number of uploaded videos from April 2020 compared to the pre-Corona year (Fig. 3). The increase in use could be compensated by scaling the platform vertically and horizontally on the virtualised infrastructure in the course of April 2020.
Structural preparations were made in the lecture halls (especially technical cabling) to enable event live broadcasts in hybrid settings (presence and remote). The team for mobile event recording was strengthened with additional staff and took over live broadcasts to YouTube, taking the present hygiene concept into account.

In addition to Cisco Webex tools for synchronous distance learning, such as Jitsi or Big Blue Button were tested as well. In parallel, experience was gained with alternative products such as Zoom and Microsoft Teams. Cisco Webex was selected as the central platform with a licence for comprehensive use in teaching and also with the possibility for students to open their own learning spaces in the platform. The introduction of Webex was professionally accompanied by ZIM through online training on the various application scenarios in teaching and through tutorials, FAQs and help for beginners. ZIM itself had the service provider Avodaq at its side from the beginning, which later also carried out training.

### 3.2 Usage behaviour and experiences

The different experiences were complemented by surveys of lecturers, students and infrastructure, both across universities and in some local institutions.

With the newly created possibilities and functions and through the further development of the tools, lecturers, students and administrators have gained many new experiences. If these experiences and the interaction with each other are classified in the pandemic by the EU framework for digital competences[8], it is possible to speak of an expansion of competences in the fields of "communication and collaboration", "digital content creation" and "problem solving". Especially interaction or exchange by means of digital technologies or collaboration on the basis of digital technologies could be greatly expanded. The topic of "dealing on the net" and experiences with managing one's own digital identity could be expanded, especially in relation to the university systems. Experiences in the area of developing digital content were also in the foreground. Technical and didactic questions often had to be considered and answered together quickly. The rapid provision of digital content led in some cases to existing content being re-used and integrated, insofar as the licensing of the content made this possible. A number of technical problems could be well dealt with through hardware recommendations for webcams, microphones, recording devices, headsets and notebooks or software recommendations for tool use in teaching. In addition to the needs assessment and many tests of tools and devices, a number of original new solutions were also created based on the new experiences through the creative use of digital technologies.

Synchronous formats with Webex were also regularly used for many large courses with between 400 and 1,200 participants. These opportunities enabled courses that would otherwise have taken place in large lecture halls to be mapped online. The Webex usage statistics provide information about some learning spaces that were regularly used by students, mostly for several hours (Fig. 4).

![Figure 4. Number of total meetings and total participants on videoconference platform per week.](image-url)
As a counterpart to group work, lecturers could use the so-called breakout sessions, which could initially be realised via the additional software Webex Trainings. In the meantime, breakout sessions and many other new functions have been integrated directly into Webex Meetings. This has significantly improved the possibilities for using Webex in distance education. This experience also shows that the manufacturers have reacted quickly to the new or increased requirements in distance learning. In the past 12 months, HHU has held 76,278 events via the Webex platform. The majority of these events were conducted as teaching events with video transmission and in almost all events the presentation mode was used (Tab. 1). Fig. 4 shows that Webex use, both in terms of the number of events and the number of participants, increased significantly in the second digital semester. The Webex platform is now used by 4,137 users in various scenarios.

| Table 1. Use of Webex options (over 12 months). |
|-----------------------------------------------|
|                                             |
| Video (Webcam)                               |
| 68.5%                                        |
| Sharing (Screen presentation)                |
| 98.5%                                        |
| Recording                                    |
| 3.9%                                         |

In the period from 22 June 2020 to 05 July 2020, an internal university evaluation was conducted on behalf of the teaching task force with 420 lecturers and 2,701 students. Additional feedback was collected through various other channels, such as an e-learning consultation hour and interviews.

3.2.1 Survey results & feedback from lecturers

More than half of the lecturers surveyed are "rather" or "completely satisfied" (71.7%) with the implementation of their digital courses. In comparison to face-to-face teaching, the lecturers were able to convey their teaching content "equally well" (31.9%), "somewhat better" (5.0%) or even "significantly better" (2.8%). The reconciliation of remote teaching from the home office and family responsibilities works "well" to "very well" (45.6%).

The main negative aspects are the time required, the lack of interaction with students and technical problems on either the lecturer's or the student's side.

Feedback from lecturers was very positive, especially in the early days of the online semester, e.g. Chemistry Professor S. posted in the internal Rocket.Chat channel of the e-learning consultation hour on 22 April 2020 "You were (as always) great! Many thanks to all who helped." + hand clap emoji.

Or in mathematics, for example, there was the following feedback: Professor A. conducted an independent evaluation of his teaching, with the result that the students were very pleased with the way the semester had gone. A large majority found the lecture recordings excellent for reviewing at their own pace. The quick accessibility of the lecturers via Rocket.Chat as well as the new possibility to hand in exercise notes online were also positively highlighted. The slow response time of ILIAS and the overburdened Sciebo (NRW cloud storage) – where manuscripts were made available – were criticised.

3.2.2 Survey results from students

The internal university evaluation among students essentially revealed that video recordings were in high demand, and social contacts were missed very much.

Almost two-thirds of the students surveyed were "rather" or "completely satisfied" with the digital courses on offer (60.5%). Many students "fully agree" or "tend to agree" that digital teaching formats allow students more flexibility in terms of time (70.9%). The majority of students said they "rather agree" or "completely agree" with the lack of personal exchange with other students (71.4%) or with lecturers (62.2%).
4 CONCLUSIONS

Regarding the handling of learning in lockdown, it can be summarized that there was good communication from the rector from the very beginning of the pandemic and a quite clear structure of the various task forces was given in relation to the hierarchy level in order to be able to react agilely to the various requirements of distance learning in times of crisis.

All participants developed themselves further in general: Lecturers gained more competences and experience with the tools, and in some cases expanded their portfolios to include suitable hardware for online teaching, which they are testing or have tested. Or they expanded their competences beyond teaching, e.g. through virtual conferences and other new formats. The central IT service providers gained more experience with the technical side of the tools and improved their knowledge of teaching requirements and fit. They have also been able to build greater proximity to lecturers through consultation and problem solving, and additionally through more user feedback on what has worked and what has not. But on the other hand, the tool manufacturers have also developed and can improve their products more quickly and, in some cases, also focus new functions more on teaching.

The cross-community collaboration of various DINI working groups resulted, among other things, in the survey "Lessons Learned from the Perspective of Central Institutions: P(ost) C(orona) Education"[9]. Taken together, it can be said that the following digital technologies and resources have proven their worth:

The crisis has brought to the surface very original instructional video, conference and OER formats by lecturers. Collaborative tools such as wikis with corresponding knowledge communication functions were often used for preparation. This knowledge management was used alongside the websites to quickly provide up-to-date information and extensive FAQs and was able to relieve the intensively involved IT service support.

Online learning spaces can be attractive: students have used the intuitive features of chat and video conferencing systems both as a natural online exchange with their lecturers and for communication in their own learning groups.

After the first online semester, an advanced second online semester followed in place of a hybrid semester with some face-to-face events. This further development places new additional demands on the infrastructure, the didactics and also the organisation of such events. The successive direction of such new formats can be classified as development in degrees of maturity[10] or also as competences that build on each other.

The organisation as a whole is also going through a learning process in maturity levels. Through a lot of communication and feedback on measures, decision-making could be systematised quickly. Thus, through the establishment of university-wide task forces with feedback from the actual learning processes of the actors, organisationally relevant aspects could be directly considered in decisions. Under the influence of the pandemic, many new and very different contacts were established, both on an informal and organisational level. Due to the diversity of the contacts and the focus on feedback on essential aspects of decision-making, the already complex situation could very quickly be adequately grasped and observed in order to take alternative decision-making paths if necessary.

The decision-making processes, the feedback, the communication channels and the regular monitoring of the situation, together with the learning experiences of the acting stakeholders, can be described as a "double loop" learning process[11], through which the organisation grows with new insights for adapting and updating strategies.

Currently, all face-to-face courses have been banned and courses are being held digitally online until the end of winter lectures. The situation remains uncertain as far as the pandemic is concerned, but the lecturers, students, administration and the entire organisation have learned a lot from the past months and are better equipped for the future challenges, which will certainly involve further learning processes and many decisions supported up by expert knowledge.
ACKNOWLEDGEMENTS

We would like to thank all lecturers and learners at HHU, and our colleagues, for the feedback, constructive criticism and the overall functioning interaction between infrastructure service provider and user with regard to all new developments. Furthermore, we would like to thank for the lively exchange of information and the cooperation with the stakeholders in the Hochschulforum Digitalisierung (HFD), the "Deutsche Initiative für Netzwerkinformation e.V." (DINI) and the German community e-teaching.org.

REFERENCES

[1] Heinrich-Heine-Universität Düsseldorf, Zahlenspiegel 2017/2018 der Heinrich-Heine-Universität Düsseldorf, 2019. Retrieved from https://www.hhu.de/fileadmin/redaktion/ZUZ/Dezernat_5/Statistiken/Zahlenspiegel_Flyer/190205_Zahlenspiegel_2017_2018.pdf

[2] Heinrich-Heine-Universität Düsseldorf, HHU digital – Digitalisierungsstrategie der Heinrich-Heine-Universität Düsseldorf, 2018. Retrieved from https://www.hhu.de/fileadmin/redaktion/Oeffentliche_Medien/Presse/Pressemeldungen/Dokumente/HHU_Digital_20181129.pdf

[3] S. Kühl, "Wie Praktiker das Wort »agil« missverstehen," Zeitschrift Führung + Organisation, vol. 89, no. 2, pp. 93-95, 2020.

[4] G. Dueck, Disruptive Zeiten. Springer Vieweg, 2017.

[5] E. Ries, The Lean Startup. Currency, 2017.

[6] Wiki der HHU, COVID-19: Informationen und technische Unterstützung für Online-Lehre und Homeoffice, 2020. Retrieved from https://wiki.hhu.de/pages/viewpage.action?pageId=155157366

[7] J. Hampe and C. Schlegel, Auswahl und Steuerung nachhaltiger Weiterbildung im Unternehmen. Springer Gabler, 2014.

[8] S. Carretero, R. Vuorikari, and Y. Punie, DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use, 2017. Retrieved from https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digcomp-21-digital-competence-framework-citizens-eight-proficiency-levels-and-examples-use, doi:10.2760/38842

[9] Deutsche Initiative für Netzwerkinformation – DINI, Programm 29.9.2020, P(ost) C(orona) Education – ein gemeinsames Projekt in der DINI, 2020. Retrieved from https://dini.de/veranstaltungen/jahrestagungen/21-dini-jahrestagung-2020/programm/

[10] T. Wolf and J.-H. Strohschen, "Digitalisierung: Definition und Reife," Informatik-Spektrum, vol. 41, no. 1, pp. 56-64, 2018.

[11] S. Cartwright, "Double-Loop Learning: A Concept and Process for Leadership Educators," Journal of Leadership Education, vol. 1, no. 1, pp. 68-71, 2002.