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D3.4 DEL RESEARCH AGENDA - CHALLENGES AND PRIORITIES VERSION 1

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Authors	Klaudia Gy. Farkas (3CL), Dr. Alex Grech (3CL), Sabine Kolvenbach (FIT), Dr. Allan Third (OU)
Reviewers	Prof. Wolfgang Prinz (FIT), Prof. John Domingue (OU), Dr. Giovanni Rimassa (Martel), Sabine Kolvenbach (FIT), Dr. Allan Third (OU), Dr. Niaz Chowdhury (OU), Kai Zhang (Martel), Dr. Verena Wottrich (Martel)
Abstract	After our experiences during the COVID-19 pandemic it is becoming increasingly difficult to separate teaching and learning from digital technologies. As increasing digitisation in all aspects of life and work is not consequential – increasing digitisation is non-fully inclusive and deepens the digital divide - non-trivial concerns related to ensuring and enhancing equality, and access to education for all European citizens must be a key priority for the evolution of our society.

Keywords	Digital education, emerging technologies

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Dissemination Level		
PU	Public, fully open, e.g. web	✔
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** R: Document, report (excluding the periodic and final reports)*

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc.

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EXECUTIVE SUMMARY

DEL4ALL aims to provide critical guidance and recommendations by analysing opportunities and challenges brought along by advanced technologies such as blockchains, AI, VR/AR, etc. The core ambition is to gather and help the DEL community understand the complex technological, organisational, and legal choices they will be facing as they progress with their activities. In close collaboration with the European Commission (EC) we aim to indicate research priorities and policy recommendations for transitioning research and innovation efforts from Horizon 2020 to Horizon Europe. We are continuously conducting surveys, interviews, and other activities to understand the best use of advanced technologies such as blockchains, digital certification, AI, Data Analytics, etc.

The current COVID-19 emergency led us to also focus on new teaching models among advanced technologies. As face-to-face education globally is made impossible, the use of technology and learning delivery methods became a concern. Within the DEL4ALL project, we started consultations with experts from different fields and disciplines to identify the main challenges and opportunities concerning digital education during this emergency time. Additionally, we collected use cases and best practices, and identified strategic priorities and research questions to help educational institutions to develop sustainable and viable learning environments.

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ABBREVIATIONS

AI	Artificial intelligence
AR	Augmented reality
CPD	Continuing Professional Development
DLT	Distributed Ledger Technologies
ERT	Emergency Remote Teaching
HEI	Higher Education Institution
HMD	Head-Mounted display
IOT	Internet of Things
LLL	Lifelong learning
LMS	Learning Management System
ML	Machine Learning
MOOC	Massive Open Online Course
NLP	Natural Language Processing
OER	Open Educational Resources
PLP	Personal Learning Profile
TVET	Technical and Vocational Education and Training
VLE	Virtual Learning Environment
VR	Virtual reality

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DEFINITIONS

Artificial Intelligence (AI) – is concerned with making machines work in an intelligent way, similar to the way that the human mind works.

Augmented Reality (AR) – is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated information.

Blockchain – is a distributed and decentralized digital ledger that records unalterable transactions.

Conference tools – are online conferencing tools with features such as virtual meetings, video conferences, chat, webinars etc.

Data analytics – is the process of examining data sets in order to find trends and draw conclusions about the information they contain.

Digital Equity - refers to whether people can access and effectively use the technology necessary to participate in modern society.

Games – educational games are designed to help people learn about certain subjects, expand concepts, reinforce development, understand a historical event or culture, or assist them in learning a skill as they play.

High-quality digital ecosystem - includes connectivity and digital equipment, user-friendly tools and secure platforms and digitally competent education actors.

Machine Learning (ML) – is a sub-domain of artificial intelligence (AI) that enhances systems by the ability to automatically learn and improve from experience.

Natural Language Processing (NLP) – is a technology that analyses and synthesizes natural language and speech.

Robotics – is a research area in computer science that designs, develops and uses robots that can substitute and replicate human actions.

Shared Virtual Spaces – enables the collaboration and interaction of many participants in virtual working environments.

Virtual Reality (VR) – is a simulated experience that can be similar to, or completely different from the real world.

3D Printing – is the construction of a three-dimensional object from a digital data model.

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1 INTRODUCTION

DEL4ALL aims to contribute to the research agenda for the transformation of education in Europe by focusing on the incorporation of emerging technologies in the advancement of digital enhanced learning.

For this purpose, DEL4ALL promotes collaboration among stakeholders and initiatives from the learning communities; best practices; relevant use cases; and resilience by coordinating stakeholders and developments across Europe in the digital education field.

DEL4ALL originally planned to organise face-to-face meetings and workshops with stakeholders from the learning community. The current COVID-19 pandemic led us to restructure public-facing activities to adapt to new social norms. One of the outcomes of the project - to provide a living “hub” to all Digital Enhanced Learning (DEL) stakeholders based on services and tools allowing efficient community building, know-how sharing, and networking mechanisms - inevitably had to be migrated online. In the process, the need to engage and consult with experts and practitioners from different fields and disciplines became particularly important as we started to identify the main challenges and opportunities concerning emerging technologies and digital learning solutions in this new, unprecedented scenario to the global education sector.

To ensure alignment with the key actions of the European Commission in making digital transformation for Europe’s economy and society, we conducted several consultation activities with our expert community through surveys, interviews, webinars, and workshops while the COVID-19 crisis continued to unfold in member states. Based on the outcome of these activities, along with the analysis of digital education research and initiatives in Europe, DEL4ALL developed the first version of deliverable D3.4 “DEL Research Agenda - Challenges and Priorities.”

This deliverable includes:

- A description of the data collection process,
- Primary findings from other initiatives in the DEL research area and community,
- Identified challenges, opportunities, and priorities from the DEL4ALL surveys and online events,
- Strategic priorities based on the DEL4ALL activities, such as surveys, interviews, and online events,
- A summary including an initial set of prioritised research questions and the findings from our third survey.

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2 DATA COLLECTION WORKFLOW

We reacted to the clear impact of COVID-19 on the global education system by changing our planned approach to incorporate more nuanced understandings of the challenges to higher education institutions, and the emerging contexts and changes being made as these institutions tried to adjust to the ongoing challenges to their operating and teaching models. The use of technology and learning delivery methods became a major issue as the majority of educators were not prepared to make a sudden change from in-class teaching to online learning. The pedagogical approaches in online learning are not simply transferred versions of face-to-face pedagogies, and the possibilities online do not match one-to-one with the physical. Therefore, DEL4ALL developed data collection workflows, a multidimensional expert catalogue and a 'Technology vs Education Matrix', that is flexible enough to support the changing education landscape. We organised workshops and supported experts and the wider DEL4ALL community in analysing, and aggregating data for future policy recommendations and research prioritisation.

FIGURE 1: DATA COLLECTION WORKFLOW

2.1 DEL4ALL TECHNOLOGY VS. EDUCATION MATRIX

To analyse the technological and educational activities and actors identified in our Expert Catalogue, we mapped the landscape of digital education activity in Europe and prepared the first version of the DEL4ALL Technology vs. Education Matrix (D1.1) and incorporated the model in our Online Aggregator. To clarify and prioritise research agendas and policy

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recommendations, we also published a white paper on our matrix introducing the concepts and our objectives. The purpose of the matrix is to provide a framework for grouping related digital education activities and actors and enabling the mapping of technologies to educational contexts. The first version of the matrix was introduced in the deliverable D1.1 Technology vs. Education Matrix summarising our scope and use, the principles for education, the methodology, and the data model. The model is designed to record the digital education activities and actors initially via the Expert Catalogue, an online spreadsheet. Data represented in this model can be analysed flexibly, to support different perspectives on the DEL landscape - for example, to identify trends in initiatives around a particular type of technology, or availability and gaps in the base of European technological or pedagogical expertise, and so on.

2.2 DEL4ALL EXPERT CATALOGUE

As part of our Expert Group Engagement (Task 3.1), we connected experts from a multidisciplinary perspective (such as people with legal, organisational, and technological backgrounds) while targeting different stakeholder domains, e.g., education, research, technology, and standardisation. The expert catalogue is a data spreadsheet, including profile information of the engaged experts, their activities, and their research interest. Additionally, we mapped the profiles of the experts to our Technology vs. Education Matrix (Task 1.1) data model, then connected the experts to projects and initiatives within the task of Stakeholder Engagement and Community Building (Task 2.2). Moreover, we identified the stakeholder type concerning the technology, whether the DEL4ALL expert is an application user, technology expert, technology provider, or a policy maker. The data will feed into the Online Best Practice Aggregator upon the approval and confirmation of our experts.

2.3 DEL4ALL ONLINE BEST PRACTICE AGGREGATOR

The aggregator is a web-based portal including search and filtering tools based on the data collected in the Expert Catalogue. The basis of aggregation is the collection of actors (stakeholders active in any aspect of DEL, whether research, development, use, or policy), activities (projects and initiatives using advanced technologies for education), the technologies they use or have expertise in, and the learning contexts in which they apply. The first version of the DEL4ALL Online Best Practice Aggregator is summarised in the deliverable (D1.6) Online Best Practice Aggregator and available at https://del4all.kmi.open.ac.uk/. Data in the Aggregator is collected and stored in accordance with the DEL4ALL data model described above and serves as input to successive versions of the DEL4ALL Technology vs. Education Matrix. The goal is also for the Aggregator to allow interested stakeholders to identify projects and other stakeholders relevant to their particular needs and interests, to promote collaboration and cross-fertilisation.

2.4 DEL4ALL EXPERT CONSULTATIONS

Our planned community building, know-how sharing, and networking mechanisms are being conducted online because of COVID-19. We designed several activities that could be delivered online by our stakeholders and directed our focus to the development of an engaged community of practice. We developed three surveys, conducted interviews with stakeholders, organised three webinars and an online workshop to gain a better understanding of how education institutions can manage the continuity of higher education and adapt education to the future during the COVID-19 pandemic.

- ➔ First survey - “COVID-19 & Digital Learning” (2. June 2020 – 17. June 2020)

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- Webinar - “Navigating digital learning during COVID-19” (18. June 2020)
- Workshop - “Lessons learned from COVID-19” (9. July 2020)
- Second survey - “Challenges and opportunities presented by the current COVID-19 emergency for higher education institutions and stakeholders” (16. July 2020 – 11. Sep 2020)
- Webinar - “Lessons learned during the COVID-19 pandemic to adapt to the new education reality” (7. Oct 2020)
- Third survey - “Emerging Technologies & Digital Enhanced Learning. Best Practices and Use Cases” (9. Nov 2020 - 6. Dec 2020)
- Webinar - “Common flagships projects for blockchain and education in the EU” (25. Nov 2020)

Additionally, we released a white paper on the COVID-19 Effects on Higher Education Institutions, Challenges, and Opportunities. The document includes the initial findings from our surveys and expert consultation, such as our workshop and webinars, to develop the DEL4ALL policy recommendations and the research agenda on sustainable and viable learning technologies and environments.

We used the responses and collected feedback from our expert community as the basis for the DEL Research Agenda identifying the most relevant research needs. The DEL4ALL survey reports, webinars, and workshops are accessible via the DEL4ALL project website.

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3 PRIMARY FINDINGS FROM DEL INITIATIVES AND RESEARCH

The COVID-19 pandemic exposed long-standing structural and operational issues in education systems worldwide. The emergency turn to online education highlighted the need for suitable technological tools and infrastructure and, more critically, the need for supportive teaching and learning environments. Teachers found it difficult to adapt to new pedagogical concepts and modes, and often found misalignment between resources and needs. *Schleicher, A. (2020)*. The digital skills and competencies of teachers need to be taken into consideration, as many educators reported teaching online as challenging due to the lack of knowledge and usage of available digital tools. *Khvilon, E., Patru, M. (2002)*.

There are two distinct 'reactions' to COVID-19 within the context of education and 'emerging technologies': one is the turn to more intense research on truly emerging tech, such as DLTs and AI (see page 14); the other is the turn to long-standing but neglected online tools and practices. In the case of the latter, here has been a revival of interest in OER, VLEs, MOOCs, CPDs, online apprenticeships and internships, often shunned by the majority of bricks and mortar higher education institutions. *Grech, A., Camilleri, A. F. (2017).* For online, blended and hybrid learning to become mainstream, institutions not only need to update and improve their training systems within faculties, but dedicate resources to instructional design. Institutions also need to map the available technology solutions to understand which technology can serve their needs best in specific cultural contexts. Some technology solutions can increase staff and faculty efficiency, others can be used to reach more students, while others are designed to help universities continue to operate in emergency mode during the pandemic. *Burns, S., McCormack, M. (2020).*

Surveillance technologies, such as cameras and facial recognition, and emerging technologies, such as AI, are increasingly being used to continue to provide education services in the absence of 'in-person' teaching and learning. *Konotop, G. (2020, October 25).* Surveillance technologies are also being introduced in the education sector as part of healthcare and welfare services by governments and the private sector, but this also raises significant privacy, safety, and security concerns and potential risks for end users, and students. *Dignum, V., Penagos, M., Pigmans, K., Vosloo, S. (2020)*. The dialectic between surveillance technologies, AI and education and the impact on the learning community will be part of the DEL4ALL research agenda for 2021.

In our interviews with the expert community, AI has been identified as a significant change agent of the labour market in the future. More than 1 billion jobs, almost one-third of all jobs worldwide, are likely to be transformed by technology, with a corresponding impact on lifelong learning. *Kumar S., R., George, S. (2020).* It is forecast that workers will need to return to formal/informal education or training at several stages across their working careers, ideally as part of structured programmes provided by their workplace without a disruption to normal workflows or career pathways. *Grech, A., Camilleri, A. F. (2020).* For this, regulation and standardisation need to be implemented to ensure that skills learnt at the workplace or online are recognised and valued by companies and educational institutions and can be used for further training. *Comyn, P. (2020, September 23).* Developing effective testing methods and advances in recognition of credentials, including micro-credentials, is also important to ensure that online training is valued in the labour market. *Scarpetta, S., Quinini, G. (2020).*

However, while teachers and trainers are working on ensuring continuity in delivery of education and TVET, it is still too early to determine if the changes triggered by COVID-19 will become 'the new normal'. Are we returning to the traditional way of formal learning or will we equally recognise distance and digital supported learning as having value in the future? *Cedefop, (2020).* As the emergency remote teaching (ERT) occurred due to the pandemic, it might be only a temporary shift to digital learning delivery methods that otherwise would be

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delivered face-to-face or as blended or hybrid courses. *Hodges, C., Moore, S., Lockee, B., Trust, T., Bond, A. (2020)*.

Changes in the economy, due to the COVID-19 pandemic, may also lead to an increase in adult learners' enrollment, as pandemic-influenced adults might consider re-skilling or up-skiling in their career path. *World Economic Forum. (2020, November 25)*. Again, in 2021, DEL4ALL will continue to monitor technology-enabled developments in the lifelong learning sector to determine changes, which are likely to remain embedded in the higher education and TVET sectors of the future. In the interim, since COVID-19 forced education to digitise quickly, technology providers are working on meeting the immediate needs of digital education. *CBINSIGHTS. (2020)*. The European Commission's Education and Training Monitor report is a valuable signpost in forecasting how EU funding for education, training and skills may become a major component of the EU's next long-term budget. *Education and Training Monitor 2020.*

Decentralisation as a Resilient Model for the future of Education

One lesson to be learned from the COVID-19 pandemic is that, globally, the education sector lacked resilience in the face of difficult circumstances such as this. It is likely that highly contagious coronavirus will remain with us in different forms in the future, and other factors, such as significant global disruption due to climate change, may also pose serious threats. We argue that a more resilient model for education is a decentralised one; that is to say, a model in which the various processes of education (e.g., learning design, material creation, delivery, assessment, and certification) are not, by default, treated in terms of a single pipeline performed within the setting of a single formal institution, but instead support the flexible combination of people, resources, and processes in response to learner needs. In practice, this approach has been a feature of ERT: online materials drawn from multiple sources, parents supported in homeschooling, remote assessment and examination, and institutions with a tradition of remote teaching (e.g., OU) swamped with requests for input on the relevant pedagogies. These responses, however, have been ad-hoc crisis responses. The adoption of decentralised thinking at the research, planning, and funding levels for education could support more resilient learning in the longer term. In particular, this type of thinking can be supported at a technical level with inherently decentralised technologies, such as blockchain and personal interoperable data stores, to ensure that both data privacy and educational standards and certification can be applied meaningfully and in a trustworthy fashion.

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4 CHALLENGES, OPPORTUNITIES AND PRIORITIES

On the basis of our primary findings, we have identified a set of educational challenges, opportunities and priorities experienced during COVID-19 by the DEL4ALL expert community. We distributed surveys and organised online expert consultations to summarise the most common issues. The results of our first survey show that the COVID-19 pandemic exposed structural weaknesses in the current higher education systems. The digital education experts reported incompatible teaching materials, non-existent infrastructure, and a lack of skills, and expect more focus on digital enhanced and personalised learning as well as Open Educational Resources. The second DEL4ALL survey resulted in highlighting the need for a digital enhanced learning guide with structured concepts, standards, and best practices. Respondents also identified open educational resources, virtual learning platforms integrated with learning analytics, digital games, and artificial intelligence as resources for digital learning in higher education. The DEL4ALL workshop highlighted that recreating what teachers do in classrooms in front of the computer cannot be the solution to education during COVID-19. Experts and participants agreed that the digital skills of teaching staff need to be improved to get the best from the available education technology. The DEL4ALL webinar highlighted the social-economic impact of the pandemic including the increased level of unemployment and the inactivity of employees, as well as the missing inspiration of educators and students due to the lack of professional development opportunities. However, participants identified opportunities in reskilling and upskilling programmes, such as new distance learning courses as there is a growing interest, due to COVID-19, in lifelong learning and short courses.

In terms of priorities, both the first and second survey resulted in highlighting the need for budgetary support from the European Commission as the main action point. Respondents from the first survey also expressed a need for regulation and legal frameworks to protect staff from being “replaced” by technology and for enabling rapid contracting of services. Furthermore, experts encouraged support in the development of concepts for Internet of Things in education and for integrating educational technologies to facilitate stronger learning. In the second survey participants additionally suggested a need for an open debate about the future of education and assistance with capacity building and skills development for teaching staff. In the DEL4ALL workshop participants identified the lack of investments in digital learning on a private and public level and the need of technology-based interactive learning processes with a project designed approach. Participants of the DEL4ALL webinar urged a rethinking of the business model of teaching, capitalising on the upskilling, development, and adoption of the new technologies and the positioning of the different technologies on the value chain. Moreover, the European Commission highlighted its aim of tackling European tools and their objectives included in the revised European Action Plan 2021-2027. *Digital Education Action Plan 2021-2027.*

In the following tables we summarised the most common suggestions by our expert community to our surveys, workshop and webinars. Therefore, some of our data inputs may overlap in the tables.

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4.1 CHALLENGES, OPPORTUNITIES AND PRIORITIES SUMMARY TABLE

TABLE 1: CHALLENGES, OPPORTUNITIES AND PRIORITIES IDENTIFIED BY THE 1ST DEL4ALL EXPERT SURVEY

Challenges	Opportunities	Priorities
Digitalisation of offline education	Transformation of education	Budgetary support from EC
Technology adoption	Improvement infrastructure	Regulations established by EC
Lack of skills	Tailored education	Concepts for education infrastructure designed by EC
IT security issues	The COVID-19 pandemic is speeding up policy changes within institutions	EC to promote the identification and sharing of best practices
The predominance of “old” education structures (i.e., single lecturer design, face-to-face centric teaching, flexible business processes and infrastructures)	People start re-thinking travelling guidelines	EC to provide an evidence base that other institutions can confidently learn from
Formative assessment	Increasing staff skills and competences	EC to help foster networks and communities
Extra work-load	Matters around diversity	EC to help with capacity building and skill development of educators
Difficult student interaction	Access and Universal Design for Learning	EC to stimulate more research on scalable and resilient educational infrastructures
Health maintenance in face-to-face settings	Wider audiences can be reached	EC to encourage a continuous debate based on rigorous evidence
Frustration, and more competition between education institutions to acquire new students and retain current ones		
Equality and fairness of access to digital ecosystems		

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TABLE 2: CHALLENGES, OPPORTUNITIES AND PRIORITIES IDENTIFIED BY THE 2ND DEL4ALL EXPERT SURVEY

Challenges	Opportunities	Priorities
Ensuring high quality online education	Improving the infrastructure of online teaching	EC to provide budgetary support
Teaching staff's lack of experience with online education	Increasing skills and competencies of staff	Encouraging open debate about the future of education
Difficulty in engaging and interacting with students	Facilitating opportunities for lifelong learning.	Assistance with capacity building and skills development for teaching staff
Converting offline teaching into online teaching material	Speeding up policy changes within institutions	Sharing of best practices between higher education institutions
Extra workload when moving from offline to online teaching	Strengthening the relevance of technology in education	EC to support research activities
Health maintenance in face-to-face settings and in work/personal life balance	Transformation of former education system	Facilitating cross-institution exchange and community building
Greater competition between higher education institutions to acquire/retain students	Better alignment between the education system and the needs of the future labour market	EC to support research activities
Lack of online teaching infrastructure in education institutions	Reaching a broad learning audience	EC to launch more regulations supporting digital education
Inflexible administrative processes inside the educational institution	More focus on diversity	EC to offer concept for improving teaching infrastructure
Difficulties with the setup of appropriate infrastructure	More student personalised learning opportunities	Build transversal vision for LLL and PLP (cross view between different DGs/align funding for EU projects, etc)
Formative assessment	Access and Universal Design for Learning	Establishing an EU standard for online education
Conducting online exams	Improvement of online teaching	Identifying and sharing a governance framework like COBIT for HEI
Frustration of teaching staff	IT to be part of the HEI strategy	Assessment and certification practices
Privacy issues	Offering greater flexibility for students	Tie funding to digitalisation of delivery
Equality and fairness of access to digital ecosystems		

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TABLE 3: CHALLENGES, OPPORTUNITIES AND PRIORITIES IDENTIFIED BY THE DEL4ALL WORKSHOP

Challenges	Opportunities	Priorities
Moving classroom-based education online	Collaboration technologies have become consumerised	Personalised learning
No movement towards project-based learning	Reorganising IT infrastructure at institutes	Preparing teachers to shift to another model of teaching, using project- based materials
No fundamental changes in education system re COVID-19	Usage of available technological tools by teachers	Support of progress monitoring, not assessment-based teaching
Creating a hybrid model between online and offline presence	Identifying students in high risk using technology	System development for teaching
Teachers and student are frustrated on the way of learning delivery	Using Learning Analytic tools in online lecture and follow student in their learning journey	The need of investment in digital learning on a political level
Developing and carrying out online exams	Improvement of technologies	Breaking the barriers between different disciplines
Lack of digital skills	Best practice and materials sharing between institutions\	Creation of an EdTech Agenda
Changing the method of education, understanding the opportunities in online teaching	COVID-19 highlighted the need for digital supported education	High level strategy for online learning
Same lectures on new technologies, student's frustration due to the conventional way of learning delivery	Understanding the best use of advanced technology potentials	Teachers to create well knowledge micro-causes and turning teaching to project-based learning
Digital inclusion	Course recommendations	Creation of a digital decentralised identity management system and micro-credentials
Introduction of artificial intelligence into mainstream education	Divisions of learning across humans and machines	Promoting of micro content and learning using blockchain
Lack of expertise		Development of soft skills

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TABLE 4: CHALLENGES, OPPORTUNITIES AND PRIORITIES IDENTIFIED BY THE DEL4ALL 7 OCT. WEBINAR

Challenges	Opportunities	Priorities
Moving from in person training to online education	Growing interest in lifelong learning and short courses	Implementing open-source systems
The standards and policies are vague for the transition of moving to e-learning	Identifying emerging skills and technologies	Digitally resilient models
Social-Economic issues of the pandemic	Institutions to re-think what they are offering	Bridging between the need of future technologies and to adapt to it
Connectivity and equipment issues	Reskilling and upskilling programs	Education scheme for educator
Increased unemployment and inactivity of employees	Working around the Learning Management Systems (LMS)	Rethink the business model of teaching
Limited access to work-based learning, assessment issues	New distance learning courses	Positioning the different technologies on the value chain
Professional development of teachers and learners	Open badges for social recognition of best practices, efforts	Capitalising on the upskilling, development and adoption of the new technologies
HEI educators are often rewarded with reductions in teaching, which works against the recognition of education itself.	Skilling people in digital, with reference frameworks for HEIs like DigCompedu	Mapping out the technology landscape for future projects
Students and teachers miss inspiration	New technologies (VR, gaming)	EC is tackling on European tools (privacy and security reasons)

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5 STRATEGIC PRIORITIES

Based on the expert responses to our surveys and online consultations, we are proposing three (3) main priority action points for building a sustainable digital transformation for Europe's economy and society. The priorities are identified from our challenges, opportunities and priorities summary tables highlighting the most common topics suggested by our experts throughout the first year of the project. The strategic priorities are well aligned with the European Commission's *Digital Education Action Plan (2021-2027)*, and could provide further help to the Education, HEI, TVET stakeholder community. The priorities are also mapped to our research questions and use cases in the next chapter.

5.1 PRIORITY 1. DEVELOPMENT OF A HIGH QUALITY DIGITAL ECOSYSTEM

High Priority Research needs

1. Concepts for education infrastructure
2. Cross-institution exchange and community building
3. Sharing of best practices between higher education institutions

Other Research needs

1. Open debate about the future of education
2. Monitoring and project-based teaching practices
3. Standardisation for interoperable learning records

5.2 PRIORITY 2. IMPROVING DIGITAL COMPETENCIES

High Priority Research needs

1. Reorganising IT infrastructure and IT to be part of the HEI strategy
2. Capacity building and skills development of educators
3. Course recommendations

Other Research needs

1. Developing and carrying out online exams
2. Converting offline teaching into online teaching material
3. Creating a hybrid model between online and offline presence

5.3 PRIORITY 3. RECONSTRUCTING STUDENT EXPERIENCE

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High Priority Research needs

1. Learning Analytic tools in online lectures and follow student in their learning journey
2. Better alignment between the education system and the needs of the labour market
3. Access and Universal Design for Learning

Other Research needs

1. Digital Equity (equality and fairness of access to digital ecosystems)
2. Facilitating opportunities for lifelong learning
3. Identifying students at high risk using technology

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6 RESEARCH QUESTIONS AND USE CASES

Based upon our main priority action points, we distributed a DEL4ALL third survey on Emerging Technologies & Digital Enhanced Learning, where we focused on technologies and tools that can add value to digital learning. During the DEL4ALL interview series with our expert community from different technology areas and multidisciplinary perspectives, we identified a first set of use cases and best practices in digital education that can be implemented by the use of emerging technologies. Therefore, our third survey aimed to gather education experts' insights on best practices, use cases, and tools within the area of Digital Enhanced Learning. The questionnaire consisted of six open questions focusing on the use of technology as part of a student's learning experience. Our goal was to identify emerging technologies such as AI, IoT, AR, VR, ML, NLP, Blockchain, Gaming, Analytics, Robotics, Shared Virtual Spaces, Video/Multimedia Creation, 3D printing, Conference tools, and other solutions. We were also interested in technologies that have become mainstream in recent months as education institutions have been trying to mitigate the impact of Covid-19.

Within the third survey we planned to both substantiate and challenge the information we collected with the unique perspective and expertise from the DEL4ALL expert community. We analysed the **thirty-one (31)** responses received in order to design our main research questions and align them to our previously identified strategic priorities. The following research questions are created from the most common responses to our third survey.

6.1 ANALYSIS OF STUDENTS LEARNING PROGRESS AND OUTCOMES

Technology: AI

Relevance of research question

The learning progress and outcomes of learners depend on a number of variables, such as: students' individual dispositions and motivation; gender; social and economic backgrounds: and the educational environment. In classroom and lecture hall settings where there is tangible interaction between educators and students, educators can rely on visual and other sensory cues to identify students' need for support, learning difficulties, and potential risk of 'failure'. In distance education the advantage of social interaction may be reduced or lost entirely.

Assessments help educators as well as students to monitor learning progress. Feedback and test results may encourage students to reflect on what steps to take to improve their outcomes, and educators on further tactics to reduce learning gaps. However, the traditional classroom approach has major disadvantages within the context of learning progress and outcomes:

- ➔ Conducting assessments at regular intervals and correcting tests is very time-consuming for educators, and stressful for many students
- ➔ Assessments come in many forms, and often in 'one size fits all' wrapping (such as written examinations and / or multiple-choice tests)
- ➔ Students are unlikely to secure immediate feedback

Learning Analytics tools leverage various computer science technologies and methods, such as statistical analysis and artificial intelligence. These systems are designed to enhance students' learning experience by the analysis and visualisation of the current learning

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progress, the prediction of the future progress, and the development of personalised learning paths that match students' needs.

Use Case(s)

Diagnostic and formative assessment takes place at the beginning and throughout a course and helps educators in large student groups to identify students' knowledge and difficulties and to develop individual learning paths. The continuous and immediate feedback to students is important to shape learning, improve the learning outcomes, and reduce the risk of not passing a course.

References to tools, technology provider, initiatives[1]

- European Training Foundation
- Common Learning Middleware
- European Parliamentary Research Service

Strategic priority

Priority 3 Reconstructing student experience

6.2 COMPUTER GAMES IN CLASSROOM ENVIRONMENT

Technology: Digital Games

Relevance of research question

Digital games can be learning tools, motivators, and generators of curiosity and as a result an effective means of optimising student learning and performance in daily educational practice. The positive relationship between learning and students' engagement while using digital games has been confirmed; however, digital games are not yet widespread in higher education. The cost/expense of games/equipment, and the lack of technical support are some of the barriers to the addition of games and simulations in education.

Using games for formal education focuses on three different approaches: *Van Eck, R. (2006).*

1. using commercial games as learning tools
2. integrating serious games, games for learning and multi-user virtual environments in the learning process
3. designing games with the students in which the practice of designing serves as a learning process

[1] See Annex A for URLs.

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Games can be classified into three broad categories according to their educational scope:*Ulicsak, M., Williamson, B. (2010).*

- leisure games
- educational leisure games
- educational games

Use Case(s)

The most successful commercial games for educational use are those referred to as the 'big G' games. *Gee, J. P. (2012)*. These are games, which include not only the game itself, but also the social interaction that develops around it. Typically, games of this type comprise a plurality of features for connecting notions of what is considered good practice in situated learning to what is experienced while playing (good) games. *Papadakis, S., J. (2018).*

References to tools, technology providers, initiatives[2]

- Institute of Digital Games, University of Malta
- Curio project
- eCrisis project
- C2Learn

Strategic priority

Priority 3 Reconstructing student experience

6.3 NATURAL LANGUAGE PROCESSING (NLP) HELPING CHATBOTS

Technology: Machine Learning (ML)

Relevance of research question

Natural Language Processing (NLP) is one of the most popular domains in machine learning (ML), playing a vital role in the research of emerging technologies, including sentiment analysis, speech recognition, text classification, machine translation, question answering.

NLP can help, for instance, a chatbot to interpret and recognise what is being said and machine learning gives it the ability to record and learn from conversations. The machine "learns" through the analysis and recordings of patterns and use of algorithms assessing multiple conversations and their impact over time. The chatbot is constantly learning and growing with the results becoming efficient in meeting user expectations.

[2] See Annex A for URLs.

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Chatbots are used as messaging networks, helping to increase the capacity to support students by providing greater help desk availability. Most of the chatbots are based in machine learning and they improve themselves constantly as they keep interacting with more users and learning new words. The solution and the research area in this topic are related to NLP and also to an applied linguistics approach to enhance user experience while using the bot, so it will not only learn from experience, it will already be taught.

Use Case(s)

- Talk to each student individually
- Answer student questions in real time and expand NLP knowledge base
- Prepare and guide students through processes
- Drive task completion and provide helpful text
- Collect insightful responses and react accordingly
- Provide important nudges and reminders
- Deliver learning context in new and exciting ways

References to tools, technology provider, initiatives[3]

- Socrates.chat
- AdmitHub
- Piazza

Strategic priority

Priority 1 Building of high-quality digital ecosystem

6.4 AR TECHNOLOGY AT UNIVERSITY LABORATORIES

Technology: AR

Relevance of research question

Augmented reality (AR) applications can enhance the learning process, the motivation, creativity, and interest of students, and it provides more authentic learning experiences. It allows its users to view a real environment with computer-generated 3D models.

AR can improve:

- student performance
- user concentration on specific tasks

[3] See Annex A for URLs.

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- students' laboratory skills and their attitudes towards their labs

AR can be used with laptops, smartphones, and tablets, where digital images and graphics intersect and interact with the real world to enhance the experience. After capturing the input from the devices, the AR application recognises the target, processes the image, and augments it with pictures, video, and audio to create an illusion that can effectively engage users in a virtual world. The hardware components of AR include:

- Sensors/tracking: Digital cameras and other optical sensors, accelerometers, GPS, gyroscopes, solid-state compasses, RFID, and wireless sensors
- Input devices from users: Microphones, touch screens, gesture devices, stylus, pointers, and gloves or other body wear
- CPU and display/output devices: Smart glasses, lenses, laptops, smartphones, and tablets

Use Case(s)

AR not only helps to improve the skills of the students but also can create a positive attitude towards practical labs. The skills and knowledge that students develop through technology-enhanced learning environments may be developed more effectively through AR technology. However, users of AR technology may experience usability issues and technical problems, and some students may find this technology complicated.

References to tools, technology provider, initiatives[4]

- TalTech
- Recreation
- UW Reality Lab
- Nextechar
- Create.eu

Strategic priority

Priority 3 Reconstructing student experience

6.5 INTEGRATING IOT PLATFORMS INTO EDUCATION

Technology: Internet of Things (IoT)

Relevance of research question

[4] See Annex A for URLs.

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As Internet of Things platforms become more widespread and cheaper to adopt, campuses, schools, and other institutions are leveraging the technology's potential. IoT has tools to optimise classwork, improve the efficiency of the learning process, connect with students better, and ensure on-site safety.

- Improved school management efficiency
- Real-time data collection
- Improved resource management
- Global interconnectedness
- Addressed safety concerns

Use Case(s)

Integrating IoT platforms into education helps students to develop digital literacy and innovative skills. IoT allows schools to improve safety by tracking key resources and enhancing access to information which facilitates teachers to create "smart lesson plans". As e-learning and blended learning became a common practice in higher education systems technology needs to be introduced to the classes not for only learning but to make it more relevant to the learners.

IoT Applications in Education

- Foreign Language Instruction
- Connected / Smart Classrooms
- Task-Based Learning
- Special education/Learning from home/Personalized learning
- Physical education
- School security
- Classroom and attendance monitoring
- Student physical and mental health

References to tools, technology provider, initiatives[5]

- Edmodo
- C-Pen Education
- Magicard
- Integrated Innovation Institute
- SmartBoard

[5] See Annex A for URLs.

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Strategic priority

Priority 2 Improving digital competencies

6.6 DIGITAL ENVIRONMENT THROUGH A SENSE OF PRESENCE

Technology: VR

Relevance of research question

Virtual reality (VR) is an interactive experience which immerses the user in a digital environment through a sense of presence. VR can encompass programmes that are simply viewed on a flat screen, such as a desktop monitor or tablet device, as well as those that require the use of “goggles” and other head-mounted displays (HMDs). VR has the potential to greatly enhance collaboration between teachers and students, both in distance learning and classroom-based teaching.

Use Case(s)

VR can act as an active learning tool and enhance the educational experience in e.g., bioscience, as it encourages active participation and self-directed learning of a student through high-level interactivity with the software. This is important as medical and bioscience education often requires students to be able to physically interact with objects, such as organs, to gain a better understanding of their form through self-directed inquiry and exploration. Civil engineering students could use VR to design buildings, history students could explore Roman ruins, and physics students could explore the universe, to give some other examples.

References to tools, technology provider, initiatives[6]

- Unimersiv
- Overview
- University of Westminster
- Digital Giza
- DOGHEAD Simulations
- YouVisit
- Arch Virtual

Strategic priority

Priority 3 Reconstructing student experience

[6] See Annex A for URLs.

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6.7 ISSUE AROUND FAKE CERTIFICATES

Technology: Blockchain

Relevance of research question

Due to globalisation, the internationalisation in education is becoming increasingly important. At the same time, the struggle with fake certificates such as transcripts, degrees and diplomas have become a large-scale problem. Ezell and Bear report about fraudulent practices and the billion-dollar industry behind it. Ezell, A., Bear, J. (2005).

Certificates confirm the achievement of certain learning outcomes. More than ever, individual learning records become essential for people's professional careers. Until today students usually receive a certificate as a paper document that is not counterfeit protected. These also have more major disadvantages such as the mainly manual activity for third parties to verify the certificate and the need for universities and certification authorities to maintain a registry or database for certificates for a long period of time. *Grech, A., Camilleri, A.F. (2017)*.

An alternative to paper certificates are digital credentials that are cryptographically signed. In the context of certification, the blockchain technology supports counterfeit protection and easy verification of certificates even if the certification authority no longer exists. However, more effort is needed to manage digital identities and secure the registry for credentials.

Use Case(s)

From a blockchain perspective, we identify three main use cases.

Managing digital identities of awarding bodies

Certifiers and awarding bodies need digital identities, i.e., blockchain addresses. Certifiers' public keys need not be bound to any publicly readable personal information. As a result, they remain anonymous. This is a requirement resulting from the European GDPR which objects to any undeletable storage of personal information in a blockchain. However, awarding bodies must be known by a non-modifiable profile that can be read by anybody who is verifying a digital credential.

Managing and issuing digital certificates

Awarding bodies manage data of students and examination results in their inhouse systems. To share and verify identities, learning achievements and skills in educational ecosystems the data has to be represented in a standardised format such as the Open Badges standard. *IMS Global Learning Consortium*. (2020). For the secure registration, the digital credential has to be cryptographically signed by the certifier and an irreversible transaction on the blockchain writes the fingerprint of the certificate to the blockchain.

Verification of digital credentials across the Web

The verification of a digital credential is always important in case of an application. An easy to use and globally available web service that guarantees trustworthy verification including the verification of digital identities is essential for employers and universities in education in a globalized world.

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References to tools, technology provider, initiatives[7]

- Europass Digital Credentials Infrastructure (EDCI)
- Common Learning Middleware
- Blockchain for Education – Lifelong learning passport
- DigiCerts
- European Blockchain Services Infrastructure (EBSI)
- Blockcerts
- QualiChain
- Netzwerk Digitale Nachweise
- Hayland Credentials
- VerifyED
- onCampus

Strategic priority

Priority 1 Building of high-quality digital ecosystem

[7] See Annex A for URLs.

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7 RECOMMENDATIONS

Participants of the DEL4ALL consultations highlighted the need for the European Commission to provide assistance through budgetary support, regulations, and stimulation of more focused research activities. Moreover, experts from the higher education field proposed the creation of an EdTech Agenda, an online Erasmus programme dedicated to professors and students in Europe, and a Central European Group where HEI pedagogy experts can rethink the traditional system. DEL4ALL experts also recommended the standardisation for interoperable learning records, credentials, blockchain identity systems, and a simple open-source as well as cross-unit experimentation, such as an experimental university with pilot students, course teams to test pedagogical methods and tools. Promoting micro-content and learning using blockchain and the creation of a digital decentralised identity management system and micro-credentials were also among the advised action points. Additionally, we are considering looking into the social impacts of emerging technologies, as suggested by our advisory board as part of our planned thematic workshop and possible survey on "Inspiring and teaching science using AR.

Our preliminary recommendations will be reviewed and extended during the next project year (2021), and further developed in the DEL Research Agenda Final Version in project month 18 (30/06/2021).

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8 CONCLUSIONS

The DEL4ALL data collection workflow provided a wide range of opportunities to support experts and DEL4ALL stakeholders to collect valuable information for future policy recommendations and research prioritisation. As part of our primary research, we identified surveillance technologies mainly used in emergency remote teaching during the COVID-19 pandemic and distinguished the emerging technologies for sustainable digital enhanced learning. We collected data on existing challenges, opportunities, and priorities within digital education and set a strategic priority list based on the most common issues. To complete our research agenda, we aligned our research questions to these priorities. *HOLON IQ, Higher Education Digital Capability Framework(2020).*

This report will be further developed in Month 18 (30/06/2021), where we will further align our research to the Digital Education Action Plan 2021-2027, developed by the European Commission. The action plan supports strengthening cooperation and exchange in digital education at the EU level. Within this, the European Commission is in the process of creating a new European Digital Education Hub supporting the development of policy and practice and monitoring the development of digital education in Europe. *Digital Education Action Plan 2021-2027.* Additionally, we are planning to adapt our research questions to our Online Aggregator to provide more data to each specific technology related project and initiative, as well as to experts for each technology. Furthermore, we are planning to analyse more technologies, such as Surveillance technologies and further look into the needs of the labour market.

The DEL4ALL consortium will continue organising online expert consultations. Our hope is that we will be able to hold a face-to-face workshop in Q3 2021 with our project community once there is a mass take-up of the COVID-19 vaccine.

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REFERENCES

[1] Becker, K. (2016) 'Choosing and using digital games in the classroom: a practical guide', in Advances in Game-Based Learning, Vol. 1, Springer, Dordrecht.

[2] Burns, S., McCormack, M. (2020). Fall Planning for the New Normal: Moving Higher Ed Online. Available at: https://www.educause.edu/ecar/research-publications/fall-planning-for-the-new-normal-moving-higher-ed-online/conclusion

[3] CBINSIGHTS. (2020). Education In The Post-Covid World: 6 Ways Tech Could Transform How We Teach And Learn. Available at: https://www.cbinsights.com/research/back-to-school-tech-transforming-education-learning-post-covid-19/

[4] Cedefop, (2020). Digital gap during COVID-19 for VET learners at risk in Europe. Synthesis report on seven countries based on preliminary information provided by Cedefop's Network of Ambassadors tackling early leaving from VET. Available at: https://www.cedefop.europa.eu/files/digital_gap_during_covid-19.pdf

[5] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Digital Education Action Plan 2021-2027 Resetting education and training for the digital age COM/2020/624 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1602778451601&uri=CELEX%3A52020DC0624

[6] Comyn, P. (2020, September 23). Analysing learning management systems during Covid-19 [Video file]. Retrieved from https://www.youtube.com/watch?v=xjm_d9AX1Qg&feature=emb_title

[7] Dignum, V., Penagos, M., Pigmans, K., Vosloo, S. (2020). Policy Guidance on AI for Children. Available at: https://www.unicef.org/globalinsight/reports/policy-guidance-ai-children

[8] Education and Training Monitor, The Monitor is the Commission's flagship annual publication on education and training in the European Union. Available at: https://ec.europa.eu/education/policy/strategic-framework/et-monitor_en

[9] Ezell, A., Bear, J. (2005). Degree mills: The billion-dollar industry that has sold over a million fake diplomas. Pyr Books

[10] Gee, J.P. (2012) 'Keynote: big-G games are good for learning', 9th Annual Games for Change Festival (G4C). Available at: http://goo.gl/dUr6Wz

[11] Grech, A., Camilleri, A. F. (2017). Blockchain in Education. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education%281%29.pdf

[12] Grech, A., Camilleri, A. F. (2020). The Digitization of TVET and Skills Systems. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_752213.pdf

[13] Hodges, C., Moore, S., Lockee, B., Trust, T., Bond, A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. Available at: https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

[14] HOLON IQ, Higher Education Digital Capability Framework. Available at: https://www.digitalcapability.org/

[15] IMS Global Learning Consortium, Open Badges. Available at: https://openbadges.org/

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Funded by the Horizon 2020 Framework Programme of the European Union

[16] Khvilon, E., Patru, M. (2002). Information and communication technologies in teacher education: a planning guide. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000129533?posInSet=2&queryId=2c81f7c0-9226-4fb2-88de-98c1e7cdab0a

[17] Konotop, G. (2020, October 25). Technological tools and their potential use in the educational sector [Video file]. Retrieved from https://www.youtube.com/watch?v=AgwqIWKqY08&feature=emb_title

[18] Kumar S., R., George, S. (2020). Why skills - not degrees - will shape the future of work. Available at: https://www.weforum.org/agenda/2020/09/reckoning-for-skills/

[19] Ulicsak, M. and Williamson, B. (2010) Computer Games and Learning, Futurelab. Available at: http://www.futurelab.org.uk/sites/default/files/Computer_games_and_learning.pdf

[20] Papadakis, S., J. (2018). The use of computer games in classroom environment. Available at: https://www.researchgate.net/publication/323181812_The_use_of_computer_games_in_classroom_environment

[21] Scarpetta, S., Quinini, G. (2020). The potential of online learning for adults: Early lessons from the COVID-19 crisis. Available at: https://www.oecd.org/coronavirus/policy-responses/the-potential-of-online-learning-for-adults-early-lessons-from-the-covid-19-crisis-ee040002/

[22] Schleicher, A. (2020). The impact of COVID-19 on education insights from education at a glance 2020. Available at: https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf

[23] Van Eck, R. (2006) 'Digital game-based learning: it's not just the digital natives who are restless', EDUCAUSE Review, Vol. 41, No. 2.

[24] World Economic Forum. (2020, November 25). The evolution of global education and 5 trends emerging amidst COVID-19. Available at: https://www.weforum.org/agenda/2020/11/evolution-higher-education-covid19-coronavirus/

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APPENDIX A

Research questions reference links:

- European Training Foundation. Available at: https://www.etf.europa.eu/en
- Common Learning Middleware. Available at: https://www.academy.fraunhofer.de/de/newsroom/blog/2019/12/fraunhofer-common-learning-middleware--so-finden-die-teile-des-l.html
- European Parliamentary Research Service. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf
- Institute of Digital Games, University of Malta. Available at: https://www.um.edu.mt/digitalgames
- Curio project. Available at: http://curioproject.eu/
- eCrisis project. Available at: http://ecrisis.eu/
- C2Learn project. Available at: http://www.c2learn.eu/
- Socrates.chat. Available at: http://socrates.chat/
- AdmitHub. Available at: https://www.admithub.com/
- Piazza. Available at: https://piazza.com/
- TalTech. Available at: https://old.taltech.ee/institutes/department-of-computer-systems/research-60/research-lab/virtual-and-augmented-reality-laboratory/
- Recreation. Available at: https://recreation.ee/
- UW Reality Lab. Available at: https://realitylab.uw.edu/
- Nextechar. Available at: https://www.nextechar.com/higher-education?utm_term=augmented%20reality%20labs&utm_campaign=Higher+Education+Search+Campaign&utm_source=adwords&utm_medium=ppc&hsa_acc=2775768637&hsa_cam=10875416379&hsa_grp=103845454501&hsa_ad=457745853004&hsa_src=g&hsa_tgt=kwd-997380979877&hsa_kw=augmented%20reality%20labs&hsa_mt=b&hsa_net=adwords&hsa_ver=3&gclid=CjwKCAiA5IL-BRAzEiwA0lcWYqFm-wppBV3D1wKh34aBee4CsYK4ExN5GoJ3uLqg4bwvaU4ckw7soxoChFwQAvD_BwE
- Create.eu. Available at: https://www.create.eu/works/
- Edmodo. Available at: https://new.edmodo.com/
- C-Pen Education. Available at: https://assistive.education/
- Magicard. Available at: https://magicard.com/solutions/by-industry/education/
- Integrated Innovation Institute. Available at: https://www.cmu.edu/iii/projects-research/iot.html
- SmartBoard. Available at: https://www.smarttech.com/en/products/education-displays
- Unimersiv. Available at: https://unimersiv.com/portfolio/
- Overview. Available at: https://www.overviewexperience.com/
- University of Westminster. Available at: https://www.westminster.ac.uk/news/the-times-virtual-reality-helps-students-to-master-criminal-law
- Digital Giza. Available at: http://giza.fas.harvard.edu/

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- DOGHEAD Simulations. Available at: https://www.dogheadsimulations.com/
- YouVisit. Available at: https://www.youvisit.com/
- Arch Virtual. Available at: https://archvirtual.com/virtual-reality-medical/
- Europass Digital Credentials Infrastructure (EDCI). Available at: https://europa.eu/europass/digital-credentials/issuer/#/home
- Common Learning Middleware. Available at: https://www.academy.fraunhofer.de/de/newsroom/blog/2019/12/fraunhofer-common-learning-middleware--so-finden-die-teile-des-l.html\
- Blockchain for Education – Lifelong learning passport. Available at: https://www.fit.fraunhofer.de/en/fb/cscw/projects/blockchain-for-education.html
- DigiCerts. Available at: https://www.digicerts.de/
- European Blockchain Services Infrastructure (EBSI). Available at: https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/EBSI
- Blockcerts. Available at: https://www.blockcerts.org/about.html
- QualiChain. Available at: https://qualichain-project.eu/
- Netzwerk Digitale Nachweise. Available at: http://netzwerkdigitalenachweise.de/
- Hayland Credentials. Available at: https://www.hylandcredentials.com/
- VerifyED. Available at: https://verifyed.io/
- onCampus. Available at: https://www.oncampus.de/

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