



Higher Education

# Advancing Digital Maturity in Croatia's Higher Education System



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# **Advancing Digital Maturity in Croatia's Higher Education System**

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# Foreword

Higher education plays a vital role in OECD member and partner countries in educating learners, driving innovation and contributing to economic development. Higher education systems operate in a context of accelerating technological advancement, the growing imperative for sustainability, and continuously increasing societal expectations. Policy makers and institution leaders are faced with the need to adapt to the increasingly diverse needs of learners by developing more flexible, responsive programmes and learning pathways.

Digitalisation has been promoted as a means to enhance inclusion and efficiency in rapidly evolving higher education systems. It has the potential to make education more accessible for students unable to attend traditional on-campus classes. It can also facilitate more personalised teaching and learning approaches, stimulate wider and deeper collaboration through virtual means, and reduce the cost of education.

The COVID-19 pandemic necessitated a rapid transition to reliance on digital technologies. Many instructors and students were insufficiently prepared for the sudden transition and had negative experiences of emergency remote instruction. Attention is now turning to important questions not considered or prioritised during the emergency period. How should learning and assessment be redesigned so digital technologies are used effectively? How should quality assurance be adapted to new modes of delivery? What are the associated needs for investment in financial and human resources?

The Croatian government views digitalisation as a way to improve access to higher education and increase its attractiveness to national and international students. It is investing substantial funds to modernise digital infrastructure and build capacity for effective integration of digital technologies into the higher education offer. This report provides an account of the activities and findings of the “Assessing the Digital Readiness of Croatian Higher Education Institutions” project, which was carried out by the OECD and funded by the European Union. The primary objective of the project is to provide support and advice to Croatian authorities as they develop their strategic approach to higher education digitalisation.

The report offers an assessment of Croatia’s general digital readiness and the digital maturity of its higher education institutions. It reviews and reflects on emerging international trends related to standards, supports and practices for enhancing the quality of digital higher education. It also provides technical advice for public authorities on the prioritisation of investments in digital infrastructure. Finally, draft guidelines for institutions are presented, aimed at supporting and advising their strategic development processes and investment strategies with respect to digitalisation.

The report forms a body of advice that is intended not only to support immediate national projects, but also inform future policy developments related to digitalisation in Croatia’s higher education system.

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The project was managed by Gillian Golden of the OECD Higher Education Policy Team, who is lead author of this report. OECD staff members Matej Bilik, Iris Figliolia and Roza Gyorfi contributed to the project at different stages, while Thomas Weko and Simon Roy, former and current team leaders respectively of the OECD Higher Education Policy Team, provided advice throughout the project. Paulo Santiago, Head of the Policy Advice and Implementation Division in the Directorate of Education and Skills and Andreas Schleicher, Director of the Directorate for Education and Skills, advised the project and reviewed the publication. Administrative support was provided by Marika Prince and Anita Buzás. Justin Steed edited the report and Stephen Flynn and Cassandra Morley assisted with the communication and production processes.

While the report draws on data and analysis from the OECD, Croatian sources, and a range of other published sources, any errors or misinterpretations remain the responsibility of the OECD team.





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# Executive summary

Croatia's higher education system has been undergoing profound change in recent years. The government has proposed a comprehensive modernisation agenda, building on its 2020 National Reform Plan and supported by Croatia's National Plan for Recovery and Resilience 2021-2026. A key part of the modernisation agenda relates to enhancing digitalisation in higher education, by improving digital infrastructure and widening access to high-quality digital education. Croatian public authorities requested assistance from the European Union's Technical Support Instrument (TSI) for provision of support and advice, to enable public authorities and higher education institutions to successfully integrate digital technologies. The OECD was asked by the Croatian Ministry of Science and Education and the Directorate-General for Structural Reform Support of the European Commission to deliver the requested support.

This report brings together the outputs of the project activities. It finds that Croatia ranks behind its European Union counterparts in many aspects of digital readiness. At the same time, Croatia is investing heavily in connectivity and establishing a favourable regulatory environment for digitalisation in the wider economy. Some strong central supports for digital education transformation also help to enhance digital readiness. It is, however, likely that more policy action will be needed if Croatia is to continue to improve the perception, accessibility, and take-up of digital education, including online and hybrid education.

An assessment of digital maturity of Croatia's higher education institutions drew on a digital maturity survey developed by the OECD and CARNET, and interviews with institutions and stakeholders conducted during an OECD fact-finding visit in May 2022. The key findings with respect to the elements of digital maturity identified in the analytical framework (leadership, infrastructure, competence and culture) are as follows:

## *Digital leadership*

- Institution leaders view digitalisation as a concept that goes far beyond online education.
- Most institutions have established digitalisation strategies, but stakeholder engagement in their development seems limited.
- Limited public investment is perceived by institution leaders as a key barrier to successful digitalisation.
- There is a lack of clarity regarding responsibility for digital transformation within some institutions.

## *Digital infrastructure*

- Institution staff express satisfaction with their internet connections provided by CARNET, but many need improvements to their on-campus networks.
- Some institutions have strong concerns about the adequacy of their current digital technologies.
- Institutions rely on in-house support staff, and some experience severe difficulties in maintaining ICT support services.
- Institutions would benefit from a more centralised provision of some software and services and expressed a pressing need for certain types of audio-visual equipment.

*Digital competence and culture*

- Some initiatives are in place to develop digital competence, but a more systematic approach would be beneficial.
- Many existing pedagogical practices for online and hybrid education lead to deficits in the social element of learning and lower student engagement.
- Students have access to various digitalised services, but institutions could make more effort to involve them in digitalisation planning.
- In Croatian institutions, certain aspects of an innovative digital culture are more advanced than others.

As part of Croatia's National Plan for Recovery and Resilience, significant investments in digital infrastructure are expected. The OECD's review showed that some higher education institutions in Croatia have strong capacities for infrastructure project planning and management, while others require more support and guidance from public authorities. To address this, the report proposes general recommendations for Croatian authorities regarding digital infrastructure investment, including tailoring investment strategies to institutional capacity, allocating public investment to support innovative approaches, and promoting partnerships and co-ownership of investments with beneficiaries.

The report also recommends evaluating potential infrastructure investment choices according to centrally defined criteria. These criteria include social impact, quality impact, alignment with systemic goals, technology lifecycle, environmental impact, future cost implications, interoperability, stakeholder consultation, and risk mitigation strategies related to the infrastructure under consideration for funding. As well as the general criteria, the report provides specific principles for investing in different categories of digital higher education infrastructure.

The project activities included a review of emerging standards, supports and practices that can improve the quality of digital higher education. There are substantial variations in the extent to which higher education institutions in Croatia are making effective use of digital technologies. Recent updates to Croatia's regulatory framework for higher education streamline the role of the ASHE to both develop and assess quality assurance criteria for digital education, including online programmes.

In Croatia, as elsewhere, post-pandemic reflections are no longer focused narrowly on online or hybrid education, but on strengthening competence for digital education across all modes of delivery. The pandemic experience has shown that digital technologies alone cannot create a high-quality education programme; they are one of many resources that institutions and their staff can use to innovate curricula and pedagogical approaches.

Quality digital higher education relies on robust quality standards from transnational organisations and quality assurance agencies. More often than not, effective implementation of these standards requires public supports, including guidance for institution-level strategic development, support for sharing good practices, funding, and opportunities to build staff expertise and promote collaboration. However, standards and supports provided from outside the institution cannot drive improvements alone. Institutions must integrate these standards and supports effectively into their own strategic processes and work to improve digital capacity and culture both individually and collectively.

Croatian institutions currently have limited time and space to innovate in teaching and learning, while academic staff have limited extrinsic motivation to do so. To build momentum for change public authorities can create a national focal point and establish long-term objectives for digitalisation in higher education, supporting institutions to work together on improving digital education quality. The activities of the e-Universities project provide a sound starting point for the transformation of digitally enhanced teaching and learning, but more support will be required after the termination of this programme to sustain and build on the progress achieved.

# 1 Introduction

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This chapter describes the context, scope and methodology of the project, and outlines the structure of the remainder of the report. It also provides definitions for two of the key concepts used in the project activities – digital readiness and digital maturity.

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## Context

The Croatian higher education system is facing several challenges linked to the country's demographic decline and changes in the labour market. Enrolment rates in higher education are decreasing, while dropout levels of higher education students are higher than the EU average. At the same time, the country's higher education offer has been assessed as not fully responding to the demands of the labour market or the needs of learners. Unemployment rates for higher education graduates are amongst the highest in the EU and the share of Croatian adults participating in lifelong learning is below the EU average.

To increase the attractiveness and relevance of higher education, the Croatian government has proposed a comprehensive modernisation agenda. This agenda builds on the 2020 National Reform Plan and is supported by Croatia's National Recovery and Resilience Plan 2021-2026. A key part of the modernisation agenda involves a shift towards digitalisation – an agenda which was accelerated by the COVID-19 pandemic.

Digitalisation is a potential way to overcome key obstacles to higher education enrolment and increase the attractiveness and adaptability of Croatia's higher education offer. The National Plan for Enhancing the Social Dimension of Higher Education 2019-2021 aims to provide wider, more equitable access to higher education, to tackle the digital divide between students in urban and rural areas, and to enhance digitalisation as a means of supporting students with disabilities. However, there are several challenges to the successful implementation of the current policy agenda. Digital infrastructure in Croatia is frequently inadequate, and it is difficult to ensure widespread access to high-quality online learning.

The outputs of this project are intended to support Croatian authorities and higher education institutions in their efforts to successfully integrate digital technologies throughout the higher education system. More specifically, the outputs can support investment decisions related to expenditure on digital infrastructure and provide a basis for review of the standards, supports and practices that currently underpin the provision of digital higher education in Croatia.

## Project scope and methodology

### ***Operational period and implementation plan***

The operational period of the project was 19 months, from October 2021 to April 2023. Apart from inception-related activities and this final report, four main outputs were produced, each with associated activities:

1. **A diagnostic report** on the digital maturity of higher education institutions in Croatia with both internal (self-assessment survey) and external (OECD fact-finding) evaluation components.
2. **A technical report on high-quality digital education**, reviewing international best practice and supporting the development of guidelines for institutions to deliver high-quality digital education.
3. **A technical report on smart investment in digital infrastructure** for the Croatian higher education system, evaluating the respective merits of different investment models and providing principles to assist with prioritising funding for digital infrastructure.
4. **Guidance for higher education institutions** to develop strategic plans, based on the technical advice developed during the project.

### ***Digital readiness and digital maturity evaluation***

The starting point for supporting Croatia's aims for improved digitalisation in its higher education system was understanding Croatia's general level of digital readiness and assessing the digital maturity of its



higher education institutions. The OECD's assessment of digital readiness and digital maturity in Croatia's higher education system, presented in this report, is based on three main sources of evidence:

- Desk research on digital readiness of the higher education system, comprising review and synthesis of evidence available to assess Croatia's level of digital readiness.
- A survey of digital maturity in higher education institutions in Croatia, jointly fielded by the OECD and the Croatian Academic and Research Network (CARNET).
- An OECD fact-finding mission to Croatia in May 2022 to carry out a deeper exploration of the digital maturity of higher education institutions. Fact-finding activities included site visits to higher education institution campuses, interviews, and roundtables with institution management, staff, students and other key stakeholders.

The objective of the site visits was to establish:

- the extent to which higher education institutions and their staff are empowered to deliver digital education;
- the extent to which students can access high-quality digital learning; and
- the availability and adequacy of digital infrastructure necessary for effective delivery of digital education.

The OECD team visited a diverse set of institutions and faculties in Croatia, considering variations in institution category, legal status, size, governance structure, field of education and geographic location.

In addition, the OECD team conducted a series of stakeholder interviews with staff from relevant bodies and organisations. These interviews were designed to complement learning derived from institution site visits. Their purpose was:

- to clarify the OECD team's understanding of the role of the stakeholder organisation regarding the issues covered by the project;
- to elicit views on the current state of play of digitalisation in the higher education sector from the perspective of the stakeholder; and
- to probe perceptions of the challenges and opportunities presented by greater penetration of digitalisation within the higher education system.

The evaluation of digital maturity was carried out according to an analytical framework developed for the project, based on desk research and literature review. The framework presents the concept of digital maturity as comprising three equally important elements – digital leadership, digital infrastructure and digital competence and culture.

### ***Technical reports to support high-quality online learning and investment in digital infrastructure***

Two technical reports were developed as part of this project. The reports were aimed at supporting Croatian authorities to prioritise investments in digital infrastructure, and to assimilate international best practices into future policies related to the provision of high-quality digital education. The reports were informed by diagnostic activities, desk research, and input from international experts.

The OECD team held international seminars in Zagreb (in hybrid format), presenting preliminary research findings to Croatian stakeholders and officials. Expert discussions, feedback from Croatian authorities, and the project's Advisory Group contributed to the final drafts of both reports. Standalone versions of the draft reports were provided to the Croatian authorities, while abridged versions appear as chapters in this publication.

### ***Guidelines for institutions***

The OECD team created two sets of guidelines for Croatian higher education institutions, drawing from Croatian and international experts' advice. The first set offers a structured process for institutions to

improve digital education through a whole-of-institution approach, inspired by the successful Irish example of the National Forum for the Enhancement of Teaching and Learning in Higher Education. The second set provides targeted advice on digital infrastructure investments.

These guidelines were tested during a workshop in Zagreb in January 2023 and revised based on the feedback received. They serve as a starting point for institutions seeking to enhance their digital education strategy and make wise digital infrastructure investments. The guidelines could be further refined and tested as part of a national deliberative process.

## Key concepts and definitions

The two key concepts used in this report are “**digital readiness**” and “**digital maturity**”. Both terms have been defined in various ways by different actors and are often used in policy discourse and documents without any definition at all. For the purposes of this project, the terms are defined as follows:

- “Digital readiness” is used to refer to the capacity at the **system level** to support digitalisation effectively.
- “Digital maturity” is used to refer to the extent of development of digitalisation at the **organisation level** (i.e. individual higher education institutions).

**Digital readiness** is a concept linking policies that impact digitalisation in higher education institutions with the wider extent of digitalisation in Croatia. It can be thought of as the extent to which the Croatian context, policies and practices (for example, national and central digitalisation policies, and the digital skills of the population) are aligned to support the development of digitalisation within the higher education system.

The concept of **digital maturity** of educational organisations is becoming embedded in Croatian national policy discourse. Digital maturity is multi-dimensional, and organisations may be at different levels of development within each dimension. In general, digital maturity exists on a continuum; organisations with greater levels of resources; competences; and strategic leadership necessary to plan and execute effective digital transitions can be considered to have higher levels of digital maturity.

Previous efforts to enhance digital maturity in the Croatian education system have mainly focused on schools. The successful pilot and rollout of the “e-Schools” project has supported many schools in increasing their digital maturity. Its success provides inspiration for a similar initiative at the higher education level.

In this report, the concepts of “online”, “blended”, and “hybrid” education are also defined and explored. However, as higher education programme structures and delivery methods continue to evolve, it becomes increasingly challenging to assign distinct labels to higher education offerings. A more realistic approach is to classify higher education programmes within a two-dimensional framework, considering both the extent of digital tool usage and the proportion of the programme delivered through online channels.

## Structure of this report

The chapters of this report present the outputs of each of the project activities described above.

**Chapter 2** provides an overview of the Croatian higher education system, including its main features, trends in learner enrolment and outcomes, and policy context. It then provides an assessment of digital readiness as it relates to the higher education system in Croatia.

**Chapter 3** proposes a framework for the assessment of digital maturity in Croatia’s higher education institutions. It provides both a quantitative and qualitative assessment of each element, based on data from a survey of Croatian higher education institutions, and interviews with institution leaders, staff and students.

**Chapter 4** contains a review of national and transnational standards proposed or adopted across OECD and EU countries to assure the quality of digital education. It analyses the different options available to public authorities to support improvements in the quality of digital higher education. The chapter also offers principles for institutions to consider when creating strategies to improve digital education quality and provides recommendations for Croatian public authorities to consider during future policy discussions.

**Chapter 5** proposes general recommendations for maximising the benefits of investments in digital infrastructure within the Croatian higher education system. It categorises digital infrastructure into various types, examining each individually and providing tailored advice for each category.

**Annex A** contains draft guidelines for Croatian higher education institutions on developing a strategy for digital education.

**Annex B** contains guidelines for Croatian higher education institutions on developing investments in digital infrastructure.

**Annex C** contains agendas of the main stakeholder events that took place during the project.



# 2 Digital readiness in Croatia

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This chapter provides an overview of the Croatian higher education system, including its main features, trends in learner enrolment and outcomes, and policy context. It then provides an assessment of digital readiness as it relates to the higher education system in Croatia, based on an examination of Croatia's position in comparative indices of digitalisation, and a review of national policies, priorities and organisations supporting digitalisation in the higher education system.

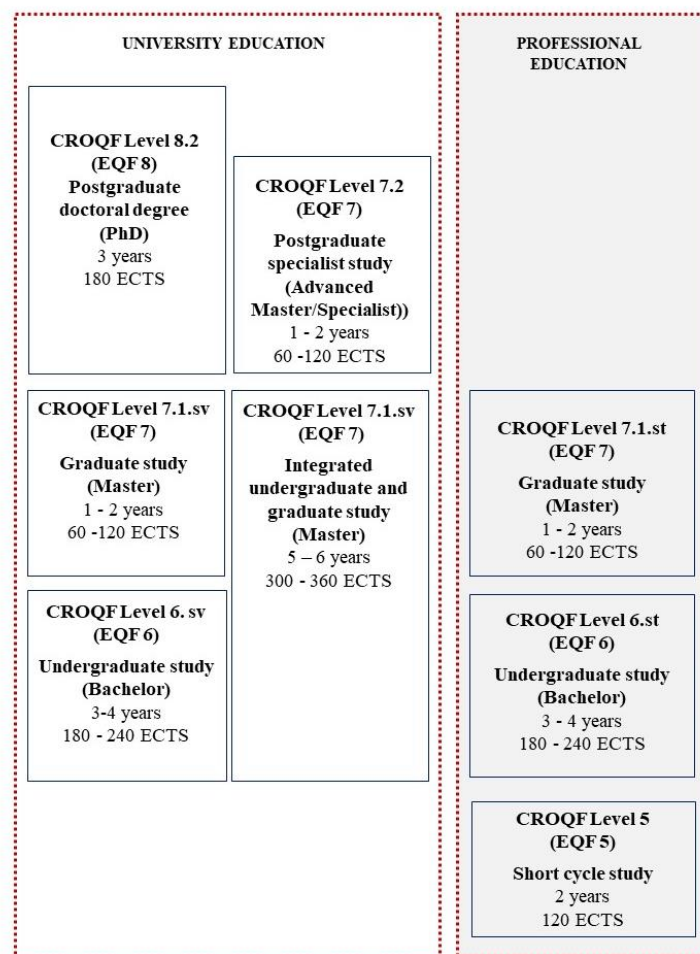
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## Overview of the Croatian higher education system

Croatia has undergone significant political and economic changes since the country's declaration of independence in the 1990s, including in its higher education system. In recent years the country has worked to modernise its universities, improve the quality of education and research, and increase international co-operation. Today, Croatia has a binary system of higher education comprising universities and professionally oriented institutions. In total, the system includes more than one hundred higher education institutions with the status of legal entities (Agency for Science and Higher Education, 2022<sup>[1]</sup>): 12 universities (*sveučilišta*) (9 public and 3 private), 71 faculties, departments and art academics which are part of universities, 18 polytechnics (*veleučilišta*) (12 public and 6 private), and 18 colleges (*visoke škole*) (2 public and 16 private).

Academic programmes up to the doctoral level are based on the Bologna three-cycle system and are offered at universities and their components. Professional studies are delivered at polytechnics and colleges at undergraduate and graduate level (Figure 2.1). While polytechnics implement professional study programmes in at least three fields, colleges provide specialised professional study programmes in fewer fields and are thematically focused – for example on professional education for the health sector or police.

**Figure 2.1. Structure of the higher education system in Croatia**



Source: Provided to the OECD team by the Croatian Ministry of Science and Education.

The apparently large number of higher education institutions compared to population size is explained by the fact that the four largest universities (University of Zagreb, University of Split, University of Rijeka and University of Osijek) are non-integrated, meaning that their constituent faculties, departments and academies are distinct legal entities maintaining their own administration, professional staff and campus, and enjoy substantial financial and administrative autonomy (OECD, 2019<sup>[2]</sup>). The remaining universities are integrated: steering and governance of the whole institution is led by a single university-wide rectorate and senate, and discrete departments within the university are not separate legal entities. This latter organisational model is by far the more common in Europe.

Enrolment in higher education is heavily concentrated both in the largest institutions, and in Zagreb. The University of Zagreb is the largest university in Croatia, enrolling about 40% of the country's students. It has more than three times as many students as the second largest university (the University of Split). (Agency for Science and Higher Education, 2021<sup>[3]</sup>). Moreover, most of the private institutions are in Zagreb. In total, higher education institutions located in Zagreb together enrolled more than 82 000 students in 2019/20 (51% of the total number of students enrolled in the country).

### ***Trends in learner enrolment and outcomes***

In 2019/20, more than 161 000 students were enrolled in institutions of higher education in the Republic of Croatia (Table 2.1). The vast majority (about 90% in 2020) study at public institutions, and students are primarily enrolled at universities (81%) rather than other categories of institution (15% at polytechnics and 4% at colleges). Croatia also has a notably high share of students studying part-time. In 2019, 30% of all of Croatia's students enrolled in tertiary education were studying part-time. The EU average for the same year was 15% (Eurostat, n.d.<sup>[4]</sup>).

**Table 2.1. Number of students in each type of institution (2019/20)**

Type of institutions	2019/20
Universities	<b>131 526</b>
Public universities	128 132
Private universities	3 394
Polytechnics	<b>23 496</b>
Public polytechnics	17 276
Private polytechnics	6 220
Colleges	<b>6 605</b>
Public colleges	1 231
Private colleges	5 374
<b>Total</b>	<b>161 627</b>

Source: Agency for Science and Higher Education (2021<sup>[3]</sup>), Higher education institutions in the Republic of Croatia, <https://www.ASHE.hr/en/higher-education/higher-education-institutions-in-the-republic-of-croatia>.

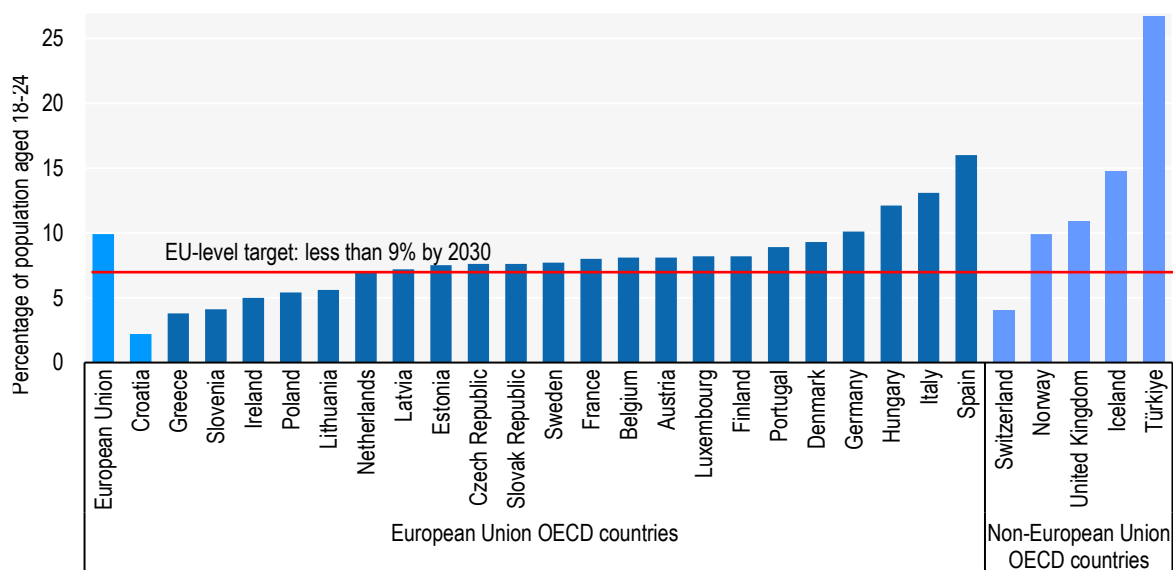
In recent decades, Croatia has succeeded in widening access to higher education, allowing a greater proportion of the population to acquire tertiary qualifications. There was a particularly strong period of enrolment growth following Croatia's declaration of independence in 1991. Higher education institutions saw an 82% increase in students from the 1990s to 2005 (Babić, Matković and Šošić, 2007<sup>[5]</sup>). By 2020, one-quarter of the population aged 25-64 had a tertiary education qualification.

Eurostat data shows that in 2020, Croatia was ranked as having the lowest proportion of early leavers from school and training in the EU, at 2.2% (Figure 2.2). This is an improvement from a rate of 5.0% in 2011 (Eurostat, 2021<sup>[6]</sup>), and indicates that Croatia continues to increase the proportion of its young people eligible to proceed to tertiary education.

Increasing the supply of tertiary graduates is an important policy goal for Croatia. Overall tertiary education attainment in Croatia in 2020 for adults aged 30-34 remains below the EU average (34.7.1% vs. EU-27 average of 41.0%) and fell short of the 2020 national target of 40% for this benchmark (Eurostat, 2021<sup>[7]</sup>). Enrolment in higher education has also tapered off in recent years. In 2013/14 166 000 students were enrolled across all types of higher education providers, while just under 162 000 were enrolled in 2019/20 (Agency for Science and Higher Education, 2021<sup>[3]</sup>).

For most of the first decade of the 2000s Croatia was experiencing net positive immigration. However, following accession to the European Union there was a rise in emigration, (Draženić, Kunovac and Pripuzić, 2018<sup>[8]</sup>) and emigration now outpaces immigration. The sharpest loss began in 2013, after accession to the EU, and peaked in 2017 (Eurostat, 2021<sup>[9]</sup>). Recent figures from the Croatia Bureau of Statistics indicate that the negative net migration pattern is continuing. In total, 34 046 people emigrated in 2020, with most re-settling in Germany (Croatian Bureau of Statistics, 2021<sup>[10]</sup>)<sup>1</sup>. The majority of emigrants are of prime working age and the average age of emigrants has been falling, reaching 33.6 years old in 2016 (Eurydice, 2021<sup>[11]</sup>; Draženić, Kunovac and Pripuzić, 2018<sup>[8]</sup>).

**Figure 2.2. Early leavers from education and training in selected EU and OECD countries, 2020**




Source: Eurostat (2021<sup>[6]</sup>); Early leavers from education and training, 2020.

Data for the United Kingdom refer to 2019 instead of 2020. The European Union average refers to 27 countries (European Union as of 2020)

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Early leavers from education and training](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Early_leavers_from_education_and_training).

Original dataset: <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>.

StatLink  <https://stat.link/vjkitm>

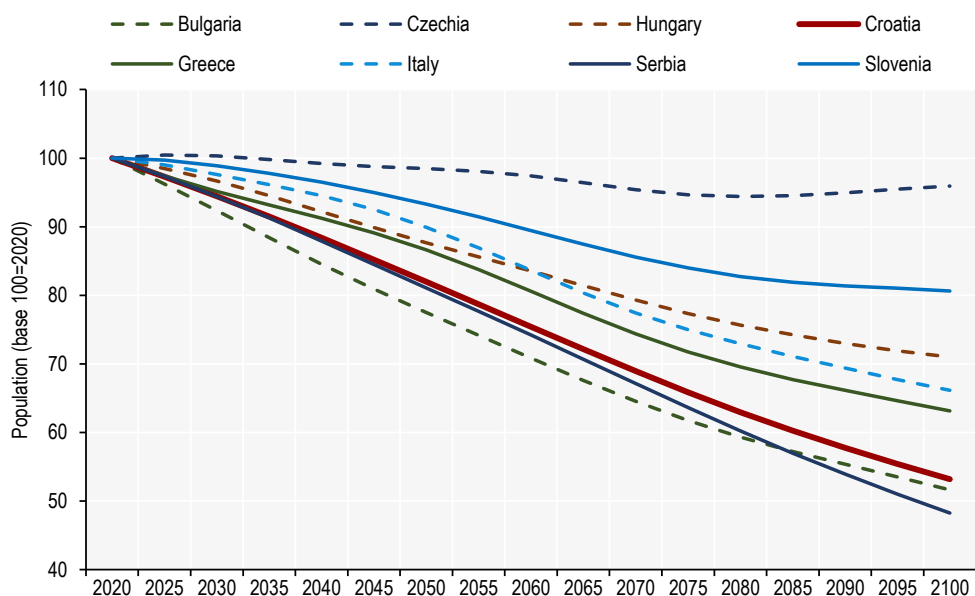
Declining tertiary enrolment numbers, negative net migration, and decreasing enrolment figures in secondary programmes foreshadow a likely decline in graduates after 2025 if current trends continue (Matković and Marčelić, 2020<sup>[12]</sup>). Alongside the high levels of migration out of Croatia, declining birth rates and longer life expectancies also contribute to population decline and a rapidly ageing population. Croatia's population currently stands at 4.1 million people. According to the United Nation's "World Population Perspectives" the country will continue to see a decreasing population, reaching a projected 3.877 million by 2030, 3.365 million by 2050 and 2.183 million by the year 2100 (United Nations - Department of




Economic and Social Affairs, 2019<sup>[13]</sup>). Thus, given its current trajectory, Croatia is projected to lose more than 15% of its population by 2050 (Figure 2.3).

Internationalisation is one means by which countries may seek to maintain vibrant higher education systems in the face of demographic decline. There were approximately 5 700 international students in 2019 (about 3% of all Croatian students), a share largely below the EU average and other European countries, including many of its neighbouring states (Eurostat, 2021<sup>[9]</sup>). Croatia also has one of the lowest proportions of international doctoral students across European countries. While the COVID-19 pandemic disrupted international student flows, the popularity of Croatian higher education institutions among students from abroad is growing. This is driven in part by relatively low tuition fees and cost of living. The Croatian government also makes scholarships available to international students through bilateral programmes, while European structural funds and support programmes such as Erasmus provide increasing possibilities for student mobility (Rončević, 2020<sup>[14]</sup>).

**Figure 2.3. Population projection for Croatia and selected European countries (2020-2100)**



Source: United Nations - Department of Economic and Social Affairs (2019<sup>[13]</sup>). World Population Prospects 2019, <https://population.un.org/wpp/DataQuery/>.

StatLink  <https://stat.link/5czln2>

Adult education participation rates in Croatia are currently amongst the lowest in the EU. Croatia's participation rate in 2020 was just 3.2%, compared with the European Union average of 9.2% (Figure 2.4). Financial barriers, relevance and perceived quality of education or training provided may all be obstacles to participation in lifelong learning (OECD, 2020<sup>[15]</sup>). A 2017 survey for the Croatian Agency for Vocational Education and Training found that 30% of respondents cited cost as a reason for their lack of participation in adult education (Vučić, 2017<sup>[16]</sup>).

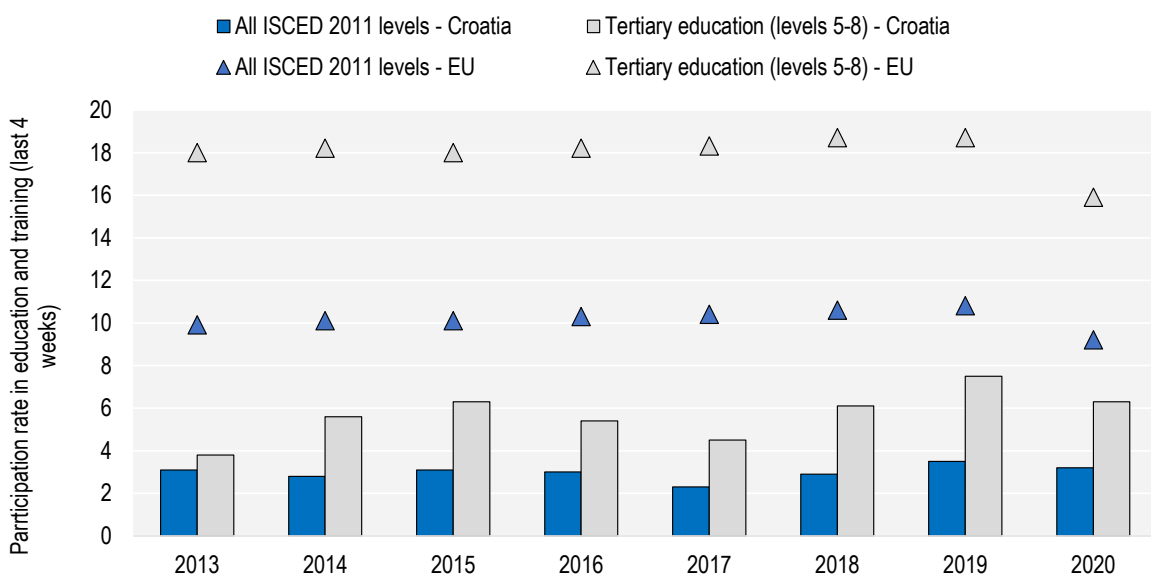
Although participation in adult education is low, Croatian adults show a high interest in learning according to some measures. The 2016 Adult Education Survey found that 91.9% of Croatian adults (aged 25-64) participated in informal learning, mainly through printed materials (45.5%), computers (60.3%), or television, radio and video (51.3%) (Eurostat, 2021<sup>[17]</sup>). This share is considerably higher than the EU-27

average rate of participation (59.5%) and may reveal a dormant demand for adult education programmes in higher education.


Croatia also faces challenges with the integration of young graduates into its labour market. The percentage of young people not in employment, education or training (NEET) in 2020 was slightly above the European Union average (12.2% v. 11.1%). It has been suggested that the very generalised secondary system, a high drop-out rate and prolongation of higher education in Croatia account for the relatively high unemployment rate among the NEET population (Tomić et al., 2019<sup>[18]</sup>). A 2018 study also noted a slow school-to-work transition in Croatia; many individuals that have completed (or dropped out of) education are inactive for months after leaving school (Tomić, Botrić and Žilić, 2018<sup>[19]</sup>).

**Figure 2.4. Participation rate of adults aged 25-64 in education and training (2021)**

Participation within the previous 4 weeks, Croatia and EU average



Source: Eurostat (2021<sup>[20]</sup>), Participation rate in education and training (last 4 weeks) by educational attainment, [https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=trng\\_lfse\\_03&lang=en](https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=trng_lfse_03&lang=en).

StatLink  <https://stat.link/yf6ecx>

Another highly visible trend in Croatia, as in much of Europe, is the gap in tertiary education attainment between cities, towns and suburbs, and rural areas. Croatia's share of adults who have attained tertiary education aged 30-34 in rural areas, towns & suburbs and cities was 23.1%; 31.8% and 51.9%, respectively. While the attainment gap between rural areas and cities in 2012 was 18.0%, it has since expanded to 28.8% (Eurostat, 2021<sup>[7]</sup>). Croatia thus faces a challenge familiar to many neighbouring European countries: finding a balance between ensuring widespread access to higher education across its regions and maintaining efficient resource provision in the face of changing demographic conditions.

The development of high-quality online and hybrid education programmes is one avenue that Croatia, along with other countries, is exploring to provide more flexible access to higher education that can cater for a wider variety of learner needs and circumstances. Providing remote access to learning opportunities could increase the supply of highly qualified graduates and narrow attainment gaps between regions and population groups. However, as discussed throughout this report, providing online content alone is unlikely to be sufficient to achieve these goals. Multiple complementary enabling actions are necessary to create a widely accessible and successful digitalised higher education offer.

## **Funding, governance and reforms**

Investment in higher education creates societal and economic benefits by supporting a more prepared workforce and a more educated citizenry. As in most European countries, the main funding source for public higher education in Croatia is the state, although approximately 30% of spending on tertiary education came from the private sector in 2018. Private institutions are funded from their own income streams. These sources of revenue are primarily tuition fees, although private institutions may qualify for targeted subsidies from the state budget for special projects of national interest, or if they fulfil a demand not met through the provision of public education and their offer complies with criteria set by public authorities (Eurydice, 2021<sup>[21]</sup>).

Budgetary funding agreements between the state and public higher education institutions are based on an annual negotiation process. Capacity, cost of study programmes, and quality assessment are all considerations in the funding allocation model for public institutions. An increasingly important source of financing is provided according to contractual agreements between the Ministry of Science and Education and higher education institutions, known nationally as “programme funding” (Ministry of Science and Education, 2021<sup>[22]</sup>). The European Commission reported that in 2020 higher education institutions received a 20% increase in funding awarded through performance contracts, compared to the previous year (European Commission, 2020<sup>[23]</sup>). It is likely that programme funding will play an even more prominent role in the new funding model foreseen in Croatia’s National Programme for Recovery and Resilience 2021-2026, part of its plans for the modernisation of the higher education system (see Box 2.1)

The global financial crisis of the late 2000s placed governments under severe financial pressure, with public funding to the higher education sector often reduced as a result. Croatian higher education institutions faced a systemwide 10% reduction in funding between 2008 and 2012. However, renewed investment in public higher education allowed Croatia to begin the process of reversing these losses and reducing its funding gap, returning funding to pre-recession levels in 2017. Since 2018 funding has increased at rates higher than economic growth rates. More recently, demographics have shifted and enrolment of full-time students in public institutions has trended downward, easing pressure on the system (European University Association, 2021<sup>[24]</sup>).

Successful implementation of any digitalisation strategy or action plan requires governance conducive to the effective deployment of digital technologies, aligned with a clear and shared vision for optimal integration and uptake. Croatia’s *Science and Higher Education Act (2003)*, last amended in 2022, guarantees academic freedom and organisational autonomy for its public universities (European Commission, 2021<sup>[25]</sup>). Integrated universities have centralised management, where decision making is led by a rector and senate. Universities following a non-integrated structure have faculties and academies that are recognised legal entities. Each autonomous faculty maintains its own professional staff and administration and is self-governed on matters of finance and administration (OECD, 2019<sup>[2]</sup>). Polytechnics and colleges are governed by deans, assisted by vice-deans. Institutional representative bodies also play a prominent role in collaboration and negotiation with national authorities. Sectoral representation is carried out by the Council of Polytechnics and Colleges of the Republic of Croatia (VVIVŠ) and the Croatian Rector’s Conference, which consists of all public university rectors.

Despite the strong focus on independence of individual faculties overall, Croatian universities are less autonomous on average in some respects than universities in other European countries. According to the European University Association (EUA) autonomy scorecard<sup>2</sup> Croatia ranks lower in autonomy on several indicators and lowest in staffing autonomy. From a field of 29 countries, Croatia ranked 18<sup>th</sup> in terms of organisational autonomy, 15<sup>th</sup> in financial autonomy, 21<sup>st</sup> in academic autonomy (European University Association, 2021<sup>[26]</sup>).

Previous OECD analysis has identified the need to balance between ensuring the beneficial impacts of autonomy of Croatian higher education institutions, on one hand, and mitigating the strategic co-ordination

and administrative challenges that can arise when defining individual faculties and academies as independent legal entities on the other (OECD, 2008<sup>[27]</sup>; OECD, 2019<sup>[2]</sup>). Challenges encountered at non-integrated universities may include limited steering power available for overall leadership, limited co-ordination of strategy, and limited ability to benefit from economies of scale at the university level.

The current governance structure of Croatian universities also creates management inefficiencies from the perspective of the national government, which must interact with more than 90 separate public entities when planning operating budgets, quality assurance procedures and strategies. This number is far higher than in many countries with similar sized population (for example, Denmark, Ireland, New Zealand or Norway). Previous efforts to negotiate reforms in order to strengthen university-level governance at non-integrated universities were met with strong resistance, and the underlying arrangements persist today (OECD, 2014<sup>[28]</sup>).

Quality assurance for higher education institutions is the responsibility of the institutions themselves, the Agency for Science and Higher Education (ASHE), and the Ministry of Science and Education. A National Council for Science and Higher Education (NVZVOTR) addresses strategic issues in higher education and has traditionally played a strong role in defining quality criteria for the system, including criteria for accreditation of programmes, appointing and evaluating teaching personnel, and delivery of online learning. The ASHE is responsible for the application of national and international standards, for the formation and reaccreditation of higher education institutions, and the reaccreditation of study programmes, while university senates have responsibility for the initiation of individual study programmes. ASHE also plays a wider role in the system, managing programme application and admission processes, and providing analytical and statistical reports drawing on the wealth of available data generated by their activities.

Croatia is steadily reforming and modernising many policies and processes relevant to higher education (Box 2.1).

### Box 2.1. Recent and upcoming national reforms impacting higher education in Croatia.

Croatia has embarked on an ambitious reform agenda in recent years, targeting its entire education system including higher education. One of the priorities of the current National Reform Programme is to improve the education and training system to make it more relevant to labour market needs, including higher education and adult education. In July 2021 a new Adult Education Act was adopted by the Croatian Government. The Act ensures the quality of adult education programmes and institutions, monitoring of the adult education system and recognises unofficial and informal acquired competencies and skills in the CROQF. Other planned measures include the definition and entry of qualification and occupational standards to the Croatian National Qualifications Framework (CROQF).

In 2019, Croatia released a new National Plan for the Social Dimension of Higher Education 2019-2021. Its aim is to improve data collection processes related to higher education equity issues, improve student guidance and linkages with lower levels of education, improve student financial support, counselling services and equity of programme completion, and introduce standards relating to the social dimension of higher education into the Croatian quality assurance system.

The Law on Scientific Activities and Higher Education aims to encourage better competitiveness among public scientific organisations and public universities, ensure an incentivised system of financing public scientific organisations and public universities, increase the quality of study programs, incentivise scientific mobility and introduce accountability principles in science and higher education. The Law was revised in late 2022.

Croatia's National Plan for Recovery and Resilience (NPRR) 2021-2026 encompasses several other higher education reforms. A model for reorganisation of higher education institutions and scientific

institutes has been developed by independent external experts and adopted by the Ministry. The NPRR envisages that at least six reorganisations of higher education institutions and scientific institutes will be finalized by 2025. A new funding model is also in development, based on transparent criteria and performance indicators linked to an institution's objectives. The introduction of the new funding model is expected to be implemented through programme agreements regarding research and teaching activities, with a funding period of two years. A new specific fund for investment in higher education infrastructure ("e-Universities") also began in 2022.

Other reforms aim to simplify administrative processes for new higher education providers, including a simplified mechanism for entry into the Register of Scientific Organisations, digitalisation of application and admission processes to higher education, and student support funding, and requests for academic recognition of qualifications.

Sources: Council of the European Union (2021<sup>[29]</sup>), Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Croatia, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0401>; Eurydice (2021<sup>[30]</sup>), National Reforms in Vocational Education and Training and Adult Learning, [https://eacea.ec.europa.eu/national-policies/eurydice/content/national-reforms-vocational-education-and-training-and-adult-learning-11\\_en](https://eacea.ec.europa.eu/national-policies/eurydice/content/national-reforms-vocational-education-and-training-and-adult-learning-11_en); Government of the Republic of Croatia (2020<sup>[31]</sup>), National Reform Programme 2020, <https://vlada.gov.hr/UserDocsImages/Europski%20semestar%202020/National%20reform%20programme%202020.pdf>

## Digital readiness in Croatia

As discussed in the introduction, digital readiness in higher education can be defined as the capacity at the policy level of the system to support digitalisation effectively. It is a concept recognising that effective digitalisation in higher education depends not only on the actions of individual institutions, but also on the extent to which digital technology and skills are embedded in the wider country context, and the extent to which public policy actions support institutions in their digital transformation agendas (OECD, 2021<sup>[32]</sup>).

The development of digital education occurs within the framework of the wider digital economy. Citizens regularly exposed to beneficial digital technologies and processes across economic and social sectors are more likely to build the skills required to navigate digitally enhanced education programmes successfully, whether as teachers or learners. In addition, the digital transformation of higher education institutions depends on their access to connectivity and technologies often rolled out at a national level, such as broadband and 5G connections. Therefore, a country's overall digital development serves as the foundation for the digital transformation of its education systems.

A second component of digital readiness is the extent to which the public policy framework for higher education supports and incentivises higher education institutions in embedding sound digital practices and ongoing support and training for its employees and students. Developing coherent assessments of the digital readiness of education systems is challenging for most jurisdictions, due to substantial data gaps and the fact there is only a nascent data infrastructure for monitoring digitalisation (OECD, forthcoming 2023<sup>[33]</sup>). Some insight can be gained, however, by reviewing Croatia's position in international and national indices of digital performance, and from examining elements of Croatia's national policy framework that may support digital readiness in higher education. The following sections review each of these in turn.

### ***Croatia's position in comparative national indices of digital performance***

This section reviews Croatia's performance on five existing international and national indices measuring digital performance and readiness at country level. Taken together, these measures provide a range of insights regarding various aspects of digital readiness in Croatia including connectivity, human capital, digital competitiveness, availability of digitalised services, geographic disparities in digitalisation and the existence of digital strategies and processes (Table 2.2).

**Table 2.2. International and national indices of digital performance featuring Croatia.**

Name of Digital Performance Index	Focus	Jurisdiction/publication date
Digital Economy and Society Index (DESI), based on DigComp	4 key dimensions, covering 37 indicators: 1) human capital; 2) connectivity; 3) integration of digital tech; 4) digital public services	EU countries Annual publication since 2014
Centre for the European Policy Studies' Index of Digital Readiness (IRLL)	3 primary pillars: 1) individual learning outcomes; 2) institutions and policies for digital learning; 3) availability of digital learning	27 EU member states Published in 2019
Portulans Institute - Network Readiness Index (NRI) 3 <sup>rd</sup> edition	4 key dimensions providing a composite index: 1) technology; 2) people; 3) governance; 4) impact	130 global economies Published annually since 2019 (Portulans took over the index from the World Economic Forum in 2019)
Apsolon's Analysis of Digital Readiness of Croatian Cities	5 composite factors to indicate digital readiness: 1) availability and quality of e-services; 2) unified payment systems; 3) availability of city data; 4) citizen participation in decision making; 5) communication channels	20 largest Croatian cities Annual publication since 2019
Croatian Digital Index (HDI) - Apsolon	4 key indicators: 1) state of digitalisation and digital transformation; 2) digital readiness of companies; 3) digital strategy and process; 4) impact of digital transformation on business	300 Croatian companies Published in 2021

### *Digitalisation in Economy and Society Index (DESI) 2021*

The European Union's DESI is a composite index tracking the digital performance of EU member states. The latest data were released in 2021, although it should be noted this data was collected prior to the pandemic. Among the 27 member states, Croatia ranked 19th position in 2021 (European Commission, 2021<sub>[25]</sub>). Its strongest rankings were in 5G readiness, the share of adults with above-basic digital skills, and open data initiatives (Table 2.3).

The DESI shows that Croatia's connectivity has steadily progressed in recent years. 86% of households now have fast broadband coverage, in line with the EU average of 87%. Additionally, Croatia has achieved complete 5G readiness and has created a dedicated comprehensive strategy for 5G introduction and deployment. A number of government initiatives currently underway, such as the National Plan for Broadband Development 2021-2027 (Republic of Croatia, 2021<sub>[34]</sub>), will further improve connectivity, including very high-capacity networks and connectivity in more sparsely populated regions (European Commission, 2021<sub>[35]</sub>).

Croatia's overall human capital ranking in the DESI stands at 16<sup>th</sup>. Specialists in Information and Communication Technologies (ICT) account for only 3.7% of the workforce, compared to an EU average of 4.3%. In total 60% of enterprises, including many higher education institutions, report having difficulty filling ICT roles. At the same time, although digital skills in the overall population are similar to the EU average, in 2020, Croatia had the highest percentage of youth in Europe aged 16-24 who hold basic or above-basic digital skills (Eurostat, 2020<sub>[36]</sub>). This means there is a positive outlook regarding the digital competence of younger learners accessing higher education systems.

There is a steady decline in the number of citizens in Croatia who have never accessed the Internet, although a lower-than-average share of citizens uses the internet for online courses (6% vs. 11% EU average). This result may be linked to the relatively low participation in adult education in Croatia, and the fact that (at least before the pandemic) online study was not widespread. The DESI also shows increasing integration of digital technology in the business sector. Provision of digital public services, including digital services for citizens, is expanding rapidly.

**Table 2.3. Croatia and EU scores on selected DESI indicators**

Dimension	Indicator	Croatia - DESI 2021	EU - DESI 2021
Broadband connectivity	Overall fixed broadband coverage (% households)	73%	77%
	Fast broadband (NGA) coverage (% households)	86%	87%
	Fixed very high-capacity network (VHCN) (% of households)	47%	59%
	4G Coverage (% populated areas)	99.5%	99.7%
	5G Readiness (Assigned spectrum as a % of total harmonised 5G spectrum)	100%	51%
	5G Coverage (% populated areas)	0%	14%
Human capital	At least basic digital skills (% individuals)	53%	56%
	Above basic digital skills (% individuals)	35%	31%
	ICT specialists (% individuals employed aged 15-74)	3.7%	4.3%
	ICT graduates (% graduates)	4.4%	3.9%
Digital public services	e-Government users (% of internet users)	52%	64%
	Digital public services for citizens (Score 0-100)	60	75
	Digital public services for businesses (Score 0-100)	73	84
	Open data (% maximum score)	82%	78%

Source: European Commission (2021<sub>[25]</sub>). Croatia in the Digital Economy and Society Index, <https://digital-strategy.ec.europa.eu/en/policies/desi-croatia>

### *Portulans Institute – Network Readiness Index (NRI) 2021*

The 2021 Network Readiness Index (NRI) by the Portulans Institute is one of the most comprehensive efforts to measure global digital readiness. It ranks 130 global economies by technology development and their capacity to capitalise on ICT opportunities according to four core pillars and 62 sub-indicators (Portulans Institute, 2021<sub>[37]</sub>). Croatia ranks 41<sup>st</sup> out of the 130 in the 2021 NRI (Table 2.4). This relatively high ranking was mainly driven by higher performance in ICT skills, privacy protection, ICT regulatory environment, e-Participation and adult literacy. Technology has the largest scope for improvement; Croatia was ranked 64<sup>th</sup>, with low ranking for indicators relating to investment in emerging technology and spending on computer software.

**Table 2.4. Croatia's Placement on Portulans Institute's Network Readiness Index 2021**

<b>Croatia's Network Readiness Index</b>	<b>41<sup>st</sup> (out of 130 world economies)</b>
Pillars/sub-pillars	Rank (out of 130 world economies)
Technology (overall)	64
Technology (sub-pillars)	Access: 58, Content: 39, Future Technologies: 108
People (overall)	46
People (sub-pillars)	Individuals: 29, Businesses: 39, Government: 77
Governance (overall)	37
Governance (sub-pillars)	Trust: 41, Regulation: 38, Inclusion: 38
Impact (overall)	40
Impact (sub-pillars)	Economy: 65, Quality of Life: 27, SDG Contribution: 39

Note: The Portulans Institute took over the NRI from the World Economic Forum in 2019.

Source : Portulans Institute ; <https://networkreadinessindex.org/country/croatia/>.

### *Centre for European Policy Studies (CEPS) Index of Readiness for Digital Lifelong Learning*

The CEPS Index of Readiness for Digital Lifelong Learning measures digital learning participation and outcomes, institutions and policies for digital learning, and availability of digital learning. The Croatian education system ranked positively on the CEPS Index, placing 13<sup>th</sup> in the EU. Croatia's ranking was heavily influenced by its 3<sup>rd</sup> place position in the “institutions and policies for digital learning” dimension; Croatia ranked highly in all sub-indicators in this category except governance and implementation, for which Croatia ranked 23<sup>rd</sup> in the EU.

The CEPS report concluded that governance quality can be improved in Croatia, as can digital policy implementation in its education sector. Croatia performed much lower in the other elements of the index, ranking 24<sup>th</sup> in learning participation and outcomes, and 21<sup>st</sup> in the availability of digital learning (Centre for European Policy Studies (CEPS), 2019<sub>[38]</sub>).

### *National indices of digital readiness – Apsolon*

Few national level analyses of digital readiness have been published in Croatia. Two recent examples were conducted by Apsolon, a national consultancy firm. It carried out a study in 2019 regarding the digital readiness of Croatian cities, ranking 20 cities of varying sizes by digital readiness using several criteria, including the quality of city government e-administration, availability of data to citizens and timeliness of response to their inquiries (Apsolon, 2020<sub>[39]</sub>). These criteria help measure the extent to which cities are becoming “smart” – able to apply digital intelligence, technology, and data to improve public services (including education) and quality of life for citizens (McKinsey Global Institute, 2018<sub>[40]</sub>).

Rijeka and Zagreb ranked highest in digital readiness for large cities in Croatia while Pula and Karlovac scored the best among medium-sized cities. In total, 12 out of the 20 cities analysed have increased their digital readiness in recent years, with Split, Dubrovnik and Rijeka noted as having made the greatest progress (Apsolon, 2020<sub>[39]</sub>). The degree of digital readiness of Croatian cities provides an indication of the underlying foundation of local digital readiness higher education institutions will encounter in their digitalisation efforts.

Another digitalisation-centred analysis by Apsolon was the 2018-2019 Croatian Digital Index (HDI) (Apsolon, 2019<sub>[41]</sub>). It was based on the results of an online survey of 300 varying-sized individual companies across different sectors, with a goal to capture the digital readiness of Croatian companies. The results indicated that companies in Croatia did not consider digital transformation a high priority. For



most companies (53%), digital transformation was not a top ten priority and only 15% of respondents indicated their business had a digital transformation strategy (Jurčević, Lulić and Mostarac, 2020<sup>[42]</sup>).

### ***National policies and priorities for supporting digitalisation in higher education***

Public policy can support digital transformation in education systems in several fundamental ways. While many national level digitalisation strategies tend to focus on economic growth, specific strategies for digital education can help to build a collective vision of how digital innovation should benefit education systems and learners. As of 2020, more than half of OECD countries have a written digital education strategy, while in other countries digital education is addressed as part of a broader national digital innovation strategy (van der Vlies, 2020<sup>[43]</sup>). In Europe, as of 2018, while 38 out of 50 European Higher Education Area jurisdictions had developed some sort of strategy or policy on the use of new technology in teaching and learning, only three had created one specifically for higher education. Many more had, though, mentioned new technologies in higher education within broader national strategies (Eurydice, 2018<sup>[44]</sup>).

While Croatia does not have a specific digital plan for higher education, the Ministry of Science and Education did prepare an Action Plan for the Implementation of Distance Learning (Ministry of Science and Education, 2020<sup>[45]</sup>) in response to the pandemic. Although this was primarily written to respond to emergency remote teaching needs, it was also intended to document steps that were taken, to provide a blueprint for potential future necessary transitions online. The report identified several systemic gaps and challenges that would need to be addressed in the future, including the requirement for improvements in strategic planning (organisation, assistance in implementation and management), training on implementation, equipment, and programme support.

The report specified 15 priority areas for teacher training for all levels of education (e.g. how to organise an online classroom, how to support students in an online environment, how to prepare one's own digital material, data protection and how to conduct digital assessment) and 12 areas for investment in digital infrastructure necessary to enable effective distance learning (Ministry of Science and Education, 2020<sup>[45]</sup>). Finally, the report proposed ways higher education could continue distance learning in 'normal' times: virtual classes, videoconferences, webinars, and the possibility of virtual mobility (e.g. ERASMUS+ Virtual Exchange, eTwinning).

### ***National organisations and projects supporting digitalisation in higher education***

Several national bodies support digitalisation within higher education in Croatia. The Croatian Academic and Research Network (CARNET) is the principal research and education network linking the academic, research and scientific community. It operates as an independent entity under the Ministry of Science and Education, providing ICT support to every level of education. Its three-pronged mission is to strengthen the educational community, develop advanced infrastructure and safeguard the nation's digital space. To this end, CARNET provides more than 70 services to its end-users, including several e-learning initiatives (teacher training, LMS hosting, national portal for distance learning, etc.) (Croatian Academic and Research Network (CARNET), n.d.<sup>[46]</sup>). CARNET has also overseen the implementation of e-Schools, a project to systematically improve digital maturity in Croatia's school sector (see Chapter 3).

In addition, the University Computing Centre (SRCE) was founded at the University of Zagreb in 2007 and has become a focal point for the planning, designing and support of e-infrastructure for academia and the scientific community. It plays an important role in the implementation and use of e-learning technologies by higher education students and staff, and on systems and services helping to modernise education. For instance, SRCE led the initiative on developing the Croatian Digital Academic Archives and Repository (DABAR) and is the lead architect of the Croatian Research Information System (CroRIS) and the Croatian Scientific and Educational Cloud (HR-OOZ). (Univeristy of Zagreb, 2021<sup>[47]</sup>); (Ministry of Science and Education, 2021<sup>[22]</sup>). SRCE also ensures the connection of Croatian e-services and infrastructure with pan-

European initiatives (SRCE, n.d.<sup>[48]</sup>); (EGI Federation, 2020<sup>[49]</sup>). SRCE's position as a key partner for many higher education institutions was further highlighted during the pandemic, as it provided a range of additional software and other supports to aid the transition to emergency remote instruction.

The ASHE and the National Council for Science and Higher Education also play a role in the quality assurance and enhancement of digital education. Responsibility for setting some quality criteria for the system traditionally rested with the National Council, including establishing the criteria for accreditation of fully online programmes. Following the revision of the Law of Quality Assurance of Science and Higher Education (see Chapter 4), the ASHE is now responsible for both setting the criteria for, and accrediting, fully online programmes. ASHE also often reflects on digitalisation of higher education when conducting its other mandated activities, such as the accreditation and reaccreditation of higher education institutions, and the reaccreditation of study programmes. The latest version of criteria for online learning for higher education date from 2016. Following the legislative changes in 2022, it is expected that the criteria will be reviewed in 2023.

Several ongoing national projects and policies support the development of digitalisation in Croatia's higher education system. One of the most prominent current national projects and policies supporting the ongoing digital transformation agenda for higher education is the e-Universities project, with EUR 84 million earmarked for investment in e-learning in higher education and the digitalisation of research and innovation activities in universities and research centres (European Commission, 2021<sup>[25]</sup>).

While most of the funding for e-Universities is reserved for upgrades to digital infrastructure (see Chapter 5), the project also includes several other activities to support the development of digital competence in higher education institutions. For example, the project includes a direct award of approximately EUR 6.5m for digital capacity enhancement in higher education institutions. Specifically, it will assist professors in the development and implementation of e-learning as well as digital evaluation tools, offer targeted support to stakeholders in the system, and link the Moodle-based e-Learning system used widely by higher education institutions with other information systems. A plan for learning analytics will also be included.

The e-Universities initiatives are additional to wider investments in access to connectivity, foreseen under the National Plan for the Development of Broadband Access. One of its main priorities is the development of a very large capacity network (VHCN) supporting broadband access, with speeds of at least 1 Gbit/s for public purposes, including higher education and scientific institutions. Other objectives of the national plan include introducing 5G networks in urban and rural areas to ensure end-users all have access to high-quality network services.

## Conclusion

Overall, evidence on Croatia's performance in a range of digitalisation and digital readiness indices shows that Croatia continues to rank behind its European Union counterparts in many aspects of digitalisation. The evidence points to a low to average level of digital readiness of the higher education system in Croatia. While basic digital skills among the population in Croatia are, in general, similar to or higher than the EU average, participation and interaction with digitally delivered education remains relatively weak, and availability of digital learning is lower than in many other EU countries. The indices also may signal some weaknesses in governance of digitalisation within the system and challenges with prioritising strategic focus on, and investment in, emerging technological solutions in both government and businesses.

Croatia is rapidly catching up with many aspects of digitalisation, including connectivity and establishing a favourable regulatory environment for digitalisation in the wider economy. It has achieved success in several areas that will support progress towards digital readiness and maturity in its higher education sector. The Ministry of Science and Education was able to react quickly during the pandemic, drafting an

emergency action plan and pivoting to online learning at all levels of education. At institution level, Croatia has a robust foundation for digitalisation efforts due to the e-Schools project. Moreover, several national plans and policies for investing in digitalisation are in train, including investment directly in improving the digital maturity of higher education institutions. The existence of strong supports for institutions, in the form of CARNET and SRCE are also fundamental elements of driving forward digital readiness in Croatia.

On the other hand, more efforts may be needed to encourage take-up of digitally delivered teaching and learning in the higher education system. Although comparative data on the take-up of online learning across countries is lacking, there are reasons to conclude that participation in online learning is particularly low in Croatia. Overall participation in adult education is low, and national criteria for the evaluation of fully online study programmes state that students enrolled in these programmes cannot be considered as full-time students, limiting available supports. The absence of strategic policies to support distance learning, infrastructural challenges, and a general perception of online education as being of low quality have been identified as causes of low take-up (Bagarić, Plantak and Škof, 2021<sup>[50]</sup>). Moreover, there is a shortage of information on the digital competence of higher education teachers in Croatia (Müller and Varga, 2020<sup>[51]</sup>).

In conclusion, while Croatia is making strides in enhancing its digital readiness, more policy action is likely to be needed in the coming years if Croatia is to continue to improve the public perception, accessibility, and take-up of online and hybrid education options.

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## Notes

<sup>1</sup> Note that these figures only include persons who have voluntarily registered the change in residency with Croatian public authorities and thus may be under-reported.

<sup>2</sup> The scorecard was launched in 2011. It is based on 30 indicators across four dimensions of autonomy: organisational, financial, staffing, and academic. Data from higher education systems is gathered from a survey of national rectors' conferences via questionnaires and follow-up interviews and subsequently weighted and scored by the EUA.



# **3** Digital maturity in Croatian higher education institutions

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This chapter proposes a framework for the assessment of digital maturity in Croatia's higher education institutions, comprising three main elements – digital leadership, digital infrastructure and digital competence and culture. It then provides quantitative and qualitative assessment of each element, based on data from a survey of Croatian higher education institutions and interviews with institution leaders, staff and students.

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## Introduction

The concept of digital maturity, as used in this project, refers to the extent of development of digitalisation at the organisation level – in this case, individual higher education institutions. Evaluating the digital maturity of an organisation is a complex, multidimensional process. Digital maturity may be influenced by both external and internal factors, including digital readiness in the system in which the institution operates and its internal capacity for effective integration of digital technologies.

Much of the previous development of digital maturity frameworks was carried out with business organisations in mind or was focused on the development of specific organisation-wide tools such as management information systems (Proença and Borbinha, 2018<sup>[1]</sup>). Still, many frameworks, whether for commercial organisations or higher education institutions, focus on similar thematic areas, encompassing both organisation-level and individual-level factors that might drive or enable digital transformation. These factors include strategic leadership, governance, technology adoption, culture and expertise. (Ifenthaler and Egloffstein, 2020<sup>[2]</sup>; Rossman, 2018<sup>[3]</sup>).

Digital maturity measurement frameworks have been proposed specifically for education organisations, although there have been few attempts to measure digital maturity of higher education institutions systematically. Croatia is one of the more experienced jurisdictions with respect to attempting to measure digital maturity directly, having developed a framework for evaluating schools' digital maturity in its e-Schools project. The project entailed triangulating internal and external school evaluations to arrive at a "starting level" of maturity for each school, and then aimed for each school to advance by at least one level (Box 3.1). Many of the indicators used in the e-Schools Digital Maturity Framework found to be significant predictors of digital maturity are also applicable to higher education institutions (Table 3.1).

**Table 3.1. Significant predictors of digital maturity in the e-Schools framework**

Domain	Indicators
Planning, Management and Leadership	Plan and programme of school development from ICT perspective (PML2)
	Managing the integration of ICT in learning and teaching (PML3)
	Learning analytics (PML5)
	Regulated access to ICT resources (PML6)
	Use of ICT in teaching students with special education needs (PML7)
ICT in Learning and Teaching	Awareness (ICTTL1)
	Use (ICTTL 3)
	Digital content (ICTTL4)
Development of Digital Competence	Awareness and participation (DDC1)
	Planning (DDC2)
	Purpose of professional training (DDC3)
	Self-confidence in use of ICT (DDC4)
	Informal learning (DDC7)
ICT Culture	Access to ICT resources by educational staff (teachers) (ICTC1)
	Access to ICT resources by students (ICTC2)
	Communication, information, and reporting (ICTC4)
	Projects (ICTC7)
ICT Infrastructure	Planning and procurement (ICT11)
	Network infrastructure (ICT12)
	ICT equipment in the school (ICT13)
	ICT equipment for educational staff (teachers) (ICT14)

Notes: The instrument evaluation focused on the digital maturity level of 151 primary and secondary schools in Croatia. 21 significant indicators, found to directly influence the maturity level of a school, are included above.

Source: Balaban, Redjep and Calopa (2018<sup>[4]</sup>) The Analysis of Digital Maturity of Schools in Croatia; <https://doi.org/10.3991/ijet.v13i06.7844>.

### Box 3.1. The e-Schools project in Croatia

At the school level, the e-Schools programme is Croatia's flagship example of bolstering digital maturity. Launched over two phases in 2015 and 2018, the programme equipped school campuses with reliable and modern infrastructure, delivered up-to-date ICT devices to classrooms for teaching and learning, and provided e-content and digital platforms for schools, as well as training and support for teachers. The project was co-ordinated by CARNET and funded by European Structural Funds (ESF), European Regional Development Funds (ERDF) and the state.

Digitally mature schools were defined as schools where ICT integration was high and a systematic approach is taken towards ICT in school management and educational processes. Teachers in digitally mature schools were better able to develop their own digital content, to use technology effectively to enhance teaching, and support independent learning and critical thinking skills in their students. Evidence shows that digital education initiatives have more success with teachers' buy-in, participation, engagement and eventually ownership of the process (Conrads et al., 2017<sup>[5]</sup>).

Measurement was carried out using a Framework for Digital Maturity of Schools (FDMS), designed to identify the level of digital maturity of schools in Croatia, their progress towards integration and efficient use of ICT and areas for improvement. Its creators reviewed 15 existing maturity frameworks and selected the European Framework for Digitally Competent Educational Organisations (DigCompOrg) and eLearning Roadmaps as the foundation for the construction of the FDMS rubric. The rubric, a "maturity matrix", has five evaluation domains: 1. Planning, Management and Leadership; 2. ICT in Learning and Teaching; 3. Development of Digital Competence; 4. ICT Culture; 5. ICT Infrastructure, with 38 individual elements assessed across five maturity levels (basic, initial, e-enabled, e-Confident and e-Mature).

The matrix, along with the self-evaluation responses and software, evaluated the digital maturity level of 151 primary and secondary schools in Croatia. To triangulate results, an external evaluation was also conducted. This revealed a visible gap between the self-evaluation and external findings, with more schools identifying themselves as further along in their digital maturity level (e.g. e-Confident or e-enabled) than was found in the external evaluation. The largest deviation was in Domain 1, Planning, Management and Leadership. The adaptation of strategic documents and upgrading schools' documents with ICT strategy is considered to positively affect digital maturity.

Source: Balaban, Redjep and Calopa (2018<sup>[4]</sup>), Analysis of Digital Maturity of Schools in Croatia; <https://doi.org/10.3991/ijet.v13i06.7844>.

The e-Schools approach to evaluating digital maturity may not translate directly to use in higher education institutions for several reasons. Firstly, the e-Schools framework was designed for schools and teachers, and as a result many of its indicators are heavily focused on the application of ICT in teaching. Higher education institutions have a much wider mission than schools, encompassing not only teaching but also research, innovative and entrepreneurial activity, the provision of wraparound services to students, and serving the wider population and local community. From the perspective of higher education institutions, digital maturity frameworks need to permit holistic evaluation and reflection across all their activities.

Higher education institutions also have more complicated leadership and organisational structures than schools, with roles and responsibilities for digitalisation spread across individual faculties and departments. As a result, self-evaluation (and improvement) of digital maturity in higher education institutions is likely to require much greater levels of co-ordination among personnel than it does in schools. Moreover, unlike with e-Schools, most higher education institutions will not enter a maturity evaluation process as "digital beginners". Many higher education institutions in Croatia have a long history of independent development of digitalisation strategies and processes to increase digital maturity, tailored to their specific needs and circumstances (Box 3.2).

Finally, it is difficult to apply the concept of “levels” of maturity coherently across an entire higher education institution, given the wide range of staff, and student categories with varied digital competence, while the extent of leadership and infrastructure may vary across departments and activities. One-size-fits-all approaches to measuring digital maturity are unlikely to bear similar fruit in higher education institutions as they do in schools. For example, subject-specific e-content repositories would have limited utility for higher education institutions compared with schools, and the development of standardised infrastructure allocation models that cover diverse institution circumstances is more challenging than for schools.

### Box 3.2. Examples of previous higher education institution strategies for digitalisation in Croatia

A 2016 survey administrated to 119 Croatian higher education institutions revealed that 84% of survey respondents did not have a dedicated fund for applying e-learning and developing e-learning resources.

At the same time, many higher education institutions across Croatia have developed initiatives aimed at improving various aspects of digital maturity.

The University of Zagreb introduced a strategic initiative (the *Zagreb E-learning strategy for 2007-2010*) to strengthen e-learning. The university e-learning committee evaluated the program in 2012 and subsequently incorporated it into the university strategy for teaching and learning 2014-25. The initiative establishes a National Centre for e-Learning in Higher Education, a university committee for E-learning, and the University Office for E-learning (Bralić, 2016<sup>[6]</sup>; University of Zagreb, 2021<sup>[7]</sup>).

The University of Rijeka implemented a multi-year strategy, *Strategy for the introduction of e-learning*, from 2006-10 and 2011-15 and founded a centre for e-learning in 2009. Wave 1 of the strategy built a foundation for increasing delivery of e-learning content and supported teachers in moving from traditional to active learning methodologies. Wave 2 continued to build on high-quality e-learning, supported students in these endeavours and developed distance learning programs. The institution also created the *E-day of the UNIRI*, established annual awards for the best e-courses and provided grants for e-course development.

The University of Split also created a multi-year strategic plan to boost e-learning content in courses by 25% and to work towards a university-wide joint e-learning system. Similarly, the University of Osijek's 2011-20 plan focused primarily on building a joint information and communication system on campus.

Source: Adapted from Bralić (2016<sup>[6]</sup>), ICT and e-learning in HE in Croatia: strategies and current state, <https://www.bib.irb.hr/846915>.

One of the most detailed and comprehensive framework development processes available, specific to higher education, was carried by Durek et al (2018<sup>[8]</sup>). Based on an exhaustive review of existing frameworks, the researchers concluded that, as well as a systematic approach towards the use of technology in teaching and learning, a digital maturity framework for higher education institutions should also include other dimensions such as leadership, planning and management; quality assurance; scientific research work; technology transfer and service to society, ICT culture and ICT resources and infrastructure.

Durek et. al. provides a comprehensive set of indicators for assessing digital maturity that builds on previous frameworks in a holistic way and reflects the diverse set of activities carried out in higher education institutions (Table 3.2).

**Table 3.2. Digital Maturity Framework for Higher Education Institutions (DMFHEI) indicators**

Areas	Elements
Leadership, Planning and Management	Financial investment in the use of ICT in learning and teaching; research and development; and the business of the institution
	Strategic planning of ICT integration in the higher education institution (HEI)
	Managing the integration of ICT in learning and teaching at the HEI
	Managing the integration of ICT in scientific research at the HEI
	The planning and implementation of training for HEI employees in the field of digital competencies and ICT application
	The relationship between the HEI and state from the aspect of ICT integration
	HEI policy in ICT integration and monitoring global trends
Quality Assurance	ICT quality assurance policies
	The monitoring and periodic review of study programs from the aspect of ICT application
	Work evaluation of teaching, research, administrative and technical staff
	The continuous monitoring of the results of scientific-teaching work and progress
	Procedures for determining the needs, development, or acquisition of ICT resources and their application
	Approved procedures and follow-up of student enrolment, progress through study, and completion of studies supported by ICT
Scientific Research Work	The use of ICT in the preparation and publication of scientific papers
	ICT support in the preparation and management of scientific research work and projects
	ICT research (collaborative ICT research in the HEI)
	A system of support for researchers at the beginning of their careers in applying ICT in scientific research
	Continuous training of researchers in applying ICT in scientific research
	The networking and collaboration of researchers with ICT support
Technology Transfer and Service to Society	Collaboration with stakeholders (employers, the local community and pre-tertiary education) supported by ICT
	Applied research and professional projects supported by ICT and/or for ICT
	The networking of researchers and users of research (stakeholders) supported by ICT
Learning and Teaching	Preparation, storage and use of digital content in learning and teaching
	Innovative learning and teaching methods with ICT
	The development of teachers' digital competence
	The development of students' digital competences
	The use of learning analytics to improve learning and teaching
	Ubiquitous learning and open curricula
	Support for under-represented groups by using ICT in learning and teaching
ICT Culture	The network presence of the HEI
	Using ICT in the HEI's promotion
	The development of digital literacy and the promotion of innovativeness in ICT application with HEI employees
	The self-confidence and motivation of employees in terms of the importance of ICT application
	Providing access to and motivation of employees in terms of the importance of ICT application
	Providing access to and support in the application of ICT infrastructure
	The application of ethical standards, copyright and intellectual property in the ICT field
	The availability of ICT resources (hardware and software) for learning and teaching
ICT Resources and Infrastructure	Network infrastructures at the HEI
	Access to ICT resources for students (both in and out of the classroom)
	The digital environment and information systems available to employees and students
	The technical support and maintenance of ICT resources at the HEI
	The information security system

Source: Durek, Kadoic and Begicevic Redep (2018<sup>[9]</sup>), Assessing the digital maturity level of higher education institutions, <https://ieeexplore.ieee.org/document/8400126>.

Despite the completeness of the framework and the rigorous approach taken to its development, several important limitations arise with its application. Most of the proposed indicators cannot be measured in a structured way by extant data systems. A demanding and expensive data collection workload would be required to collect all data required for the evaluation framework. The model developers envisaged that the involvement of field experts would be necessary to collect and analyse data and make subsequent judgements about the levels of maturity (starting with ‘basic, followed by ‘initial’, ‘e-Enabled’, ‘e-Confident’ and ‘e-Mature’) indicated by each element of the framework. The selection process for field experts and how they would be funded and governed in their operations adds additional complexity to the measurement process. In addition, the model developers acknowledge that further validation of the assessment rubric would be needed (Durek, Kadoic and Begicevic Redep, 2018<sup>[8]</sup>).

Taking the considerations above into account, one can conclude that a framework for digital maturity for higher education institutions in Croatia and elsewhere needs to be more comprehensive than for schools. At the same time, the framework cannot be too prescriptive or excessively burdensome for institutions and stakeholders working with it. Considering these factors, the following section proposes a model to evaluate digital maturity in Croatian higher education institutions.

### A framework for evaluating digital maturity of higher education institutions

Recent OECD research identifies several enabling factors for supporting high-quality digitalised education. These encompass adequate infrastructure and equipment, strong leadership, a digitally competent and capable human infrastructure, and capacity for monitoring and evaluation (OECD, forthcoming<sup>[9]</sup>). Similarly, the DigiCompOrg framework for digitally competent educational organisations stresses the importance of human capacities and organisational culture, as well as access to appropriate and sufficient digital technologies. Taking these results, and various other available digital maturity approaches proposed for Croatia into account (as detailed in the previous section), Table 3.3 proposes a simple conceptual framework for digital maturity evaluation of higher education institutions, summarised also in Figure 3.1.

**Table 3.3. A conceptual framework for digital maturity evaluation of higher education institutions**

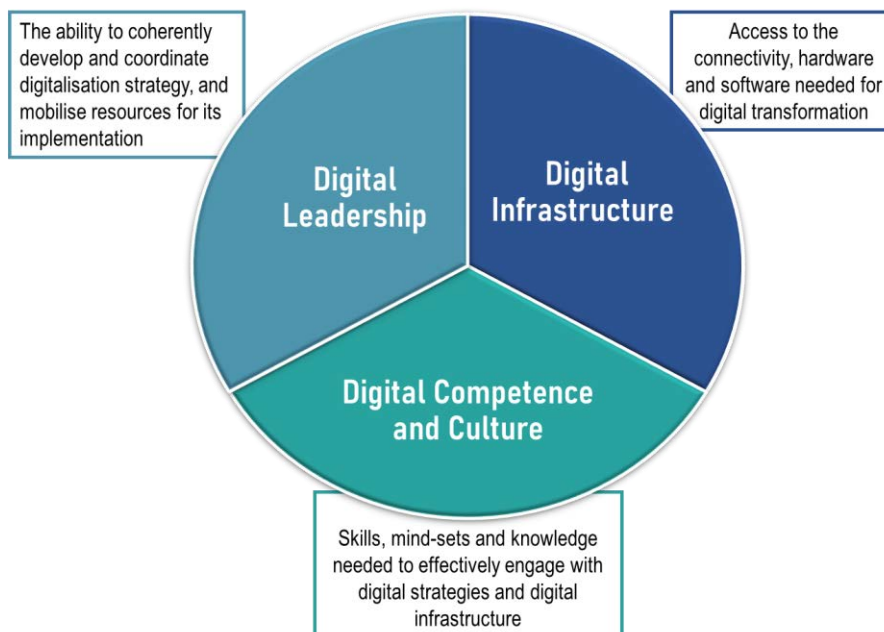
Enabling element	Definition statement
Digital leadership	The institution has a coherent and widely shared strategic vision for digital transformation at the level of the organisation and capacity to mobilise resources for its implementation. Internal activities and processes related to the enhancement of digital infrastructure, competence and culture are connected to the overall institution vision for digital transformation.
Digital infrastructure	The institution has adequate access to the connectivity, physical equipment, software, and technical support services needed to allow all activities of the institution to benefit from digital transformation.
Digital competence and culture	The institution has active internal policies and practices that support the cultivation of the skills, mind-sets and knowledge that people (academic staff and leadership, administrators, and students) need to successfully engage with and integrate digital technologies in their activities.

Source: Author’s elaboration.

The framework identifies three key enabling elements – digital leadership, digital infrastructure, and digital competence and culture. The stronger the presence of each of the enabling factors in the framework, the more likely the organisation will advance towards full digital maturity. Each of the three constructs in the proposed digital maturity framework can be measured in many ways. Specific evaluation and measurement strategies will depend on several factors, including whether the maturity framework is being

used for accountability purposes or formative assessment and development; the level of available resources for data collection and assessment, and future national and institutional goals and priorities related to digital maturity.

**Figure 3.1. A conceptual framework for digital maturity evaluation and improvement**



Source: Author's elaboration.

Trade-offs must also be made between what is ideal and what is possible – balancing the effort required for measurement with the value of the information provided. Evaluation measures for the framework should be formulated considering information that may already be available and the ease of collecting additional data. Scarce resources are best focused on measuring areas where there is the greatest uncertainty, and where the measurement is crucial to the success of an initiative.

Assessments of digital maturity using the framework can be carried out on a qualitative basis by defining specific indicators and approaches that aim to measure important attributes of each enabling element. The framework can also serve as a useful inception point for qualitative evaluation and as a basis for conversations about needed improvements (at institution or national level). The following sections apply the framework to conduct both a quantitative and qualitative evaluation of digital maturity in Croatia's higher education institutions, drawing on a digital maturity survey conducted as a joint exercise between the OECD and CARNET in February 2022, and interviews of higher education institution staff and students carried out in Croatia by the OECD team during a country visit in May 2022.

### Quantitative assessment of digital maturity in Croatian higher education institutions

As part of the activities of this project the OECD team, in collaboration with CARNET, launched a digital maturity survey of higher education institutions. The intention of the survey was to collect a baseline set of data on institution activities, internal policies and practices related to digital transformation. The CARNET-OECD survey was fielded in February 2022 and received 95 responses from public and private institutions (Table 3.4), together covering about 77% of student enrolments in Croatia in 2020/21.

**Table 3.4. Respondents to the 2022 CARNET-OECD survey, by type of institution.**

Institution type	Number of responses
University top-level (non-integrated universities)	4
Colleges	1
Faculty/Academy/Department	69
Integrated university	5
Public Polytechnic	9
Private institutions	7
Total	95

Source: CARNET-OECD survey of digital maturity of higher education institutions.

The items covered in the survey included many variables that could be used to measure the elements of digital maturity, as laid out in the framework in Figure 3.1. Table 3.5 proposes a set of ten binary indicators that can be populated from the CARNET-OECD survey data for each of the three elements of digital maturity proposed in the conceptual framework. The indicators proposed are similar to many of those appearing in other frameworks for benchmarking and measuring the extent and impact of digitalisation in education, including the Australasian Council on Open, Distance and e-Learning framework for Technology-Enhanced Teaching and Learning, the E-xcellence framework of the European Association of Distance Teaching Universities and the Commonwealth of Learning e-learning benchmarks (DIGI-HE, 2021<sub>[10]</sub>). They are, however, presented only as an example and a starting point for collaborative deliberation and potential development of national indicators of digital maturity.

**Table 3.5. Example indicators of digital maturity using the CARNET-OECD survey data**

Indicator code	Indicator name	Value assignment from CARNET-OECD survey data
<b>Digital Leadership</b>		
DL1	Institution-wide strategy or shared vision for digitalisation	1 if the institution reported the existence of either an institution-wide strategy or shared vision, 0 otherwise
DL2	Annual operational plans related to digitalisation	1 if the institution reported the existence of an operational plan, 0 otherwise
DL3	Wide ownership of the strategy	1 if the institution reported at least two of students, staff, external stakeholders included in strategy development, 0 otherwise
DL4	Diverse funding sources	1 if the institution reported at least two distinct funding sources are available for digitalisation, 0 otherwise
DL5	Specific locus of responsibility for digitalisation	1 if the institution reported a specific person or unit has an assigned responsibility for digital transformation, 0 otherwise
DL6	Recognition of the importance of leadership and management	1 if leadership was reported as one of the most important enabling factors for digitalisation, 0 otherwise
DL7	Procurement related to the overall strategic plan	1 if the institution reported digital infrastructure procurement strategy is linked to overall institution strategy, 0 otherwise
DL8	Strategy for digitalisation in teaching, learning and assessment	1 if the institution reported the existence of strategic goals for digital teaching and learning, 0 otherwise
DL9	Digital teaching and learning is considered in internal quality assurance processes	1 if the institution reported that digital teaching and learning is considered in internal QA, 0 otherwise
DL10	Central institution-wide support service available	1 if the institution reported that institution-wide support is available, 0 otherwise

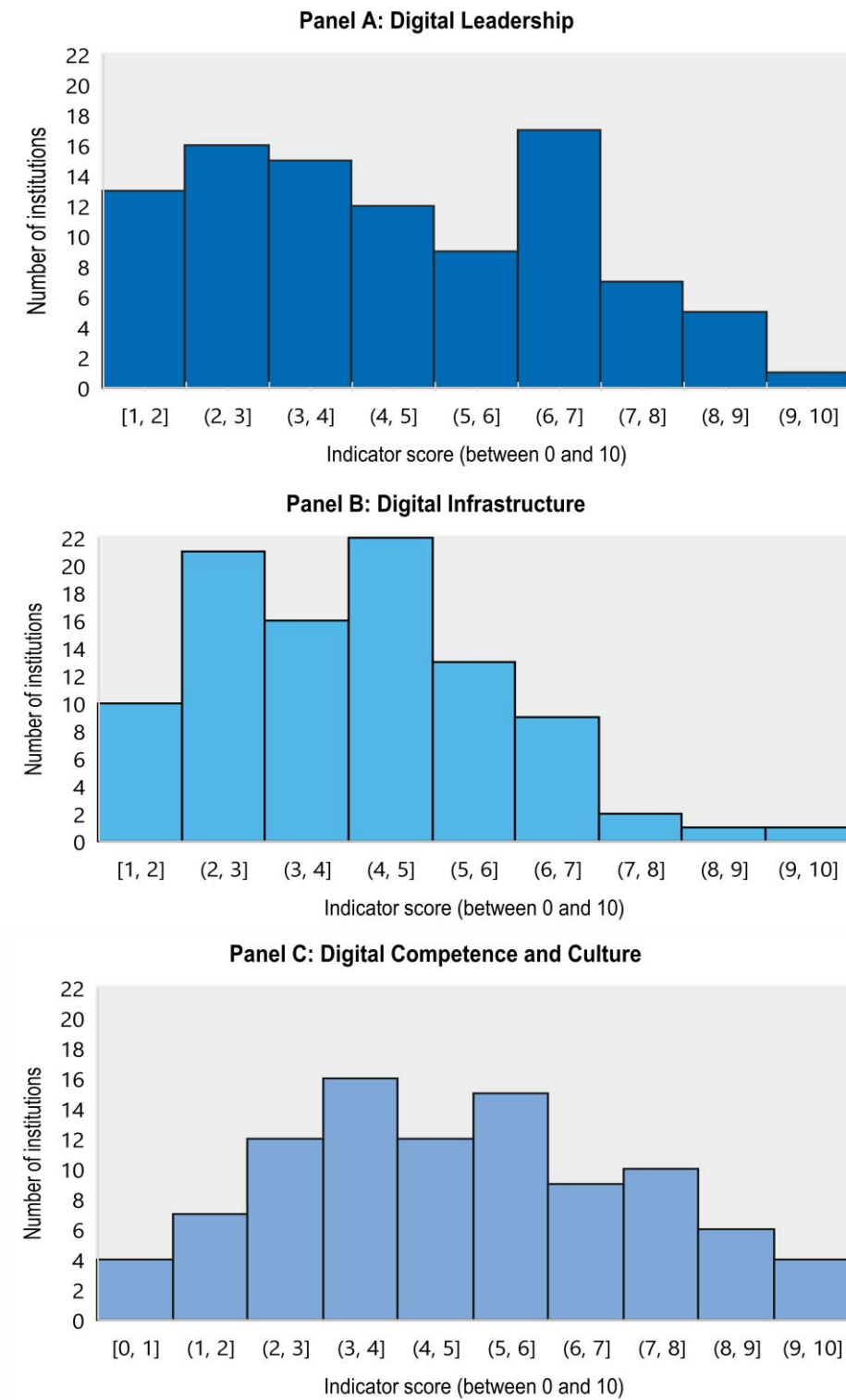


<b>Digital Infrastructure</b>		
DI1	High-quality internet connection is available	1 if the institution rated the quality of their connection as "4" or "5" on a five-point scale, 0 otherwise
DI2	High-quality wired connection is available	1 if the institution rated the quality of their connection as "4" or "5" on a five-point scale, 0 otherwise
DI3	High-quality Wi-Fi is available at the main location	1 if the institution rated the quality of their connection as "4" or "5" on a five-point scale, 0 otherwise
DI4	Adequate facilities for hybrid teaching	1 if the institution rated their need for hybrid teaching facilities as "1" or "2" on a five-point scale, 0 otherwise
DI5	Adequate facilities for lecture recording	1 if the institution rated their need for lecture recording facilities as "1" or "2" on a five-point scale, 0 otherwise
DI6	Digital security policy has been adopted	1 if the institution reported the existence of a digital security policy, 0 otherwise
DI7	Measures to raise awareness about cybersecurity - staff and students	1 if the institution reported that measures exist for both staff and students, 0 otherwise
DI8	Quality of servers and computing	1 if the institution rated the quality of the equipment as "4" or "5" on a five-point scale, 0 otherwise
DI9	Quality of support for maintenance	1 if the institution rated the quality of the available support as "4" or "5" on a five-point scale, 0 otherwise
DI10	Open technologies widely adopted across the institution	1 if the institution rated the extent of adoption of open technologies as "4" or "5" on a five-point scale, 0 otherwise
<b>Digital Competence and Culture</b>		
DCC1	Strategic objective related to digital competence - staff	1 if the institution rated the existence of specific digital competence objectives for staff, 0 otherwise
DCC2	Strategic objective related to digital competence - students	1 if the institution rated the existence of specific digital competence objectives for students, 0 otherwise
DCC3	Intention to offer fully online mode of delivery	1 if the institution reported its intention to offer some fully online education programmes (post-pandemic), 0 otherwise
DCC4	Intention to offer hybrid mode of delivery	1 if the institution reported its intention to offer some hybrid programmes (post-pandemic), 0 otherwise
DCC5	Mature use of hyflex tools	1 if the institution reported its maturity as at "project" or "service" level, 0 otherwise
DCC6	Maturity of use of digital tools to reform course design and/or pedagogy	1 if the institution reported its maturity as at "project" or "service" level-, 0 otherwise
DCC7	Use of AI or learning analytics to support and/or personalise student learning	1 if the institution reported its maturity as at "project" or "service" level in the use of AI and/or learning analytics, 0 otherwise
DCC8	Academic support for students engaging with digital technologies	1 if the institution reported that measures exist to support students learning in a digital environment, 0 otherwise
DCC9	Supports for teachers are in place (training or support with course design)	1 if the institution reported that measures exist to support teachers teaching in a digital environment, 0 otherwise
DCC10	Deep integration of digital tools in research activities	1 if the institution reported that digital tools had been used in more than two-thirds of a list of 29 research-related activities, 0 otherwise

Notes: The indicators are provided as an example and starting point only. Agreement on a final set of indicators of digital maturity for Croatian higher education institutions is best progressed as a national collaborative exercise.

Aggregation of the binary indicators for each element of the framework into a score shows that, on average, institutions appear to have the highest levels of maturity in the digital competence and culture element (average indicator score of 5.3 out of 10) and the lowest rates of maturity on digital infrastructure (average indicator score of 4.5 out of 10). Few institutions achieved an indicator score greater than 7 out of 10 on the maturity measure for digital infrastructure (Figure 3.2).

Figure 3.2. Digital maturity indicator scores for each element of the maturity framework

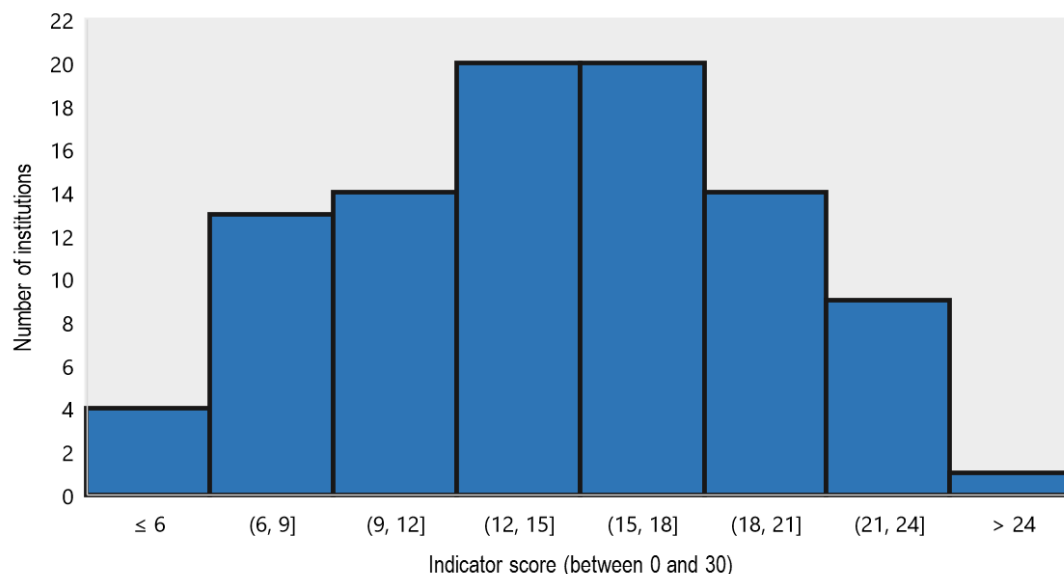


Source: OECD analysis of the 2022 CARNET-OECD survey data. Based on survey responses from 95 higher education institutions.

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When data for each of the three elements of the framework are combined into an overall measure of digital maturity (out of a total possible score of 30), most institutions exhibit scores in the range between 12 to 18 (Figure 3.3). Slightly fewer institutions reach the highest levels of maturity according to this measurement than achieve the lowest scores: in total 14 institutions exhibit a combined indicator score of greater than 21, while 17 institutions show a combined indicator score of less than 9.

**Figure 3.3. Distribution of digital maturity scores in Croatian higher education institutions**



Source: OECD analysis of the 2022 CARNET-OECD survey data. Based on survey responses from 95 higher education institutions.

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These results serve only as a very preliminary indication of digital maturity in Croatian higher education institutions. More comprehensive validation of the proposed indicators and underlying data as appropriate measures of digital maturity would be required before integration of any quantitative framework into national and institutional deliberations on digitalisation. Nevertheless, the results provide a crude indication that, while some institutions have well-established digital leadership, high-quality infrastructure and an embedded digital culture, many other institutions have made few steps towards digital transformation of their activities. The detail provided in the CARNET-OECD survey can allow for more comprehensive institution-level comparisons to be carried out, if required, to support conversations about future strategies for digital transformation.

### Qualitative assessment of digital maturity in Croatian higher education institutions

The final diagnostic element of this report is a qualitative evaluation of the digital maturity of Croatian higher education institutions, organised according to the framework proposed above. It presents the key findings of the OECD review team related to digital maturity in Croatia, based on interviews and discussions the OECD conducted with institution staff and other stakeholders in Croatia, and illustrated in some cases by aggregate results from the CARNET-OECD survey.

## **Digital leadership**

Digital leadership in higher education institutions is defined as an ability to coherently develop and co-ordinate organisation-level digitalisation strategy and mobilise resources for its implementation. It can also be indicated by robust institution-level strategies to monitor and improve the quality of its digital operations. Evidence from the CARNET-OECD survey and from interviews with institution staff and students is summarised in the following key messages about digital leadership in Croatian higher education institutions.

### *Institution leaders view digitalisation as a concept that goes far beyond online education*

In Croatia, few fully online programs have been accredited, and many stakeholders reported to the OECD team that appetite for fully online higher education in Croatia is limited, especially after the experience of emergency remote instruction. Some interviewees noted that during the emergency remote period, much of the online delivery was made up of uneven ad hoc solutions which are unsustainable in the long run. Going forward, public authorities have a role to play in regularising the current situation with online and hybrid programs and reviewing national criteria for digitally delivered education.

OECD interviews with higher education institution leaders also indicated that most consider online tools and content as a valuable complement to face-to-face teaching, rather than as a primary objective. There is a growing desire among students to have access to online learning material in addition to face-to-face instruction to support, reinforce and, at times, replace their on-campus lectures. Some institutions have maintained online access to digital learning content developed during the pandemic, but differences are evident among institution leaders in terms of the extent to which they are willing and able to provide such complementary digital content in the future.

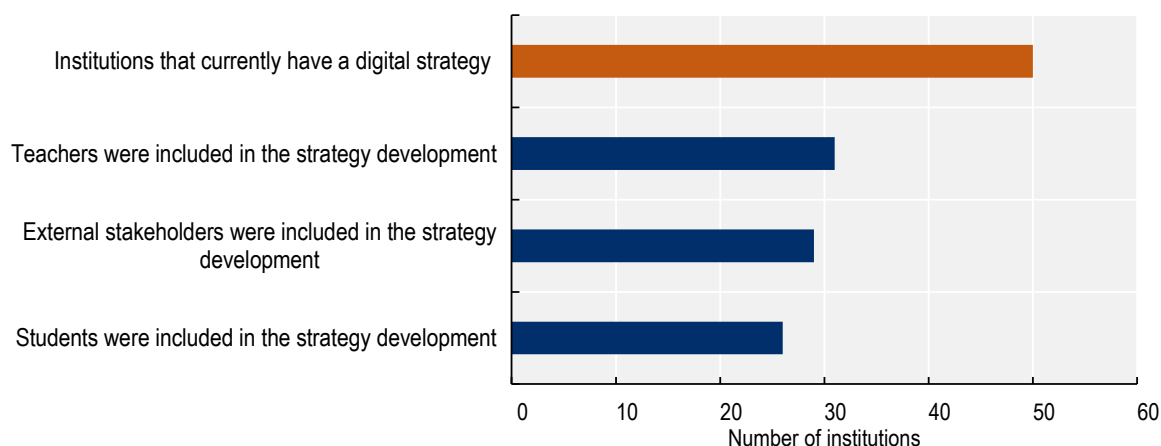
It is also clear that institution leaders in Croatia do not view digitalisation simply in the context of education provision – there is an imperative to integrate digital tools and technologies into all the activities of higher education institutions. Specific requirements mentioned multiple times include the need for digital tools and software to streamline administrative processes, a need for wider access to digitalised content (including e-books, research articles and databases, qualification and occupational standards), and requirements for specialised software licences and high-performance computing needed in many fields of study.

### *Stakeholder involvement in strategies for digitalisation appears limited.*

Data from the CARNET-OECD survey of digital maturity in higher education institutions showed that more than half (53%) of responding institutions have a digital strategy in place, either as a standalone strategy or (more commonly) as part of an institution-wide general strategy. However, the results also show that, in most cases, important stakeholder groups affected by digitalisation were not consulted during the development process (Figure 3.4). Students were the least consulted of any group, while teachers were only consulted in the development of approximately 60% of institution strategies. Leaving students and staff out of the consultation process creates the risk that institution leaders develop strategies irrelevant to the actual needs or previous experiences of staff and learners.

The results indicate that more efforts may be needed to embed coherent institution-level digital leadership across Croatian higher education institutions. In OECD site visits, some interviewees acknowledged a need to improve leadership and strategic co-ordination. Within independent constituents of non-integrated universities, for example, it was noted that change efforts at the faculty level are often not sufficient but must rather be embedded across the entire university structure. However, even within an integrated university, strategic approaches to digitalisation can vary across departments and specialisms. It was also noted in interviews that an overly narrow view of digital strategy is sometimes taken both at central and institutional level, with a focus mainly on providing equipment rather than a more holistic capacity-building approach.

**Figure 3.4. Development of institutional strategies for digitalisation in Croatian institutions**



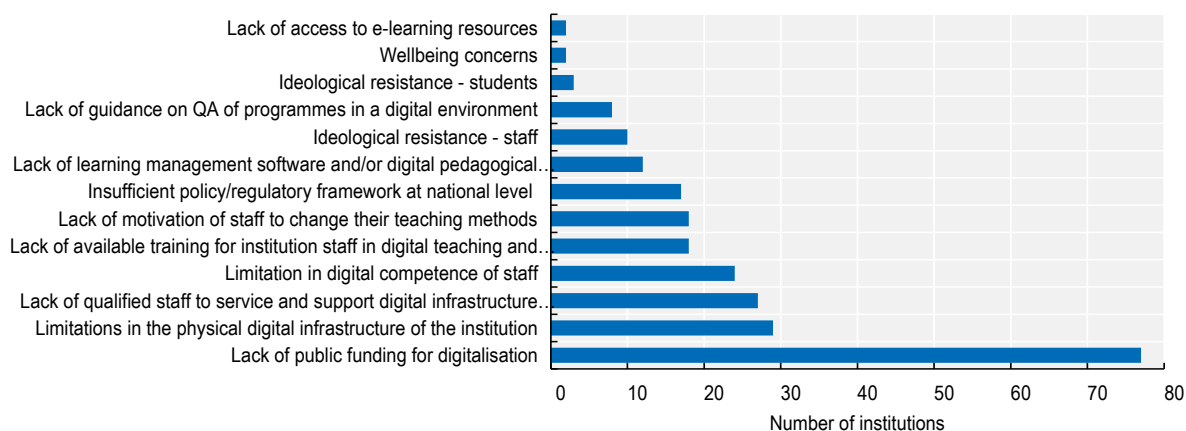
Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

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*A lack of public investment is considered a key barrier to successful digitalisation*

In the CARNET-OECD survey of digital maturity, a lack of access to public funds for digitalisation was identified as the greater barrier to digitalisation, followed by limited physical infrastructure and a lack of available staff to support digital operations (Figure 3.5). In interviews, many institution leaders and senior staff expressed gratitude and appreciation for the range of services provided by CARNET and other bodies such as SRCE, but also noted that available public funding was not sufficient to meet national needs. Some interviewees also perceived a greater tendency to fund digital projects in STEM fields, even though there are emerging needs for access to digital technologies in all fields.

**Figure 3.5. Barriers to digitalisation identified by respondents to the CARNET-OECD survey**

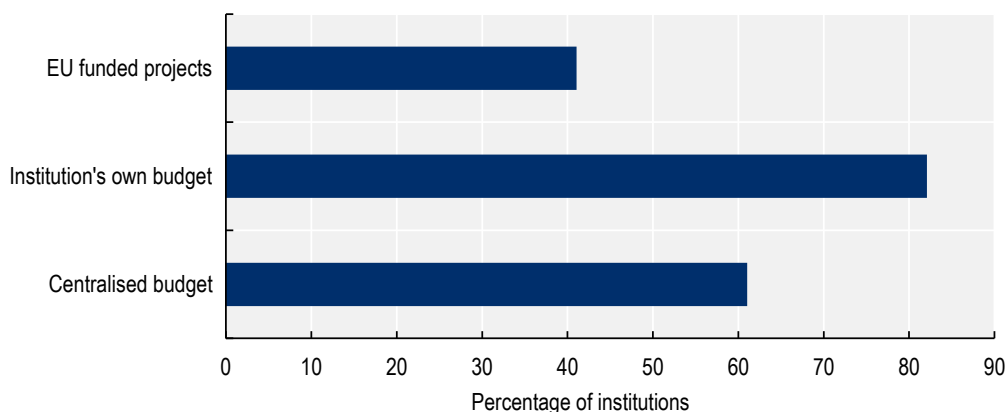


Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

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Capacity for strategy development can also vary according to the resources available to the institution (Figure 3.6). Stakeholder interviews with the OECD team highlighted that Croatia's polytechnics in general are smaller than universities and tend to have fewer resources available for digital transformation. In addition, many institutions' current digital development strategies were produced before the pandemic and do not reflect the latest developments.

**Figure 3.6. Sources of funding available to institutions for digital transformation**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

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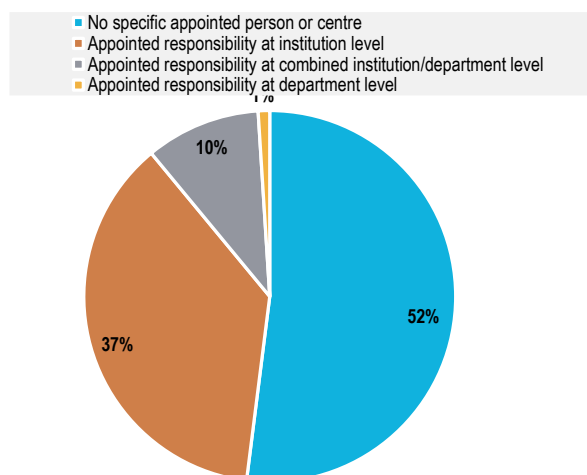
Institutions are not fully dependent on public sources for investment in digitalisation. In fact, institutions are most likely to fund digital tools from their own budgets rather than rely on public funds (Figure 3.6). At the same time, 15 survey respondents, almost all of which were faculties of non-integrated universities, reported that centralised public funding was their only source of funds for digitalisation.

*There is a lack of clarity about responsibility for digital transformation in some institutions.*

Data from the CARNET-OECD digital maturity survey highlights disparities in the way that institutional responsibility is allocated for digital transformation. In total, about half the respondents could not highlight a specific appointed person or unit within their institution who has responsibility for digital transformation, while approximately one-third of respondents reported that responsibility for decisions lay at overall institution level (Figure 3.7). On the other hand, decisions about the acquisition of specific tools and technologies are most often made at the faculty level (Figure 3.8). Taken together, these results indicate potential fragmentation in institution decision making and responsibilities in some institutions, which may create inefficiencies and limit knowledge flows within the organisation.

This conclusion is supported, to some extent, by evidence gathered during the OECD team's site visits. Some stakeholders felt institutions themselves could take on greater leadership and responsibility for their transformation efforts by playing a greater role in encouraging cultural change within their institution. On the other hand, some institutions and their representative bodies reported the need for a stronger legislative backbone for digital education and were awaiting clarity from public authorities on matters such as the revision of criteria for online and hybrid learning and the parameters of upcoming reforms (for example, the updated Law on Science and Higher Education). The imminent finalisation of reforms in Croatia may create a clearer understanding within institutions of the emerging future policy framework in which they will operate and support the development of appropriate institution-level policies and practices for digitalisation.

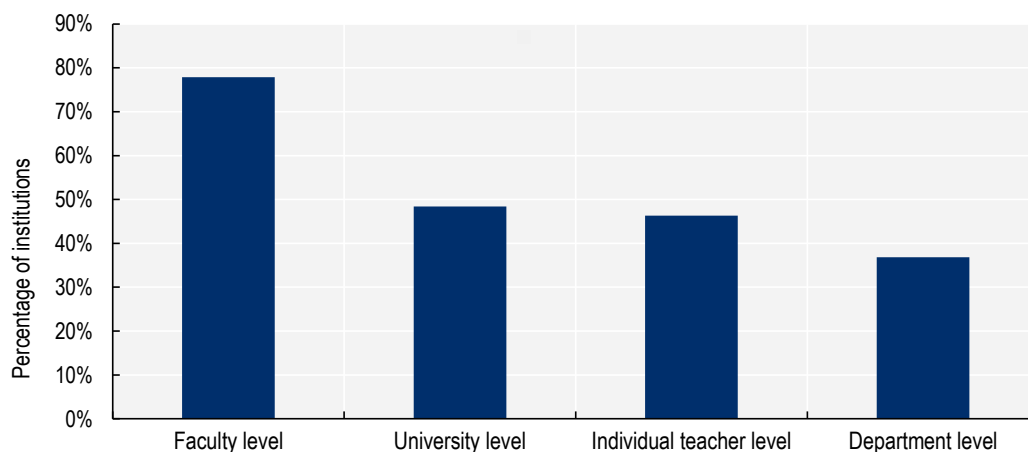
**Figure 3.7. Institution-level allocation of responsibility for digital transformation**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions,

StatLink  <https://stat.link/5x4esb>

**Figure 3.8. Locus of decision making about the acquisition of digital tools and software**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

StatLink  <https://stat.link/qo35he>

### **Digital Infrastructure**

Investment in digital infrastructure is fundamental to enhancing the ability of higher education institutions to achieve their digitalisation objectives. The following sections provide a selection of key findings from the institution digital maturity survey and interviews conducted during the OECD review visit. Additional perspectives on digital infrastructure are available in the technical advice on investment in digital infrastructure developed during this project (see Chapter 5).

*Higher education institutions are satisfied with the internet connection provided by CARNET, but most require at least some upgrades to their on-campus networks*

The CARNET-OECD survey results show most responding institutions were satisfied with the internet connection provided by CARNET. Average satisfaction among institutions on a scale from 1 (least satisfied) to 5 (most satisfied) was 4.6. On the other hand, institutions overall reported much lower satisfaction with the quality of their wireless connectivity (Table 3.6). More than one-quarter of all respondents to the survey provided a ranking of 1 or 2 for the quality of their on-campus wireless network.

**Table 3.6. Average institution quality ranking of different types of network connectivity**

Type of connection	Average institution ranking (1-5)
Internet connection via CARNET	4.6
Wired LAN	4.1
Wireless LAN	3.4

Source: CARNET-OECD survey of digital maturity of 95 higher education institutions.

A lack of reliable network connectivity can have an adverse impact on the ability of institutions to conduct their day-to-day operations, and their capacity to improve their overall digital maturity. During interviews, many institution staff mentioned their satisfaction with the services and connectivity provided by CARNET. However, a few institutions reported that their existing internet connection was either no longer sufficient or was soon likely to become insufficient due to increased demand on-campus for network connectivity.

Conversely, and reflecting the results of the survey, many institution staff raised concerns during interviews about the state of their on-campus network equipment, which in some cases was reported as being up to 20 years old and in need of urgent upgrades. This has various impacts on operational efficiency. For example, one institution reported a need to outsource support for hybrid meetings as the local network could not manage the connectivity required, while others noted they had bandwidth issues when delivering online learning or large online meetings. These issues limited the extent to which participants could engage with meetings (e.g. needing to keep cameras off) or created lags when accessing Merlin (the centrally provided installation of Moodle). In other cases, institutions reported uneven access to connectivity in different parts of the campus, with some older buildings and buildings with thicker walls presenting more challenges for network upgrades, along with a lack of documentation on the current network structure.

*Most institutions rely on in-house support staff, and some experience severe difficulties in maintaining ICT support services*

Most institutions rely heavily on in-house specialist staff or their own IT departments to maintain their local networks and computer hardware, as well as to provide technical support to students and staff (Table 3.7).

Almost all the institution leaders interviewed by the OECD team during site visits raised the challenge of recruiting skilled IT staff to support their existing digital infrastructure. Higher education institutions are limited in the level of salary they can offer their staff. This constraint results in difficulties finding and retaining qualified staff, as the private sector often offers more attractive terms and conditions and is perceived by candidates as offering a more stimulating job environment. Many institution leaders said that achieving stable IT support staffing is at least as high a priority for their institution as upgrading their equipment.

Existing staff members are often overworked and have a heavy burden of responsibility. This was especially true during the period of emergency remote instruction. While institutions express their high appreciation for the work the staff members do, current regulations limit how they can be explicitly



rewarded. While institutions have made efforts to come up with innovative ways to reward and retain IT staff, few of them have been able to arrive at a comfortable long-term solution for this difficulty, and are overdependent on existing staff members.

**Table 3.7. IT support available within institutions for different functions.**

Number of institutions reporting the existence of each type of support

	Maintenance/repair of computer hardware	Maintenance/repair of the network	Student/Staff support helpdesk
Permanent specialist staff employed by the institution	64	62	62
Institution's IT department	55	52	55
External company or institution	36	36	12
Temporary contract staff	8	10	8

Source: CARNET-OECD survey of digital maturity of 95 higher education institutions.

*Strong concerns are evident in many institutions about the quality of digital infrastructure*

Following its fact-finding visit, the OECD review team concluded that many higher education institutions had been notably proactive and diligent in identifying infrastructure gaps and finding the means to plug them. For example, some institutions have a policy of applying systematically for any available grant funding from national and international sources to improve digital infrastructure, including the use of research funds to purchase needed equipment. Others detailed their efforts to attract partners nationally and internationally to work with on digitalisation initiatives.

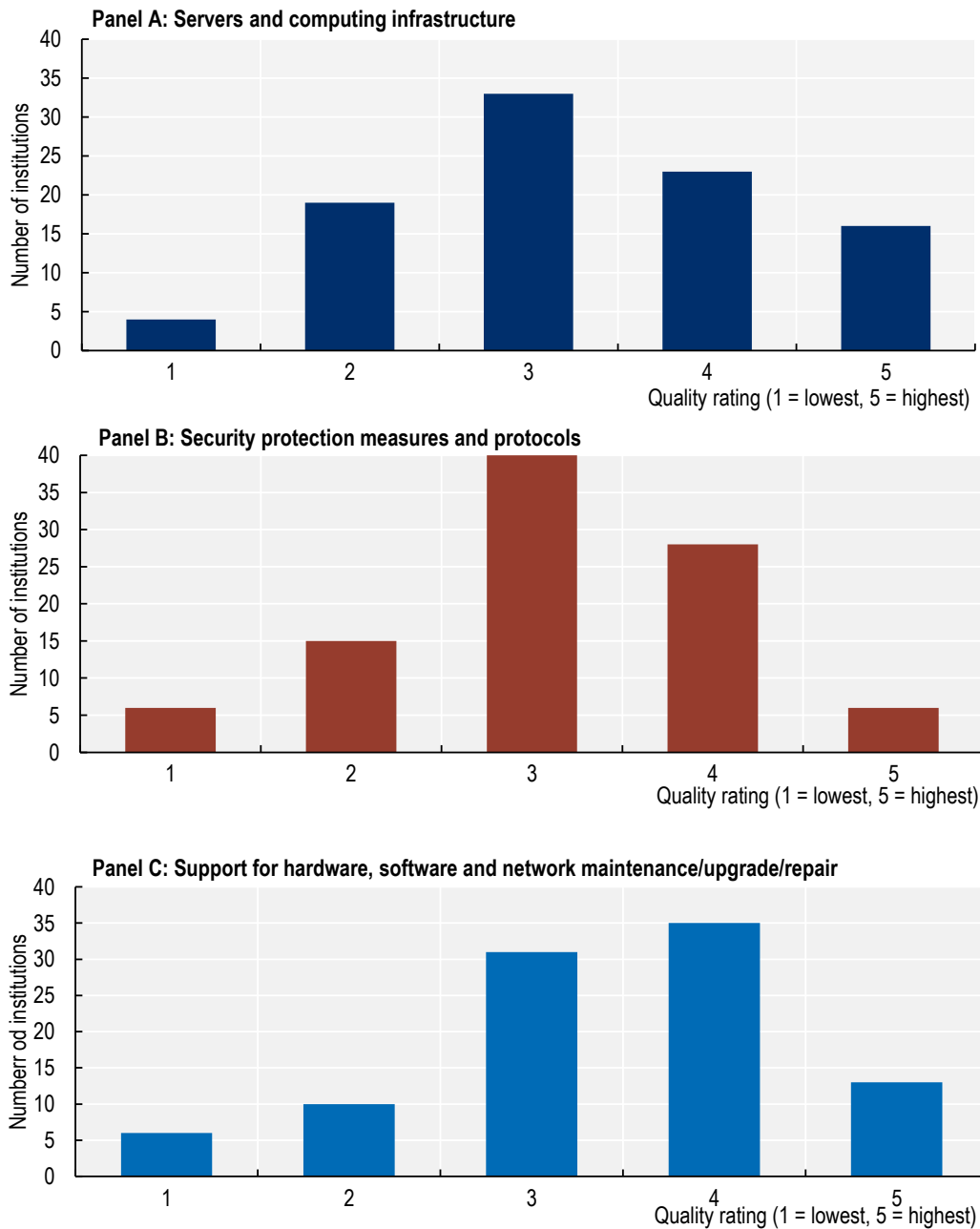
At the same time, many institution staff indicated persistent concerns about the quality of some of their infrastructure, equipment and technical services. In the CARNET-OECD survey, when asked to rate the quality of various services on a scale of 1 to 5, the vast majority of institutions reported the medium score (3). While in general institutions had a more positive perception of the quality of their own support services, almost one-quarter of institutions rated the quality of the servers and computing infrastructure as poor (a score of either 1 or 2) (Figure 3.9).

*Croatian institutions would benefit from more centralised provision of software and services*

Institution staff interviewed by the OECD team expressed appreciation for the software services provided to them by public authorities (directly or through organisations such as SRCE and CARNET). Frequently cited examples of software in heavy everyday use included Merlin (a SRCE-provided and supported Moodle-based virtual learning environment) and the Microsoft Office 365 licence provided by the Ministry of Science and Education. There is a clear demand from institutions and their representatives for more centralised software solutions. Examples of services in high demand include the implementation of persistent academic identifiers for students and staff that would be operational up to European level, research tools and access to databases for research students and staff, and software that can support assessment and detect plagiarism.

### Figure 3.9. Institutions' quality rating of different elements of digital infrastructure

Frequency of institutions' quality rating, on a scale of 1 to 5



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

StatLink  <https://stat.link/jvwbus>

Institution staff and stakeholders said cybersecurity protection was also essential, and uncertainty was expressed by some interviewees about the vulnerability of some software and open-source platforms to cyber-attacks. Smaller institutions and those with less capacity have reached out to resource providers such as SRCE for assistance, while larger and more equipped institutions have developed and implemented their own solutions. The survey results also highlighted a general demand for central provision of services related to cyber and data security. For example, 73 of the 88 respondents from public institutions expressed interest in having an advanced firewall service provided, while 56 expressed interest in traffic encryption/decryption services.

Finally, institutions expressed a need for strong central support and guidance in relation to online exams and assessments. Ensuring the integrity of assessment processes carried out online is a persistent challenge. Many institution staff perceive a lack of central support, tools or guidance on this issue. During the pandemic, some institutions held exams online but required candidates to be located on the university campus, with restricted Wi-Fi access. Others aimed to redesign exam questions to be less fact-based and more analytical in nature. While some institutions concluded that in-person examinations were the only option to ensure integrity and quality, others noted that digital assessment tools offered the ability to automate some grading processes (e.g. for quizzes and some formative assessments) and expressed interest in building further capacity for high-quality digital assessment, with central support.

*Institutions expressed a pressing need for certain types of audio-visual equipment*

Croatian higher education institutions expressed a need to improve their on-campus audio-visual equipment, both during the site visits carried out by the OECD team and in their responses to the CARNET-OECD digital maturity survey. In particular, the survey results indicate a pressing need for audio-visual equipment to support the use of digital resources during lectures, as well as equipment that can be used for recording live lectures and hybrid teaching. Notably, these needs are ranked much more highly, on average, than the need for end-user equipment stocks for students and staff (Table 3.8).

**Table 3.8. Croatian higher education institutions' perception of on-campus equipment needs.**

Type of equipment/facility	Mean Need Ranking (1-5)
Lecture halls (with the ability to use digital resources in lectures; consists of projectors, lecturer computer and sound system)	4.31
Small halls/classrooms for hybrid teaching and recording lectures (ability for face-to-face and online instruction, recording of a live lecture in front of live audience; consists of camera(s) and lighting, audio equipment, projector/smart screen)	4.18
E-archipelago/e-laboratories - public spaces for learning (individual computer stations, pair/group learning, project rooms, libraries for quiet learning, linkable via video conferencing)	4.07
Simple audio-visual studio (ability to produce video lectures and educational video; consists of video; audio recording equipment, lighting, editing software, sound insulation)	3.54
Specialised hardware for learning (robots, microcomputers, 3D printers)	3.20
Computer lending services for students and teachers (lending/leasing when needed and in emergencies)	3.01
Professional audio-visual studio (ability to produce more complex and advanced educational video such as experiment/demo recording, talk show recording, stop animation, audio recording; consists of video; audio recording equipment, lighting, editing software, sound insulation)	2.86

Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

Evidence from interviews indicates that funding equipment for lecture recording may be a particular challenge, as it generally cannot be financed by project-based funding (e.g. from research funding). Recordings carried out during the pandemic were often not of professional quality and were considered useful for emergency purposes only. Some institution staff highlighted the need not only for the audio-visual equipment itself, but also for suitable room environments in which to conduct the recordings, with proper acoustics and lighting.

### **Digital competence and culture**

Digital learning in higher education is most successful, “when the socio-environment, supporting digital infrastructure, host institutions, and human participants are well prepared” (Blayone, 2018<sup>[11]</sup>). This requires digital competence of individual participants in higher education activities. Digital competence has been defined as “sets of knowledge, skills and attitudes relating to the purposeful and effective use of digital technologies” (Ala-Mutka, 2011<sup>[12]</sup>). At the European level, this is considered one of the core competencies necessary for learners both in current and future society (European Commission, 2019<sup>[13]</sup>). Broad evidence indicates that academic staff often lack the necessary competences to progress beyond using basic digital technology (e.g. slide decks) in the classroom (Englund, Olofsson and Price, 2017<sup>[14]</sup>); (Schneckenerg, 2009<sup>[15]</sup>).

Croatia has a long history of supporting development of competence in e-learning in its higher education system (Kupres and Pašić, 2005<sup>[16]</sup>). As in other countries, there is limited evidence available regarding the extent of digital competence in higher education teaching staff. A recent study did, however, highlight differences in competences across both fields of study and generations (Box 3.3).

A teacher’s use of digital technology to create quality learning for their students can depend on their own knowledge, skills and attitudes towards digital technology (Hofer, Nistor and Scheibenzuber, 2021<sup>[17]</sup>). But it can also depend on the existence of supportive and like-minded colleagues with a similarly high commitment to maximising the value of digital technologies. This can be considered the “digital culture” of the organisation. A strong digital culture within an organisation promotes collaboration above individual efforts, and aims to create a supportive, innovative environment where individuals feel empowered to use and experiment with digital technologies (BCG, 2018<sup>[18]</sup>).

The development of digital competence and culture also needs to consider the needs of learners. Today’s young entrants to higher education grew up surrounded by digital devices (Creighton, 2018<sup>[19]</sup>). But they still may not automatically be proficient with using common digital tools and software found in higher education institutions, particularly as digital technologies become increasingly integrated into all fields of education.

With these considerations in mind, this section presents some findings from the CARNET-OECD digital maturity survey and interviews conducted during the OECD’s site visit that are relevant to the development of digital competence and culture in Croatia’s higher education institutions.

#### **Box 3.3. Assessing digital competence of higher education lecturers in Croatia**

Few cross-national studies have been carried out addressing digital competence in higher education lecturers. A 2019 research study in Croatia aimed to fill the evidence gap. The study in Croatia was part of the wider 2015 DFGP study, “E-learning and Multimediakompetenz der Deutschen Initiative für Netzwerk Information” Research was also conducted in Germany and France. A representative sample (n=1800) of teachers and associates from institutions in Osijek, Split and Zagreb were polled through an online questionnaire regarding their level of digital competence and usage of modern technologies in their teaching practices.

One significant finding was the difference in digital competencies between faculties. Those working in technical faculties reported being “more competent” in conducting scientific research and using modern technologies than their counterparts in social sciences and humanities faculties. On the other hand, respondents from the humanities reported using technology in teaching more often and for their own scientific work than those in the technical and social sciences fields.

More than 70% of respondents noted they are ‘competent’ in the use of computers and new technologies. However, there is an apparent generational divide - 65% of assistant professors, teaching assistants and lecturers consider themselves part of the “digital generation” while only 33% of full-time professors felt the same, citing insufficient training in ICT technologies. There was also a difference in fields, with those in the technical field (56.8%) reporting a higher usage of e-learning technology (e.g. Moodle) than those in social sciences (39.6%).

The study authors also highlight that flexibility and a critical approach to information is necessary to address the growing obsolescence of competences caused by the speed of advancement in technology. A clearer definition of digital competences is required (defined as “complex integration of cognitive processes and dimensions”) along with a need to identify and develop different dimensions of digital competences, so teachers can respond to learner needs with the appropriate pedagogy and technology. The authors proposed a Multimedia Training and e-Learning programme tailored to education institutions offering teacher training. The programme would focus on honing basic levels of digital competence and would include analysis and implementation of e-learning; methodology and didactics in e-learning, models of e-learning platforms and techniques for using multimedia.

The authors also proposed 15 specific key competencies all educators should acquire, including acquisition of basic digital knowledge and literacy, knowledge of the Microsoft Office productivity suite, ability to search, collect and process information and data, ability to independently design an education programme for use in an online environment, and capacity to understand and use different e-learning tools (e.g. SCORUM, Open Content, MOOCs).

Source: Muller and Varga (2020<sup>[20]</sup>), Digital Competences of Teachers and Associates at Higher Education Institutions in the Republic of Croatia, <https://doi.org/10.32914/i.52.1-2.4>.

*Some initiatives are in place to develop staff digital competence, but a more systematic and joined-up approach would be beneficial*

During the OECD team review visit, many interviewees stressed the need to further improve digital competence in its staff members and outlined their efforts to do so. Some institutions have developed their own initiatives for digital competence development, while others encourage the use of CPD among their staff. The period of emergency remote instruction was also mentioned as indirectly providing general development of pedagogical skills – the large-scale upload and digitalisation of learning material was beneficial not only for students, but also for teachers to engage in peer-based learning; allowing younger professors to review the teaching practices of older and more experienced colleagues in a way that wasn’t possible previously.

Regardless of progress made during the pandemic, many staff expressed a need for a more systematic approach to the development of digital competence and culture that requires a rethinking of existing academic staff terms, conditions, and reward structures. In Croatia, as in most OECD countries, academic staff begin teaching in higher education institutions without having or needing a formal teaching qualification or training, and there are no standardised requirements for professional development of staff to enhance their teaching skills (OECD, 2020<sup>[21]</sup>). As was pointed out multiple times to the OECD review team, this renders the efforts and progress of staff and organisations in improving digital competence largely invisible, with no clear channels available to either recognise or reward high performance.

Some interviewees felt centrally provided training on digital competence could move towards systematically imparting knowledge and evidence on the best pedagogical practices for engaging and supporting students in a digitalised environment. In some cases, current training offers and competence-building initiatives were perceived to focus more on the use of technical tools and sharing of content, rather than how to apply these resources effectively. More training is needed to teach staff how to design and construct courses fit for a digital environment, rather than simply duplicating practices used in face-to-face instruction.

*Many existing pedagogical practices for online and hybrid education lead to deficits in the social element of learning and lower student engagement*

As in other countries, the period of emergency remote instruction in Croatia exposed many limitations in current pedagogical practices for delivery of online learning. Teaching staff reported several difficulties with supporting student learning in an online environment. Frequently mentioned challenges included:

- A lack of eye-contact and inability to read non-verbal feedback of students (i.e. facial expressions and body language), which provide vital signals to teachers about students' level of understanding of the material being taught, and cues for which concepts and knowledge need ad hoc reinforcement.
- An inability to provide adaptive instruction, particularly with asynchronously provided material. Each student is required to consume the same content, with no ability to reinforce learning by asking questions of the instructor or of peers in the classroom.
- The attention span of students in an online environment appears shorter. Online study provides easy access to a range of distractions, leading to reduction in student engagement.
- Lack of engagement of students in an online environment leads to greater inefficiencies in contact between instructors and students (e.g. instructors needing to respond to the same query multiple times to individual students, rather than dealing with it once during a live class).

The online environment also created new pressures for teaching staff. Many staff made increased efforts to support students in a remote environment, becoming more available and responsive over a range of communication channels. This led in some cases to increased student expectations for immediate access to staff and quick responses to ad hoc queries, even following the return of in-person education. Some teaching staff also reported that students increasingly expect digitalised content to be made available as a complement to their in-person lecturers, which has led to a greater workload for staff.

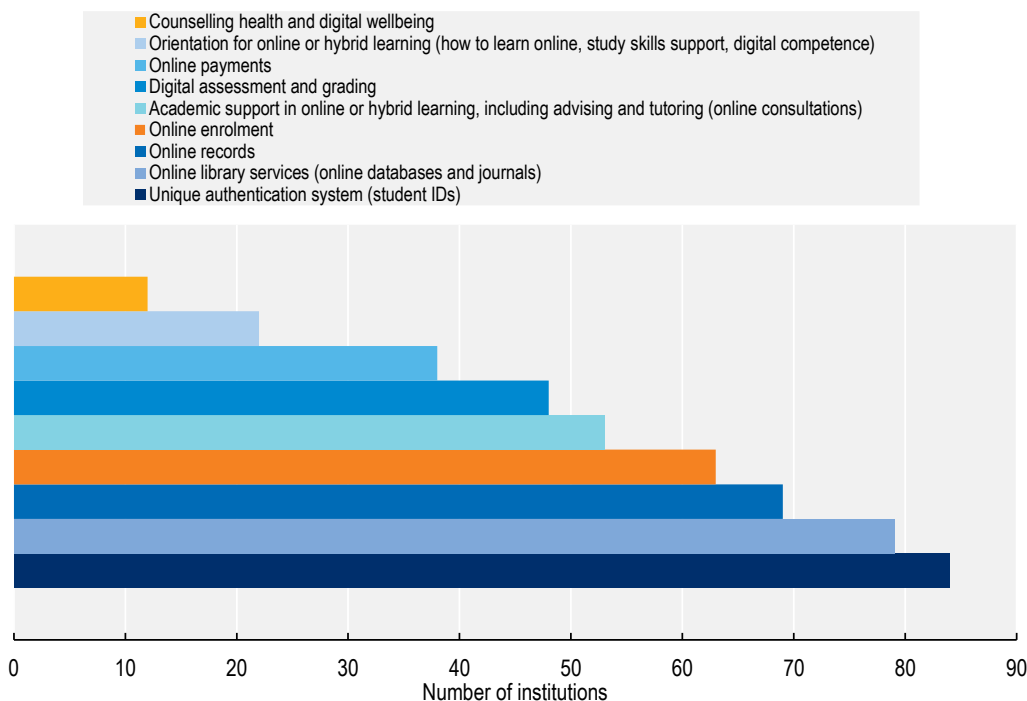
Many of the issues raised, it is acknowledged, were heightened by the emergency context in which mass online learning was introduced and staff had to adapt their content very quickly to an online environment. Nevertheless, the OECD review team concluded that successful mainstreaming of online education in Croatia would only be achieved with greater emphasis on engaging students through pedagogical principles and practices specifically designed to be effective in an online environment.

*Students enjoy a range of digitalised services but could be more heavily included in institution plans for the development of digital competence and culture.*


Students in many higher education institutions in Croatia enjoy access to a range of digitalised administrative support and wraparound services that can simplify and streamline their educational pathways. Students in most reporting institutions have access to a common identity authentication service, online library services and online enrolment and records services, while about half of institutions report that digital assessment and grading and online academic support or tutoring is available to their students (Figure 3.10).

On the other hand, far fewer institutions offer counselling online or orientation to students for online study or study skills support. The CARNET-OECD survey also indicated that in general, teachers have far more access to formalised opportunities to improve their digital competence than students (Figure 3.11). Teaching staff in almost all institutions that responded have access to occasional formal training aimed at improving digital competence, while many also avail of informal learning through communities of practice and other forms of knowledge sharing. On the other hand, students are generally expected to build digital competence through their regular coursework, or via self-directed learning. A few institutions do offer targeting training and certification for students to acquire digital skills (Figure 3.11).

**Figure 3.10. Digitalised student services available in Croatian higher education institutions**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

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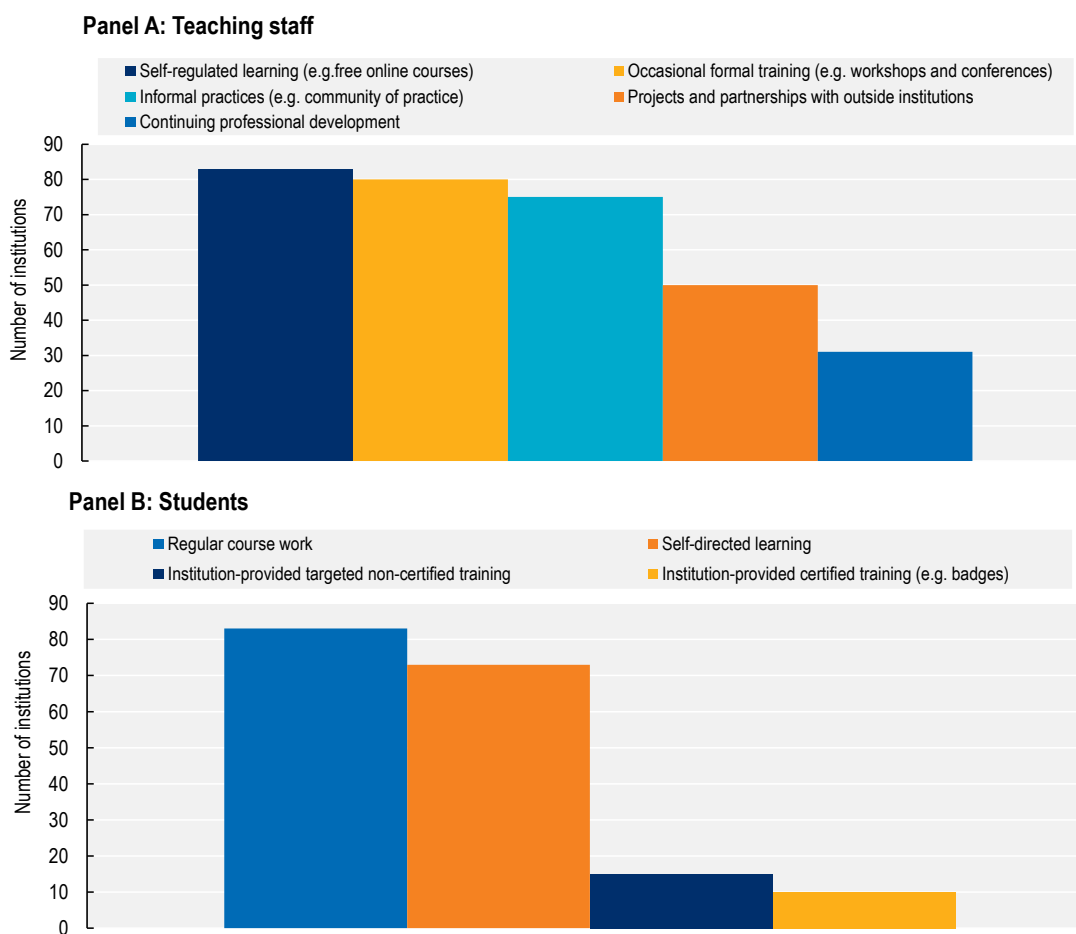
National studies and reviews of practice (e.g. from the Agency for Science and Higher Education) have indicated a need for greater efforts to build digital competence among students. Student representatives reported to the OECD team in interviews that while institution staff made substantial efforts to support them during emergency remote instruction, many classmates struggled with stress and mental health issues – including before and during online assessments – and did not always feel able to ask for assistance. Students also reported difficulties communicating with some professors, particularly those with more limited experience in working online.

Overall, however, it was clear students highly appreciated the efforts made by staff during the emergency period and were more likely to have encountered problems with connectivity and lack of access to on-campus equipment (e.g. for practical study) than difficulties in using the digital tools and content provided during the pandemic. Many students report that they have been able to improve their digital competence using resources located outside their institution (e.g. YouTube videos or asking friends).

Some student representatives highlighted that, despite being the target audience for much of the digital content being developed by instructors, they were rarely consulted on issues of pedagogical design or user

experience. They perceived substantial differences in the approach to online learning taken by their institutions, compared to professional education technology companies, such as edX or Coursera. Greater student involvement in digital learning design could improve the relevance of content for students and increase their engagement.

**Figure 3.11. Available means for teachers and students to improve digital competence**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

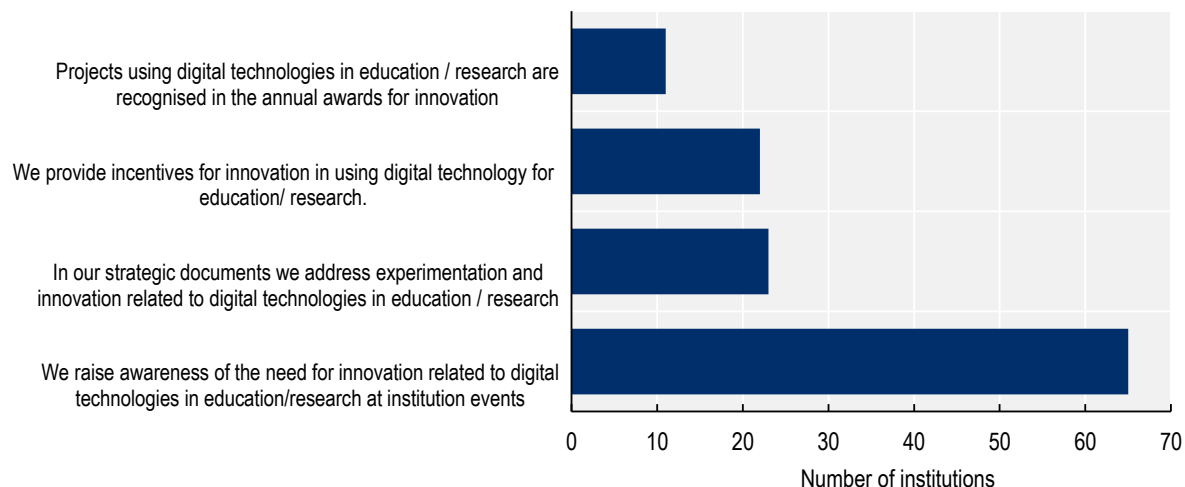
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*Some elements of innovative digital culture appear to be more developed than others in Croatian institutions*

Digital culture entails building a comprehensively supportive environment for digital innovation and improvement across the entire organisation. Some items included in the CARNET-OECD survey provide an indication of the extent to which there is a culture for digital innovation embedded in Croatian higher education institutions. For the most part, Croatian institutions tend to focus on raising the general awareness of the need to innovate, at staff gatherings and events. Less emphasis is placed on more concrete steps, such as the development of an innovation strategy, providing incentives for innovation, or recognising and awarding innovative projects (Figure 3.12).



**Figure 3.12. Supports for digital innovation in Croatian higher education institutions**



Source: 2022 CARNET-OECD survey of digital maturity of 95 higher education institutions.

StatLink  <https://stat.link/6kc9ha>

Challenges associated with innovation were also raised during site visits with the OECD team. While many institution staff mentioned examples of recent innovative digital initiatives, others reflected that innovation was dependent on the motivation and capacity of individual academic or ICT staff, rather than a product of the general culture of the institution. While some staff are enthusiastic and eager to become involved in experimentation with digital technologies, others are less engaged or simply do not have the capacity to do so. Specific incentives and additional staff supports are necessary to establish a broader culture for digital innovation across Croatian higher education institutions.

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# **4 Enabling standards, supports and practices for high-quality digital higher education in Croatia**

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This chapter contains a review of national and transnational standards that have been proposed or adopted across OECD and EU countries to assure the quality of digital education. It also analyses the different options available to public authorities to support improvements in the quality of digital higher education. Finally, the chapter provides principles for institutions to consider when developing strategies to improve the quality of digital education, and recommendations for Croatian public authorities to reflect on in their policy deliberations.

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## Policy context

Traditionally, quality assurance processes and standards in higher education were primarily focused on face-to-face education. Before the COVID-19 pandemic, digital technologies were increasingly integrated into higher education operations, and online education was gaining popularity in many countries. Consequently, quality assurance agencies and institutions began re-evaluating their quality standards. The pandemic significantly accelerated this shift by forcing a widespread transition to online higher education and driving emergency investments in digital infrastructure across OECD and EU countries.

In Croatia, as in other countries, it is now time to consider the reactive innovations required by the pandemic. The aim should be to build on what worked well and address issues requiring either further development or a change in direction. The Croatian higher education system has already made substantial progress on these deliberations, as evidenced by the 2022 amendments to the laws governing science and higher education (Box 4.1)

The revision of quality assurance criteria alone is unlikely to lead to quality improvements. There needs to be a simultaneous investment in **people**. One of the key urgent challenges across countries is the need for further development of digital competence and culture across higher education institutions. Digital competence and culture refer to the abilities of people within higher education institutions, both individually and collectively, to contribute to digital innovation within their organisation and to utilise digital technologies for enhancing teaching, research, operational, and administrative performance.

This chapter aims to support Croatian stakeholders and higher education institutions as they move forward with reforms and investment in high-quality digital education. It focuses on public supports, capacity developments and organisational culture shifts required to deepen digital competence. After some definitions, the chapter commences with an overview of recent transnational and national trends in quality assurance, reflecting on the balance quality assurance agencies are trying to achieve between taking an integrated approach and addressing the specifics of online and hybrid delivery modes.

The chapter then presents a categorisation of recent examples of public support for higher education institutions across OECD countries, which aim to improve the quality of digitally delivered or digitally enhanced higher education. The concluding section highlights institutional approaches that may improve the effectiveness of digital higher education and proposes a framework for institutions to build their own improvement strategies. The institution-specific framework is complemented by a set of institutional guidelines also developed as an output of this project (see Annex A).

### Box 4.1. Croatia's regulatory framework for quality assurance of digital higher education

Quality assurance of higher education institutions is the responsibility of the Agency for Science and Higher Education (ASHE) and the Ministry of Science and Education, as well as the institutions themselves. Croatia's external quality assurance framework is co-ordinated and implemented primarily by the ASHE. The responsibilities of the ASHE are prescribed by law. They encompass initial accreditation and re-accreditation of higher education institutions and study programmes, as well as external evaluation of higher education institutions internal quality assurance mechanisms. The ASHE also carries out a range of research activities and thematic analyses using data collected from higher education institutions and administrative data systems to identify strengths and areas where further action is needed to improve quality of provision.

In Croatia, as in other European countries, the ASHE increasingly co-ordinates its actions with other national quality assurance bodies. Croatia's external quality assurance framework was established with regard for European best practice and seeks to inform its operations with best practices promoted by the European Network for Quality Assurance Agencies in the European Higher Education Area (ENQA)

including the European Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).

An amended Law on Quality Assurance in Higher Education and Science (Parliament of Croatia, 2022<sup>[1]</sup>) entered into force in December 2022. One provision of the amended law assigns primary responsibility for the development of criteria for the establishment of online higher education programmes to the ASHE. The Agency is responsible for authorising wholly online programmes, defined nationally as programmes where more than 50% of the subjects are delivered online (see Box 4.3).

Source: Agency for Science and Higher Education (n.d.<sup>[2]</sup>), Scope of Work, <https://www.azvo.hr/en/about-ashes/scope-of-work/activities>

### **Higher education, digital technologies, and modes of delivery**

There are many different definitions describing the mode of delivery of education programmes, often with limited mutual understanding evident across – or even within – countries. “Distance education” is one of the oldest terms used to describe the delivery of education where the learner is at a physical distance from the provider. It is generally understood to refer to all modes of delivery of education other than in-person (e.g. correspondence courses, TV and radio delivery, and online delivery using digital technologies).

In recent decades, many other terms have been coined to categorise the mode of delivery of higher education (Finol, 2020<sup>[3]</sup>). Following review of the various definitions in use, recent OECD analysis (Staring et al., 2022<sup>[4]</sup>) defines three categories of online delivery of higher education as follows:

- *Fully online education*: All instruction is delivered online, either synchronously or asynchronously, or in combination. While instruction is wholly delivered online, learners may still be provided with opportunities to interact with peers or instructors in person, or to access on-campus facilities.
- *Hybrid education*: Instruction is delivered using a mix of online and on-campus instruction, with the online components taking place synchronously, asynchronously, or simultaneously with in-person instruction (the latter category being increasingly labelled as “hyflex” education).
- *Blended education*: Instruction generally takes place in person and is supplemented, but not replaced, by online materials and activities such as a virtual learning environment, open educational resources, simulations, or gaming. (Siegelman, 2019<sup>[5]</sup>).

Various forms of online and hybrid education exist along a continuum of learner exposure to online material. This ranges from programmes with no online component to varying degrees of web-supported offers and eventually to programmes that are primarily or fully web-based (Guiney, 2016<sup>[6]</sup>).

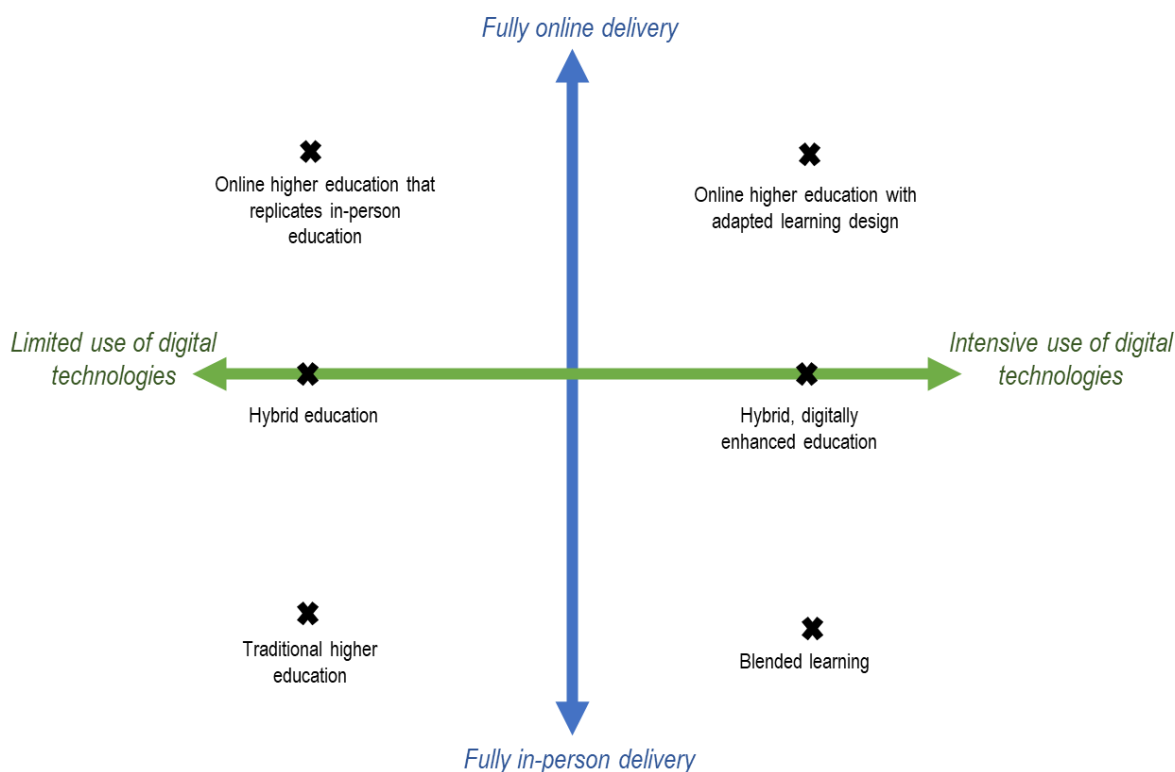
A related group of definitions refer to the wider concept of *digital education* (often also called e-learning or digitally-enhanced teaching and learning), which includes not only using the internet to deliver education, but also using a range of digital tools and technologies to augment, streamline or enhance teaching and learning both in person and online (Qayyum, 2022<sup>[7]</sup>).

Digital education is, therefore, a broad term encompassing a wide range of digital tools, technologies, and resources to enhance learning. The extent to which a higher education programme integrates digital technologies will vary regardless of the mode of delivery of the programme. As digital technologies become more embedded in higher education systems it becomes more difficult to assign programmes to meaningful and mutually exclusive categories such as online, hybrid or blended. A more realistic approach, reflecting the complexity of today’s higher education offer, may be to map higher education programmes within a two-dimensional framework, considering both the intensity of use of digital tools and technologies and the proportion of the programme delivered through online channels (Figure 4.1).

Online or hybrid education necessarily employs digital technologies, but the extent to which it makes use of digital technologies can vary from simple recording and/or streaming of a live lecture (i.e. minimal

technology use) to the employment of various evidence-based digital tools to promote engagement and learning (i.e. heavy technology use) (Figure 4.1). While this chapter focuses on improving the quality of online and hybrid learning, it recognises that successful high-quality online and hybrid learning necessarily depends on effective digital education. The analysis in the next sections proceeds on the principle that strategies for achieving high quality in online teaching and learning should be considered within, or be connected to, wider strategies for digitalisation in higher education.

**Figure 4.1. A two-dimensional framework for mapping digital higher education programmes**



An emerging principle from the deliberations of quality assurance bodies is that the fundamental conditions for high-quality education are, or should be, the same regardless of mode of delivery. Nevertheless, there are indications from international research evidence that further work is required before this vision can become a reality. While few rigorous studies of the impact of online education have taken place in Europe, available experimental and quasi-experimental evidence, primarily from North America, provides a mixed picture of the impact of online learning on student access, progress and achievement, and cost efficiency (Table 4.1).

As in most countries, the COVID-19 pandemic forced Croatian higher education institutions to switch their entire education offer, almost overnight, to remote learning. The situation in Croatia was further exacerbated by the 2020 earthquakes. These caused considerable damage to buildings and necessitated prolonged periods of emergency remote instruction in some education institutions. Emergency remote teaching was generally considered to have been efficiently implemented in higher education institutions. During structured interviews conducted as part of this project many practitioners and institution leaders, however, expressed concerns to the OECD team about the potential adverse impacts of emergency remote instruction on quality, due to reliance on assessment procedures, educational materials and teaching methods not designed to be used in an online environment.



The studies presented in Table 4.1, and the experience of many higher education institutions during the emergency period of COVID-19 indicate that caution is needed when moving from traditional face-to-face instruction to online modes of delivery.

There is also evidence, however, to suggest that many challenges related to providing higher education in online or hybrid mode could be surmounted by careful design of interventions tailored specifically to the online context, by iterative improvement of web-based or web-enhanced offers, or by more thoughtful use of digital tools. For example, a recent randomised controlled trial in Germany which offered remote, online peer tutoring to students during the pandemic led to significant improvements in remote students' grades and credit acquisition (Hardt, Nagler and Rincke, 2022<sup>[8]</sup>). In New Zealand, a 2016 study showed that as web-enhanced and web-based courses became embedded and normalised in the tertiary education, gaps in completion rates between extramural (remote) and intramural (on-campus) disappeared for most groups of students (Guiney, 2016<sup>[6]</sup>).

Uncovering and sharing examples of good practice can help support better outcomes for students studying in online or hybrid modes. If higher education institutions are to make effective use of digital technologies in teaching and learning, they need support from quality assurance agencies and other public authorities to discover and assimilate emerging knowledge of good practices, and to design their own digitally enhanced teaching and learning innovations. They also need clear mechanisms to collaborate and exchange on their own best practice discoveries.

This chapter provides a review of emerging standards, supports and practices that can enable high-quality education to be partially or fully delivered online and argues such measures should be cultivated within a coherent and collaborative institution-wide strategy for digital education aligned to national and international policy developments.

### ***Defining standards, supports and practices***

High-quality digital education requires a range of enabling factors. Quality can be supported by a set of clear and cohesive **standards**, set by external quality assurance bodies, for the development and delivery of digital education. Such standards can help to set clear expectations for the measures that need to be taken to ensure high-quality, consistent delivery of teaching across national higher education systems (OECD, 2021<sup>[9]</sup>).

At the same time, the existence of standards alone is not sufficient to support widespread access to high-quality education. Institutions are likely to need a range of additional external **supports** to ensure they can achieve the standards required by external quality assurance bodies. Such supports may include, for example, public financing, staff training and mechanisms to incentivise co-ordination and collaboration among institutions.

Finally, institutions can promote quality through their own internal **practices** including internal policies, leadership on digitalisation, teaching and learning improvement, and mechanisms to support staff and student skills development.

This chapter reviews in turn emerging trends for each of the enabling factors supporting the delivery of high-quality digital education:

- national and transnational standards as developed and evaluated by organisations external to higher education institutions;
- supports, as provided by governments, public bodies, and supranational organisations to enable higher education institutions to improve quality standards;
- practices, internal to higher education institutions, which can help to build the foundation of digital competence and culture to support successful online and hybrid learning.

**Table 4.1. Selected studies on the impact of online, blended and hybrid higher education**

Study/review author	Description of study/review	Main messages
Cellini and Grueso (2021)	Evidence synthesis, mainly focused on causal studies	<ul style="list-style-type: none"> <li>• Online study yields overall worse performance and lower course completion than in-person coursework, especially for males, less prepared students, and undergraduates</li> <li>• Students studying online have more difficulty concentrating and feel less connected to peers</li> <li>• Streamed/video lectures are better than no attendance, but not better than in-person attendance</li> <li>• Outcomes likely depend on provider and programme design, as much as the mode of delivery</li> </ul>
Bowen et. al. (2014)	Experiment – delivering a hybrid statistics course with an adaptive learning methodology on several campuses	<ul style="list-style-type: none"> <li>• Student performance and learning outcomes in the hybrid course were equivalent to the performance of students studying in-person</li> <li>• If results are not worse, cost savings may be achieved (indicated by cost simulations)</li> </ul>
Bettinger et. al. (2017)	Quasi-experimental study of undergraduate degree-seeking student cohort in a large for-profit institution, where each course is available in both online and in-person format	<ul style="list-style-type: none"> <li>• Students in online version of courses perform substantially less well than students attending the same course in person</li> <li>• Negative effects are stronger for weaker students</li> <li>• First order costs in the study are the same for both online and offline courses (tuition costs for students, staff costs for the institution)</li> <li>• Other costs may be lower for online students (e.g. transportation), and the institution (e.g. cost of physical assets) potentially providing a basis for accepting poorer results</li> <li>• A full “welfare analysis” would take account of learners otherwise unable to study</li> </ul>
Hemelt et. al. (2021)	Descriptive study of postsecondary instructional costs in 200 four-year colleges in the United States	<ul style="list-style-type: none"> <li>• Simply moving more education online does not fundamentally alter the costs of provision</li> <li>• Deep inequities are evident in access to online education and supplementary supports</li> <li>• Since online education requires more support for certain student groups, additional costs for support may be incurred</li> </ul>
Cacault et. al (2021)	A large-scale randomised experiment in a Swiss university. First-year bachelor students were offered access to a live streaming platform for many of their compulsory courses, randomised across students and weeks of the course	<ul style="list-style-type: none"> <li>• Students use the live streaming technology only occasionally, when unable to attend class</li> <li>• Offering live streaming only mildly reduces in-class attendance</li> <li>• Attending lectures via live streaming lowers achievement for low-ability students and increases achievement for high-ability students</li> </ul>
Kofoed et. al. (2021)	A randomised experiment assigning 551 students in a military academy to either an online or in-person version of an introductory economics course	<ul style="list-style-type: none"> <li>• Final grades for online students dropped by 0.215 standard deviations, with worse performance observed in both assignments and exams</li> <li>• Performance gaps were largest for academically at-risk students</li> <li>• A post-course survey found that online students struggled to concentrate and felt less connected to instructors and peers</li> </ul>

Sources: Bowen et al (2014<sub>[10]</sub>), Interactive learning online at public universities: Evidence from a six-campus randomized trial, <https://onlinelibrary.wiley.com/doi/10.1002/pam.21728>; Bettinger et al. (2017<sub>[11]</sub>), Virtual classrooms: How online college courses affect student success, <https://www.aeaweb.org/articles?id=10.1257/aer.20151193>; Cellini and Grueso (2021<sub>[12]</sub>), Student Learning in Online College Programs, <https://doi.org/10.1177/23328584211008105>; Hemelt et al (2021<sub>[13]</sub>), Why is math cheaper than english? Understanding cost differences in higher education, <https://www.journals.uchicago.edu/doi/full/10.1086/709535>; Cacault et al. (2021<sub>[14]</sub>), Distance Learning in Higher Education: Evidence from a Randomized Experiment, <https://doi.org/10.1093/jeeal/jvaa060> and Kofoed et al (2021<sub>[15]</sub>), Zooming to Class?: Experimental Evidence on College Students' Online Learning during COVID-19, <https://docs.iza.org/dp14356.pdf>.

## National and transnational standards for digital higher education

Prior to joining the European Union, Croatia had already committed to fully adopting the Bologna Process and restructuring its higher education system to align with European norms. While there remain significant differences across Europe in the ways higher education institutions are created, regulated, and funded (EHEA, 2022<sup>[16]</sup>) there is increasing convergence on quality assurance standards and guidelines being adopted to assure higher education. This convergence of norms is beginning, to some extent, to cover higher education provided online. This section provides an overview of current trends in the evolution of both transnational and national quality assurance standards for digital higher education, with a focus on online and hybrid delivery of education programmes.

### ***Transnational approaches***

Transnational quality assurance bodies work to ensure comparability of study programmes across countries. This comparability supports trust in the quality of higher education delivered across participating countries, permits recognition of qualifications gained abroad, and facilitates the mobility of learners and graduates. Transnational bodies may work on a regional basis (for example, ENQA) or global basis (for example, the International Network of Quality Assurance Agencies in Higher Education (INQAAHE)). As well as transnational quality assurance agencies, other international bodies promoting international collaboration on improving quality of online and hybrid education include UNESCO, the European Commission, the OECD, and the International Council for Open and Distance Education.

A key point of reflection for transnational and international organisations in recent years has been how to approach quality assurance of online higher education. For the most part, these bodies have concluded that standards for assuring the quality of online education are best integrated into existing frameworks. In practice, this entails either clarifying that existing standards should be fully applied to higher education provided online, or deciding that specific standards for online higher education should be embedded within the overarching quality assurance framework (Ossiannilsson et al., 2015<sup>[17]</sup>).

Transnational organisations taking the former approach include UNESCO, whose *Global Convention on the Recognition of Qualifications Concerning Higher Education* states that qualifications delivered through emerging modes of delivery should be assessed “using the same criteria as those applied to similar qualifications acquired through traditional learning modes.” Similarly, the Asia-Pacific Economic Council (APEC) advocates integrating quality assurance of online education within existing frameworks, which *ensures that standards and quality are equivalent for all modes of learning* (Staring et al., 2022<sup>[4]</sup>).

At the same time, some transnational organisations have evolved slightly from fully advocating an integrated approach. For example,

- INQAAHE’s base position is that its *Guidelines of Good Practice* (INQAAHE, 2018<sup>[18]</sup>) are equally applicable to online and in-person delivery. However, following a recent global review of trends (Karakhanyan and Stensaker, 2020<sup>[19]</sup>), INQAAHE acknowledged more specific guidance is needed for online education. Its 2022 release of international standards and guidelines for quality assurance includes a specific module on online and blended modalities (INQAAHE, 2022<sup>[20]</sup>).
- ENQA’s *European Standards and Guidelines for Quality Assurance 2015* state that the standards and guidelines apply to “all higher education offered in the EHEA regardless of the mode of study or place of delivery” (ENQA, 2015<sup>[21]</sup>). However, an ENQA Working Group subsequently recommended that external quality assurance “should include consideration of the characteristics of e-learning in regular procedures” (Huertas et al., 2018<sup>[22]</sup>).

A proliferation of frameworks and toolkits containing standards for quality of higher education digital provision have been developed by transnational organisations and other bodies (Volungevičienė et al., 2021<sup>[23]</sup>). In the European context, including Croatia, the most important are the *European Standards and*

*Guidelines for Quality Assurance 2015*, and their proposed extension to specifically cover e-learning (Box 4.2). In other regions, emerging frameworks include UNESCO's *Blended Learning Self-Assessment Tool* for the Asia-Pacific region (UNESCO, 2019<sup>[24]</sup>), and the Virtual Quality Seal developed in part by the Organisation of Ibero-American States for Education, Science and Culture (Organisation of Ibero-American States for Education, 2021<sup>[25]</sup>).

#### Box 4.2. The European approach to external quality assurance of digital education (ESG)

The ESG 2015 comprises a set of standards and guidelines grouped under ten key topics (ESG 1.1 to 1.10). These standards and guidelines can be used by external quality assurance agencies operating in the EHEA to guide their development of national standards. Building on ESG 2015, an ENQA Working Group created a set of non-binding considerations for e-learning to integrate with the existing standards relating to each ESG area (Huertas et al., 2018<sup>[22]</sup>). The Working Group adopted a broad definition of e-learning as, “encompassing every form, including blended learning... and that which is facilitated through the use of ICT.”

#### Selected indicators related to e-learning recommended for evaluation within the ESG

ESG area	Key proposed indicators related to e-learning
<i>Policies for quality assurance (ESG 1.1)</i>	<ul style="list-style-type: none"> <li>the inclusion of e-learning in the institution's overall strategy</li> <li>the involvement of remote learners in the internal quality assurance system</li> </ul>
<i>Design and approval of programmes (ESG 1.2)</i>	<ul style="list-style-type: none"> <li>the institution has a clear strategy for digital innovation</li> <li>e-learning programmes are aligned with the institutional mission</li> <li>curricula design reflects pedagogical practices and innovation</li> <li>those involved in designing, developing and evaluation e-learning have the required academic and technical expertise</li> <li>teaching staff are aware of the challenges and opportunities of developing e-learning</li> <li>students are key stakeholders to be consulted when developing e-learning curricula</li> </ul>
<i>Student-centred learning, teaching, and assessment (ESG 1.3)</i>	<ul style="list-style-type: none"> <li>teaching and learning processes, learning materials and technical infrastructure meet the aim of achieving learning outcomes, allow for e-assessment, facilitate student learning, and are regularly reviewed and updated</li> <li>students are informed about e-assessment processes, plagiarism rules, trained on how to appropriately work with online materials and behave in online environments</li> </ul>
<i>Admission, progression, recognition, certification (ESG 1.4)</i>	<ul style="list-style-type: none"> <li>students are informed about the equipment, e-learning, digital skills, and knowledge requirements</li> <li>students are informed about the workload and pedagogical model</li> <li>there is an institutional policy and procedure in place to recognise prior learning</li> </ul>
<i>Teaching staff (ESG 1.5)</i>	<ul style="list-style-type: none"> <li>teaching staff is trained and proficient in the use of learning technologies and e-assessment methods</li> <li>the institution has developed procedures to identify the support requirements of the teaching staff</li> <li>technological and pedagogical support services for teachers are adequate, accessible, and timely</li> </ul>

	<ul style="list-style-type: none"> <li>institutions monitor student-staff ratio to keep teachers' workload manageable as well as staff hiring and recruitment procedures</li> </ul>
<i>Learning resources and student support (ESG 1.6)</i>	<ul style="list-style-type: none"> <li>the Virtual Learning Environment (VLE) supports a variety of methods and tools</li> <li>the technical infrastructure allows accessibility of e-learning programmes by students with special educational needs</li> <li>students with an adequate e-library and virtual labs</li> </ul>
<i>Information management (ESG 1.7).</i>	<ul style="list-style-type: none"> <li>institutions collect and use data to evaluate the quality of e-learning programmes, including learning analytics to track students' performance in real time</li> <li>information management systems include relevant, updated, and reliable information concerning the institution and its programmes</li> <li>policies consider ethical norms and government policy with respect to data protection and the privacy</li> </ul>
<i>Public information (ESG 1.8)</i>	<ul style="list-style-type: none"> <li>institutions publish dependable, complete, and up-to-date information on study programmes, technical supports, technical requirements to use the system, completion rates, pass rates and dropout rates</li> </ul>
<i>Ongoing monitoring and periodic review of programmes (ESG 1.9).</i>	<ul style="list-style-type: none"> <li>e-learning programmes are regularly reviewed, updated, and improved</li> <li>pedagogical developments are aligned with institutional strategy</li> <li>ICT and pedagogy developments are analysed and implemented</li> <li>the internal quality assurance system considers feedback from key stakeholders (especially students)</li> </ul>
<i>Cyclical external quality assurance (ESG 1.10).</i>	<ul style="list-style-type: none"> <li>institutions exchange with their respective quality assurance agencies on their e-learning provision</li> <li>institutions engage in a process of exchange of information and collaboration for the development of sector-wide accepted standards and processes for the QA of digital higher education</li> </ul>

Source: Adapted from Staring et al (2022<sup>[4]</sup>), Digital higher education: Emerging quality standards, practices and supports, <https://www.oecd.org/education/digital-higher-education-f622f257-en.htm>.

Additional frameworks and standards have been developed by other bodies to evaluate and improve online and hybrid learning, including some with a focus on all forms of digital higher education. For example, the International Council for Open and Distance Education – a global association of more than 190 institutional members across 70 countries – developed a Benchmarking Framework for Online, Open, Smart, and Technology Enhanced Higher Education (Hassan, 2022<sup>[26]</sup>). Other prominent international standards covering digital education include the ACODE benchmarks for technology-enhanced learning (Sankey and Padró, 2016<sup>[27]</sup>) and the e-Excellence manual of the European Association of Distance Teaching Universities (EADTU, 2016<sup>[28]</sup>).

### **National approaches**

National quality frameworks for higher education are often heavily informed by transnational frameworks and standards. In Croatia, for example, the national approach to quality assurance is heavily aligned with and informed by ENQA standards and guidelines. However, national quality assurance agencies are also guided by their own regulatory requirements and the extent to which national processes emphasise accountability and/or improvement as the main purposes of quality assurance (OECD, 2018<sup>[29]</sup>).

Thus, the specifics of national quality assurance frameworks will vary depending on whether the focus is on external evaluations (of programmes, institutions and/or individuals) or on building institutional capacity

to improve digital competences and embed digital culture. Recent OECD research (Staring et al., 2022<sup>[4]</sup>) categorised national approaches to quality assurance of digital higher education provision in the OECD and European Union countries. A review of quality assurance documents across 43 higher education systems showed three distinct approaches:

- *The system has no specific standards for digital higher education.* In 23 of the 43 systems, no specific standards or procedures for the external QA of digital higher education were identified. In these systems, common standards and processes for the accreditation and review of higher education providers and programmes are applied, regardless of delivery mode.
- *Common standards are in place for online and traditional study modes.* In three systems, common standards are in place for all modes of delivery. However, in contrast with the previous category, common standards came about as the result of a conscious decision made by the quality assurance body to extend the application of standards for in-person provision to digital provision.
- *Specific standards for digital higher education.* Specific standards or guidelines for digital higher education were identified in 17 systems, although further variation within this category is evident, depending on whether the standards are optional and the categories of institution to which they apply.

Table 4.2 presents a more detailed breakdown of the systems in each category.

**Table 4.2. Approaches for the external quality assurance of digital higher education**

Approach	Systems	Number	
No specific standards	<b>No or limited evidence of digitally enhanced standards or guidelines</b>  Austria, Belgium (Flemish Community), Belgium (French Community), Chile, Colombia, Costa Rica, Denmark, France, Germany, Greece, Iceland, Israel, Italy, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, Poland, Slovakia, Switzerland, Türkiye	23	
Common standards	<b>Intentional application of common standards for digital and traditional study modes</b>  Finland, Spain, United Kingdom	3	
Specific standards	<b>Optional standards or accreditation digital higher education (8)</b>  Czech Republic, Estonia, New Zealand, Norway, Slovenia, Spain, Sweden, United States (DEAC, NWCCU, NECHE, HLC)	17	
	<b>Standards or guidelines applicable to all types of digital higher education (12)</b>  <i>Mandatory:</i> Australia, Canada (Campus Alberta Quality Council), Croatia, Czech Republic, Estonia, Malta, New Zealand, Norway, Romania, Slovenia, Sweden, United States (selected accreditation bodies)		<b>Standards or guidelines applicable to specific types of digital higher education (7)</b>  <i>Fully online:</i> Hungary, Japan, Portugal, Spain <i>Hybrid:</i> Ireland, Romania <i>Other:</i> Canada (British Columbia's Digital Learning Advisory Committee)
	<b>Standards or guidelines applicable to higher education providers (9)</b>  Australia, Czech Republic, Estonia (institutional accreditation), Ireland, Malta, New Zealand, Norway, Slovenia, Sweden		<b>Standards or guidelines applicable to higher education programmes (9)</b>  Canada (Campus Alberta Quality Council, British Columbia Digital Learning Advisory Committee), Croatia, Estonia (e-course quality label), Hungary, Japan, Portugal, Romania, Spain, United States (selected accreditation bodies)

Source: Adapted from Staring et al (2022<sup>[4]</sup>) Digital higher education: Emerging quality standards, practices and supports, <https://www.oecd.org/education/digital-higher-education-f622f257-en.htm>.

Some national standards for online or blended higher education are provided on an optional basis, although public authorities may offer incentives to institutions to undergo external review using the standards. For example, the Estonian Quality Assurance Agency for Higher and Vocational Education (HAKA) offers instructors the opportunity to apply for an external review of their digital courses and to obtain an “E-Course Quality Label” (HAKA, 2022<sup>[30]</sup>). Take up of such incentives may vary depending on the attractiveness of the award and/or the administrative burden on the institution. In Spain, while institutions can apply to have a degree programme receive a Quality Label for Distance Learning from the national quality assurance body (ANECA), as of 2022 just 12 degrees in total had received the label (Staring et al., 2022<sup>[4]</sup>).

In countries where specific quality assurance criteria exist for online programmes, including Croatia, standards are applied only to programmes that meet specific national definitions of an “online” or “blended” programme offer. For example, in Hungary, Japan, Portugal and Spain, specific standards exist only for the *ex-ante* accreditation of programmes defined as fully online, while in Ireland and Romania specific quality considerations have been established for hybrid education (Table 4.2). Croatia’s specific criteria apply to education programmes where more than 50% of the contained subjects are to be offered online (Box 4.3).

Conversely, some countries target their specific standards or guidelines at entire institutions. In Australia, the Tertiary Education Quality and Standards Agency has developed a list of “risks to quality” for technology-enhanced learning (TEQSA, 2019<sup>[31]</sup>). The risks are assessed within the legislative basis provided in *Higher Education Standards (HES) Framework (Threshold Standards)*. In Malta, providers wishing to offer digital education have to apply to the Further and Higher Education Authority for necessary approval before undergoing an evaluation by independent digital education experts (Malta Further and Higher Education Authority, 2021<sup>[32]</sup>).

Croatia’s approach falls between the two models described above. Institutions must have accreditation at the programme level for online learning, but there is also a comprehensive set of standards requiring institutions to have certain infrastructures and supports in place. Croatia’s approach to quality assurance for online learning is currently evolving from a situation with separated definition and evaluation of criteria for online programmes to a more integrated approach located within the ASHE (Box 4.3).

#### Box 4.3. Quality assurance of online programmes in Croatia’s higher education system.

In Croatia, institutions wishing to offer a programme of study in which at least 50% of subjects or 50% of teaching hours are provided online must meet several additional quality criteria, established in 2016. These requirements are checked by the ASHE as part of *ex-ante* programme accreditation procedures. In addition, students pursuing such programs are automatically classified as part-time students.

The requirements on institutions to meet the criteria for online programmes are comprehensive, and include:

- clear articulation of programme purpose, including the modes of delivery, and how it relates to the institution’s strategy, based on robust research;
- infrastructural requirements, including implementation of a VLE, interoperability with other technologies and programme offers, embedded use of learning analytics, financial plans for infrastructure procurement and maintenance, and detailed information provided to students about the technologies and associated policies;
- defined programme learning outcomes;
- a detailed weekly schedule of online activities; a list of quality online learning materials, specifically prepared for the independent use by students; a list of other resources that will be

used in the online course; clear and precise instructions for students' online work; and a clear description of how online assessment will be carried out;

- a range of specific technical, administrative, and academic supports to be made available to students studying online.

The extensive criteria were perceived in some cases to be too stringent for institutions to meet. Prior to the pandemic, fewer than 20 online higher education programmes had been established which meet these criteria.

With the entry into force of the revised Law on the Quality of Higher Education in December 2022, ASHE became the competent body for the establishment of criteria for accreditation of online programmes. It plans to set criteria to align with the considerations for quality assurance of e-learning developed by the ENQA Working Group for Quality Assurance and e-learning (Box 4.2).

Sources: Republika Hrvatska (2016<sup>[33]</sup>), Kriterije i postupke za vrednovanje online studija, <https://www.nvzvotr.hr/images/documents/Kriteriji%20i%20postupci%20za%20vrednovanje%20online%20studija.pdf>; Parliament of Croatia (2022<sup>[11]</sup>), Law on Quality Assurance in Higher Education and Science, [https://narodne-novine.nn.hr/clanci/sluzbeni/2022\\_12\\_151\\_2330.html](https://narodne-novine.nn.hr/clanci/sluzbeni/2022_12_151_2330.html)

## Public supports for improving digital higher education

Quality standards alone are unlikely to lead to improvements in higher education delivered in online, hybrid or blended mode. Increasingly, quality assurance bodies are playing a more active supporting role – aiming to guide and collaborate with institutions on improving their internal quality assurance systems. Potential drivers of this trend include the need to respond to the largely unregulated mass movement to online education during the COVID-19 pandemic, and calls from transnational organisations such as INQAAHE and ENQA to move towards institution-based quality assurance and permit wider self-accreditation of programmes (Council of the European Union, 2022<sup>[34]</sup>). When external quality assurance agencies devolve more trust and responsibility to individual higher education institutions, they also free up agency resources to become a more supportive and collaborative partner for institutions, even if they maintain some external regulatory functions (Staring et al., 2022<sup>[4]</sup>).

Other public bodies may also support higher education institutions as they seek to improve the quality of their digital education provision. This section develops a taxonomy of five support types that have been introduced or strengthened across OECD and EU countries in recent years with an explicit objective or implicit possibility to assist in the improvement of digital higher education. These supports include:

- advice on strategic alignment and development;
- collecting, and sharing good practices for digital education provision;
- providing funding and financial incentives;
- building skills, expertise, and capacity;
- taking actions to stimulate collaboration (Figure 4.2).

While institutions are primarily responsible for building digital competence and culture within their organisations, they are more likely to be successful with a strongly supportive policy framework.

### **Support type 1: Supporting strategic development and alignment**

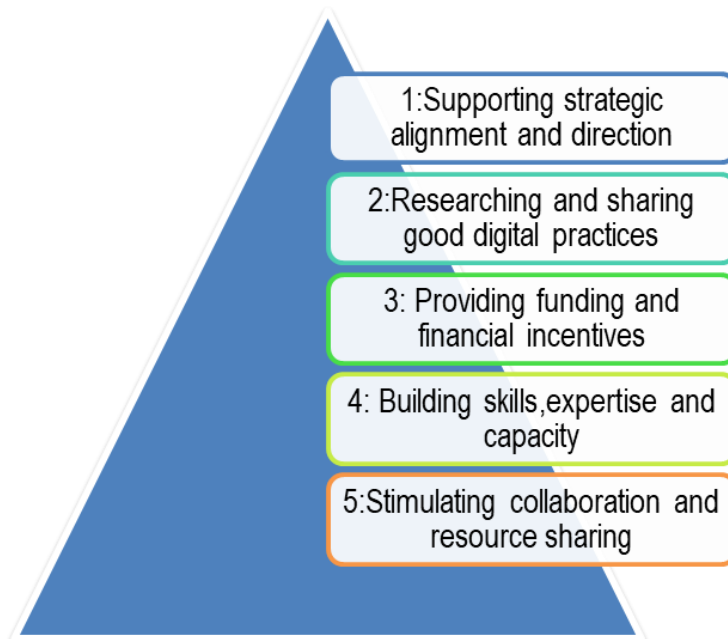
In some countries, external quality standards for digital higher education are accompanied by guidance to higher education institutions to help interpret the formal language of standards and support their implementation. As an example, the United Kingdom Quality Assurance Authority has developed a



*Taxonomy for Digital Learning*, providing definitions and classifications of terms commonly used by education providers in the UK to describe their digital offerings (e.g. blended, hybrid, online, virtual, distance, remote, face-to-face, in-person) (QAA, 2020<sup>[35]</sup>).

Public authorities may also provide more comprehensive guidance to institutions seeking to adapt their own strategies to align with national and international quality standards. In this regard, governments seek to take into account the autonomy and academic freedom of higher education institutions. They provide information, resources, and capacity-building opportunities that institutions may not have easy access to from other sources. For example, while higher education institutions across the OECD tend to have autonomy to set their own strategies for digital education, many governments and other actors still provide a statement of national policy and/or other guidance to support institutions' strategic development. This helps them understand and assess their current capacity to develop high-quality digital education and chart a course for its improvement (OECD, 2023 (forthcoming)<sup>[36]</sup>).

**Figure 4.2. Options for public supports to improve the quality of online and hybrid education**



Advice for strategic alignment and institution self-evaluation of its digital higher education provision is becoming widespread across OECD countries. In New Zealand, Ako Aotearoa first established strategic advice for institutions on e-learning in 2014 (Coolbear, 2014<sup>[37]</sup>). Norway's Standing Quality Committee of Flexible Education Norway (FuN) also has long-established guidelines to support institutions with the development of strategy for digital higher education quality (Flexible Education Norway, 2018<sup>[38]</sup>).

Transnational and supranational organisations also provide a wide range of advice to support institutions in strategy development with respect to digital education. Prominent examples in Europe are the European Commission's frameworks of best practice statements to support reflection and improvement of digital practices in education institutions. These include the European Framework for the Digital Competence of Organisations (DigCompOrg) and the European Framework for the Digital Competence of Educators (DigCompEdu). These frameworks cover a range of thematic areas including leadership and governance practices, collaboration, and networking (Redecker and Punie, 2020<sup>[39]</sup>).

Institutions can also increasingly access more precise guidance and advice on specific topics related to, for example, the improvement of teaching and learning, and the provision of open educational resources. A recent report by the European University Association found that institutional advice for improving digital

teaching and learning is offered not only by quality assurance agencies but also by a range of different organisations operating at a national or regional level. These include National Research and Education Networks, foundations, sectoral associations, or networks of institution leaders. A wealth of self-assessment instruments are also now available to higher education institutions to help guide their self-evaluation and strategic development with respect to digitalisation (Volungevičienė et al., 2021<sup>[23]</sup>).

The provision of advice and guidelines to institutions can support their improvement. However, as the number of toolkits and guidelines multiply, institutions may become overloaded with efforts to integrate and assimilate them. This is a particular risk where multiple guidelines and sets of advice available from various national and international actors do not align or share a common vision, or where they duplicate each other. Depending on the context, institutions may require external support to curate and interpret knowledge and guidance from many diverse sources and adapt it to their local context.

One promising development in a small number of countries (including Ireland, Germany, Norway and the United Kingdom) has been the establishment of specific national centres whose role is to support higher education institutions as they work to improve their education function (Ehlers and Zhang, 2022<sup>[40]</sup>). Such centres (for example, the Irish National Forum for the Enhancement of Teaching and Learning, Box 4.4) can play a pivotal role, helping institutions to integrate and reflect on guidance and advice provided by various sources related to digital education.

#### Box 4.4. National Forum for the Enhancement of Teaching and Learning, Ireland

Established in 2012, Ireland's National Forum for the Enhancement of Teaching and Learning has responsibility for leading and advising on the enhancement of teaching and learning in Irish higher education. Funded by the Irish Higher Education Authority (HEA), the National Forum co-ordinates many different initiatives, all focusing on the goal of enhancing teaching and learning. From its inception, building digital capacity was one of five principal areas of action. Following an external review and a sector-wide consultation process, in 2018 the National Forum Strategy 2019-21 was launched, with four key strategic priorities, one of which is "Teaching and Learning in a Digital World". This priority has the objective of *"supporting those who learn, teach, and support learning to embrace and harness the potential of digital technologies"*.

The National Forum for the Enhancement of Teaching and Learning has published a range of strategic advice for higher education institutions, developed through research, collective discussion, and co-creation among higher education institutions in Ireland. For example, a *Guide to Developing Enabling Policies for Digital and Open Teaching and Learning* was published in 2021.

Also in 2021, a project on *"Next Steps for Teaching and Learning, moving forward together"* was established, to bring together a range of stakeholders from across the higher education sector (including Quality Qualifications Ireland (the Irish quality assurance agency), institution representatives, students and other stakeholders) to answer one shared question: *'In the context of Covid, what have we learnt and what does it mean for the future of teaching and learning in higher education.* The project represented a new departure in the higher education sector in Ireland in terms of the scale of and the approach to national collaboration. The recommendations of the report attracted targeted public funding to support their implementation through a specific funding instrument - the Strategic Alignment of Teaching and Learning Enhancement Funding in Higher Education in Ireland. The funding is targeted specifically to teaching and learning and is non-competitive (with funding allocated on a pro rata basis based on student numbers), thereby encouraging cross-institution collaboration.

Source: Adapted from National Forum (n.d.<sup>[41]</sup>), National Forum for the Enhancement of Teaching and Learning in Higher Education: Resource Hub, <https://www.teachingandlearning.ie/resourcehub/>.

## **Support type 2: Researching and sharing good digital practices**

The COVID-19 pandemic led to an acceleration of digitalisation in teaching and learning and in some cases forced educators to adopt digital practices for the first time, many of whom characterised the rapid shift to online education necessitated by the pandemic as challenging or very challenging (OECD, 2021<sup>[42]</sup>). Many who integrated digital tools into their teaching did so with little awareness of how technology can support teaching and, in a crisis, made limited use of evidence from the research literature on good practices (Martin et al., 2020<sup>[43]</sup>). There is now an imperative across countries to increase digital competence of staff in higher education institutions, including building the pedagogical knowledge of teachers to produce high-quality content intended for online delivery. Governments and other national bodies can play a role in researching and sharing good organisational and pedagogical practices that drive improvement of digital education provision, helping to inform and orient educators and institution leaders.

Strategies for collecting information on promising practices vary across countries. Some public bodies collect information directly from institutions to gain an understanding of practices that can be shared more widely. For example, in Hungary, the Ministry for Innovation and Technology commissioned two surveys on digital higher education in 2020, one of which sought information on digital practices and institutional leaders' views on factors determining the extent of digitalisation in their organisations, including external factors (e.g. students' digital skills) and internal factors (e.g. access to digital infrastructure, teachers' digital skills) (OECD, 2021<sup>[9]</sup>).

Quality assurance agencies in many countries also actively collect and disseminate national and international good practices and resources for the quality improvement of digital provision. In Australia, for instance, TEQSA published a series of key considerations for providers of online delivery in 2020 which was subsequently broadened into an *Online Learning Good Practice* website (TEQSA, 2022<sup>[44]</sup>). In the UK, QAA offers training sessions and instructional videos to institutions on best practices in digital education, and published "*Hallmarks of Success*" covering student-centred teaching; assessment in digital and blended pedagogy; programme design and management; and empowering teaching staff (QAA, 2022<sup>[45]</sup>).

Some national quality assurance bodies have also carried out specific thematic surveys to elicit information on best practices among the institutions for which they bear responsibility for supporting. While such surveys became far more common during and following the pandemic (as in Croatia), in some systems, thematic reviews of digital learning were carried out years beforehand. In 2017, for instance, UKÄ in Sweden conducted a survey among Swedish institutions on "strategies and range of distance learning courses and degree programmes, and the support they offer distance students" (UKÄ, 2018<sup>[46]</sup>).

Some governments and public bodies also conduct or fund regular research reviews on organisational practices associated with improved quality in higher education and curate their results to share with institutions. For example, the Digital Higher Education Consortium of Texas commissioned a comprehensive meta-analysis of available data and research relevant to online and blended higher education, to synthesize messages about good practices from the existing evidence and identify important gaps in the research (Box 4.5).

### **Box 4.5. Meta-analysis to surface good practices in digital higher education in Texas**

In 2020, the Digital Higher Education Consortium of Texas carried out a meta-analysis of existing data and research on digital (including distance and online) higher education in Texas to identify gaps in the evidence base. It also worked on strategies to improve the body of knowledge in areas with less evidence of good practice available. The review found that there is a pressing need for more quantitative, empirical, and experimental research about digital education. At the same time, digital education produces substantial amounts of data about teaching and learning previously difficult to

capture at scale in face-to-face courses, which, if harnessed effectively, can support a better understanding of the impacts of digital education.

Some of the studies reviewed in the meta-analysis highlighted positive student outcomes, notably in institutions with an extensive experience and history in using online education to support successful outcomes for diverse learner populations. At the same time, it was noted that few of the reviewed studies were able to disaggregate data for minorities and disadvantaged populations, limiting ability to focus on equity issues.

The review also highlighted gaps in research on impact and outcomes, including student retention, progress, completion, and success, related to digital education. Comparative studies of online and face-to-face courses and programs, even though they are complex in design, are needed. Some studies highlighted in the meta-analysis offer a template for experimental and quasi-experimental designs.

Source: Sebesta et al, (2020<sup>[47]</sup>). Digital Higher Education in Texas: A Meta-Analysis of Data and Research, [https://tacc.org/sites/default/files/documents/2020-06/digitex\\_meta-analysis.pdf](https://tacc.org/sites/default/files/documents/2020-06/digitex_meta-analysis.pdf).

A small number of countries have developed specific portals that can be used to widely disseminate the results of evidence reviews of different practices and approaches across education organisations, including reviews of the impact of digital technologies. Such initiatives include the Teaching and Learning Toolkit of the United Kingdom’s Educational Endowment Foundation’s “What Works” centre (EEF, n.d.<sup>[48]</sup>), and the Danish Clearinghouse for Educational Research (DPU, 2022<sup>[49]</sup>).

### ***Support type 3: Providing funding and financial incentives***

Many higher education institutions, including in Croatia, struggle to secure financial and human resources to develop their capacity for high-quality digital education. This is particularly true for smaller institutions, with few staff available to lead on building digital capability across the institutions and often not representing a lucrative customer or partner for educational technology companies. Public authorities have a role to play in supporting institutions to mobilise resources to improve digital education, either through direct provision of funding or through indirect financial incentives. In many countries, governments also are a key funder or provider of the vital digital infrastructure needed to support effective digital education.

Few public authorities systematically award earmarked funding for digitalisation to institutions, although some countries, such as Germany, are considering it (Box 4.6). Where funding has been provided for digital innovation, it tends to be targeted for specific purposes and time limited (OECD, 2023 (forthcoming)<sup>[36]</sup>). One of the most common ways that governments financially support institutions to develop online provision is through the financing of digital infrastructure, either directly or funnelled through NRENS. In many systems, including in Croatia, NRENS play a vital role in supporting institutions with procurement, provision, or joint purchase of a wide range of technologies and services and building capacity among user groups, as well as their traditional role of providing Internet connectivity (see Chapter 5).

OECD research shows that one of the main sources of revenue for higher education institutions in many systems – government-funded tuition fees – is often not applicable to students studying online. The 2020 edition of the OECD Higher Education Policy Survey found that OECD countries typically limit eligibility to public student financial aid programmes for students enrolled in online and hybrid programmes. For example, while all 28 responding systems indicated that full-time students in recognised on-campus bachelor’s programmes were eligible to apply for student financial aid, this was the case for online bachelor’s degrees in only 15 jurisdictions. Additionally, just 9 of the 28 systems provide financial aid to students taking online short-cycle programmes and only 5 provide support for students taking non-degree short online programmes (Golden, Troy and Weko, 2021<sup>[50]</sup>).

Nevertheless, there are indications that governments in some countries may be starting to adapt funding mechanisms and financial incentives to support the provision of high-quality digital education. An increasing number of countries in Europe operate institutional performance agreements as a steering and accountability tool for publicly funded higher education institutions, some of which have targets related to the quality of their digital teaching and learning offer. In the Netherlands, for example, the government and publicly funded higher education sector have agreed on six priority themes for their 2019-24 performance agreements, and some institutions have formulated digitalisation targets under the themes of “education infrastructure” and “professional development of educators” (Rijksoverheid, 2018<sup>[51]</sup>). In Austria institutional performance agreements for 2022 to 2024 include digitalisation as a key priority, aiming to achieve a significant expansion and development of digital education (BMBWF, 2022<sup>[52]</sup>).

#### Box 4.6. Funding digital innovation in higher education in Germany

Germany is an example of a country working to establish a recurrent public funding line for digitalisation in higher education, in a context where it has been found to be lagging on many general measures of digitalisation. A 2019 report by the National Commission of Experts for Research and Innovation (EFI) argued the “digitalisation of Germany’s structurally under-financed tertiary education system is an ongoing task which requires long-term financing” and proposed a per-capita public funding allocation specifically for digitalisation. This funding could be used to invest in digital infrastructure and build capacity for the creation of new and improved digital education offers (EFI, 2019<sup>[53]</sup>). The German Rector’s Conference adopted the proposal in 2021 (HRK, 2021<sup>[54]</sup>) but no final agreement has yet been reached.

Germany also has several targeted funds to support improvements in digital higher education. For example, the Foundation for Innovation in Higher Education Teaching receives EUR 150 million annually from the federal and state governments to award to higher education institutions in competitive calls for learning innovation projects, including projects aimed at improving teaching through the use of digitalisation (Stiftung Hochschullehre, 2022<sup>[55]</sup>).

Source: OECD (2022<sup>[56]</sup>), OECD Reviews of Innovation Policy: Germany 2022, <https://doi.org/10.1787/50b32331-en>.

#### **Support type 4: Building skills, expertise, and capacity**

Several concepts have emerged to describe factors supporting effective assimilation of digital technologies by education institutions, including e-capacity (Vanderlinde and van Braak, 2010<sup>[57]</sup>), and digital capacity (Costa, Castaño-Muñoz and Kampylis, 2021<sup>[58]</sup>). In Croatia, the concept currently used widely in both schools and higher education institutions is that of digital maturity (Balaban, Redjep and Čalopa, 2018<sup>[59]</sup>). Regardless of the specific language used, these concepts emphasise broadly similar dimensions in institutions’ capacity for digital education. There is a strong focus on technical and pedagogical knowledge of educators, their access to professional development; institutional leadership capacity and a conducive organisation structure and culture (Castaño Muñoz, Pokropek and Weikert García, 2022<sup>[60]</sup>).

Across OECD and EU countries, governments and other actors have established initiatives aimed at building skills, capacity, and expertise in digital education. Governments can support staff development in several different ways, through:

- direct provision of high-quality training and other opportunities for building skills;
- support for communities of practice;
- adaptation of human resources policies; and
- recognition and reward of teaching excellence.

Efforts to incentivise staff to improve digital course materials form part of wider efforts to attach a higher value to teaching activity within academic careers, in a context where research has been widely perceived to be (from a career perspective) the most rewarding activity (Janger, Campbell and Strauss, 2019<sup>[61]</sup>).

National networks have emerged to build communities of practice around digital learning. These include SURF in the Netherlands, Flexible Learning Norway, and the Online Learning Consortium in the United States. While these networks are managed by a range of different organisations, they often receive recurrent or project-based funding from governments. For example, SURF received funding from the Dutch Ministry for Education, Research and Culture between 2019 and 2022 to support 40 higher education institutions, collaborating on the development of resources, practices, and guidelines to advance the quality of digital higher education (SURF, 2022<sup>[62]</sup>). International networks and capacity building projects also exist at European level, such as the European Distance and E-Learning Network (EDEN, n.d.<sup>[63]</sup>), and the European Digital Learning Network (DLEARN, n.d.<sup>[64]</sup>).

Another area where capacity-building efforts are strengthening is the use of learning analytics to monitor and improve the education experience of learners. For example, the UK NREN Jisc has created a *Senior Managers' Guide to Learning Analytics* (Jisc, 2020<sup>[65]</sup>) with six key factors to target for the effective implementation of learning analytics. The Japanese government has also embarked on an ambitious project to design and implement learning analytics across its education system. Its first stage will establish an infrastructure and align software across the system so it is ready for learning analytics, while the second stage will collect learner log data that can feed into monitoring and evaluation mechanisms. A third stage envisages personalisation: using the data collected to optimise learning to the individual and to evaluate academic progress. (Digital Agency et al., 2022<sup>[66]</sup>).

Developing capacity and building skills for digital course design and development takes time. Yet most academics do not have time for these activities available in their existing workloads. While most national governments are not directly involved in prescribing workload models for higher education institution staff, they could consider creating incentives for investment of instructional time in the effective use of digital technologies. This could include providing financial assistance with training fees and/or time off to focus on digital education improvement. It could also include augmenting administrative supports to free up capacity for leadership in instructional design and delivery (OECD, 2023 (forthcoming)<sup>[36]</sup>). As yet, there are few examples available of governments attempting to incentivise the creation of such supportive human resources policies.

Capacity can also be built by reconsidering the range of staff roles that can be involved in the development of online and blended learning. Emerging professional roles with job titles including “digital learning technologist,” “educational technologist” and “instructional designer” are well-established in higher education systems in the United States and are becoming more prominent in Europe. Learning technologists can support and advise academic staff on the effective development of online and blended learning material. They are expected to have good pedagogic knowledge as well as technical knowledge.

### **Support type 5: Stimulating collaboration and resource sharing**

Encouraging collaboration and resource sharing can be an effective way to build capacity among academic staff and institution leaders with responsibilities for developing high-quality digital education (OECD, 2017<sup>[67]</sup>). Beneficial and impactful collaboration can take place both within and between institutions. This section examines collaboration instigated or supported by government authorities while the next section will explore institution-led efforts to support collaboration. Given the elevated levels of autonomy and academic freedom enjoyed by higher education institutions, public authorities tend to focus on encouraging higher education instructors, leaders, and IT support staff to engage in peer learning and collaboration on digital teaching and learning through funding incentives.

One of the more innovative recent public funding schemes aimed at supporting peer learning among higher education institutions is the French “digital demonstrator programme” (Box 4.7).

#### Box 4.7. The French “digital demonstrator programme”

In 2021, the French government awarded EUR 110 million to 17 “digital demonstrator projects” (*Démonstrateurs numériques dans l’enseignement supérieur – DemoES*) to fund strategy development, infrastructure, and pedagogical innovation in public higher education institutions across France. The intention is for these demonstrators to enable the state and other organisations to draw inspiration from emerging good practices and embed them in the digital transformation of the entire higher education system.

Each of the 17 projects was chosen to provide next generation showcases of technology integrated into pedagogy in digital higher education. For example, one demonstrator project chosen, a collaboration between Arts et Métiers, CEA Tech, the National Conservatory of Arts and Crafts (CNAM) and the Center for Higher Industrial Studies (CESI) creates “digital twins” – mechanisms to allow students to do practical training on equipment using remote access. The project also focuses on the creation of immersive virtual and augmented reality experiences for students to learn in environments that realistically replicate professional or industrial contexts.

Technologies developed will serve as a showcase example for the rest of the higher education system and support more efficient transfers of the technologies to other higher education institutions.

Source: ANR (2021<sup>[68]</sup>), *Démonstrateurs numériques dans l’enseignement supérieur*, <https://anr.fr/fileadmin/aap/2021/ia-ami-demoes-2021-jo.pdf>

As mentioned previously, collaboration can also be effectively stimulated by public support and funding for the establishment of permanent national organisations with a remit to support teaching and learning in higher education, such as the Irish National Forum for Teaching and Learning in Higher Education (Box 4.4). Few organisations of this type exist, but existing models exhibit promising signs of improving and systematising collaboration across institutions.

The European Commission is also working to address perceived fragmentation in the institutional, national, and international landscape of collaboration and exchange related to digital learning, through the launch of a Digital Education Hub. The Hub aims to establish a European community of practice, engaging a wide variety of stakeholders and supporting cross-sector collaboration on digital education in Europe (European Commission, 2022<sup>[69]</sup>). Finally, support is coalescing around the greater use of Open Education Resources (OER), driven in part by recent UNESCO Recommendation on OER, adopted in 2019 (UNESCO, 2020<sup>[70]</sup>). Governments can also support resource-sharing between institutions by funding or otherwise supporting the creation of national platforms for sharing of e-learning material.

The next section moves from the level of transnational organisations and public authorities to the level of institutions, discussing some of the practices that institutions can adopt to improve their digital competence and culture. This in turn can improve the effectiveness of digitally enhanced teaching and learning.

## Practices to support high-quality digital education

### ***Higher education institutions are likely to benefit most from integrated strategy and joined-up implementation***

Assuring the quality of digital teaching and learning is, first and foremost, the responsibility of higher education institutions, given their organisational autonomy and academic freedom. As with external quality assurance standards, some evidence indicates institutions may be best served by integrating specific considerations for digital education in their existing internal quality mechanisms (Jung, 2022<sup>[71]</sup>). Institutions have been active in this regard: a recent EUA survey of 368 institutions across Europe found that 51% were already integrating digitally enhanced teaching and learning in their internal QA strategies, while integration was under development in a further 41% (Gaebel et al., 2021<sup>[72]</sup>).

While many institutions have developed internal digitalisation strategies, few have developed written guidance or training for institution staff to support the implementation of internal strategies. For example, a review of institution practices in Commonwealth countries (Latchem, 2016<sup>[73]</sup>) found that only 36% of institutions surveyed had access to internal quality assurance manuals when working on quality assurance or improvement activities. Recent reviews of practice indicate that implementation guidance through manuals and similar documents is becoming more widespread (OECD, 2023 (forthcoming)<sup>[36]</sup>).

However, written internal guidance represents only one narrow avenue for progressing improvements. Institutions should take a whole-of-institution approach to developing high-quality digital education, encompassing all modes of delivery. A whole-of-institution approach entails building a shared and aligned vision, strong leadership on both digitalisation and teaching and learning issues, improving infrastructure, equipment, and skills of staff, decision makers and students.

There are three important principles higher education institutions can strive towards embedding throughout their organisation to maximise their capacity to implement high-quality digital education:

- building a shared vision and strong culture for the improvement of digital teaching and learning;
- emphasising innovative and engaging digital course content, design, delivery, and assessment;
- using an evidence-informed framework to guide institutional improvement processes.

The approaches presented below are informed by a comprehensive recent OECD literature review on enabling factors for high-quality digital education (OECD, 2023 (forthcoming)<sup>[36]</sup>) and external expert contributions to the project.

## Principles for institutions to achieve high-quality digital education

### ***A shared vision and strong culture***

Adopting a coherent approach towards improving digitally enhanced teaching and learning enhances the chances of an institution improving its overall education offer. Evidence shows the quality of co-ordination and relationships within a higher education institution can positively influence its performance (De Carmen et al., 2013<sup>[74]</sup>). Co-ordination and alignment of strategy for online and blended education is likely to lead to better results for the institution as a whole compared to a top-down policy or fragmented “pockets of excellence” (Tømte et al., 2019<sup>[75]</sup>).

Some higher education systems are beginning to shift their position on digital education from control-based governance to culture creation (Jung, 2022<sup>[71]</sup>). Recent EUA research stresses the need for educational leaders to build both positive shared beliefs and an enabling climate and atmosphere when designing and implementing major learning innovations, including digital innovations. (EUA, 2022<sup>[76]</sup>). Digital tools can themselves stimulate and streamline co-ordination, creating superior relationship management and more



effective communications (Mendoza and Heredero, 2016<sup>[77]</sup>). Finally, co-ordination between institutions on strategy development can potentially lead to more efficient use of individual institution resources and promote widespread peer learning and practice sharing (Lerstad, 2019<sup>[78]</sup>).

A fundamental first step in supporting high-quality online and blended learning within a higher education institution is the development of a shared, institution-wide vision for improving the quality of digital higher education. This should be co-created with stakeholders from across the institution. Co-creation within the institution supports internal alignment of objectives, while external alignment of the vision with wider national and international policy objectives can be helpful when mobilising resources for implementing reforms.

### ***Focus on innovative and engaging digital course content, design, delivery and assessment***

There is a growing expectation, enshrined in many digital education quality standards and frameworks, that courses designed for online or blended delivery should reflect up-to-date theory and practice in the subject area, as well as best pedagogical practices for engaging students in a digital environment.

Ensuring the active participation of, and interactivity with, students has long been reported as one of the main challenges of teaching online (Garrison, Anderson and Archer, 2010<sup>[79]</sup>). This challenge was underscored by the negative reactions of many learners during the pandemic period to emergency remote instruction, which often attempted to replicate the face-to-face experience in terms of both duration of interaction with instructors and presentation of learning materials. When talking to the OECD review visit team, instructors in Croatia also reported difficulties engaging students in an online environment. These difficulties were often attributed to lack of time and competences needed to prepare a high-quality online learning experience (see Chapter 3).

There is an emerging consensus that educational materials intended for online consumption should be designed to stimulate interactivity, and be usable, accessible, and engaging (OECD, 2023 (forthcoming)<sup>[36]</sup>). Conversely, it has long been recognised that digitalisation can offer solutions to challenges encountered when teaching in-person, and that some digital tools used in online delivery can provide greater engagement between students and their instructors (Oblinger, 2004<sup>[80]</sup>). Therefore, development of high-quality digital teaching and learning can entail both designing content for online delivery and harnessing digital technologies to augment in-person education.

Simunich et. al. (2022<sup>[81]</sup>), provides an overview of general good practice principles for improving the quality of institutional course design as follows (Staring et al., 2022<sup>[4]</sup>):

- Choosing the right people – senior but not remote – so they can lead but also act as a bridge between different groups.
- It is essential to achieve the buy-in of multiple stakeholders to the proposed action.
- New processes must ease, rather than increase, administrative burden, and workload.
- Promote widespread conversation and exploration of the envisaged goals and be willing to accept incremental change rather than expecting major impact overnight.

Individual institutions are pursuing innovations in the use of digital tools for course design and delivery across several fronts. Examples of emerging practices include establishing partnerships with online learning platforms and course or programme managers. The number of such partnerships has been increasing rapidly in both Europe and the United States (HolonIQ, 2021<sup>[82]</sup>). Institutions pursuing course development also have increasing recourse to evidence-based models and frameworks for digital course design. For example, Universal Design for Learning (UDL) is emerging as an important pedagogical principle that should underpin the development of any course, regardless of delivery mode, to support greater inclusion and equity in student outcomes (Ehlers and Zhang, 2022<sup>[40]</sup>).

A major challenge reported by institutions and instructors is how to ensure authentic and trusted online assessment, and in particular mitigating quality risks when students take tests online (Manoharan and Ye, 2020<sup>[83]</sup>). While much of the policy and practice responses to date have focused on enforcement measures such as student authentication and proctoring (Lee-Post and Hapke, 2017<sup>[84]</sup>), there are persistent concerns about the intrusiveness of some measures, and their overall effectiveness in ensuring quality and integrity of assessments. Partly as a reaction to these concerns, there is an emerging focus on prevention, including the redesign of examinations – such as structuring examinations as open-book/open-web tasks or making greater use of oral examination – or shifting towards more authentic, problem-based assessment. Many institutions have ethics and academic misconduct policies to make students aware of and accountable to their responsibilities in terms of academic integrity (OECD, 2020<sup>[85]</sup>).

### ***Harness the power of collaboration to progress more efficiently and increase influence on public policy***

The previous section outlined some ways public authorities can support and incentivise institutions to collaborate on teaching and learning improvement. Institutions can also build capacity for collaboration from the bottom up. While collaboration and connection between diverse individuals and organisation is considered beneficial for innovation, the smaller scale of the higher education system in Croatia and the country's ongoing demographic changes make it even more prudent for institutions to co-operate on digital education issues. Inter-institutional collaboration creates opportunities for the limited funding that is available to be put to the best use possible, through sharing the time and cost involved in building capacity for digital education across institutions.

Furthermore, when institutions and other stakeholders do collaborate effectively, they provide a more influential force to inform national policy development than would be possible with each institution acting alone. Small scale collaborative initiatives can provide powerful use cases to serve as a basis for scaling up. This can happen with the aid of public support or by incentivising more institutions to get involved and contribute to the initiative. A recent example of bottom-up collaboration in Portugal provides a useful example of how collaboration can start small and scale up in a relatively brief period of time (Box 4.8).

#### **Box 4.8. Scaling up teaching and learning innovation in Portugal**

In Portugal, the Universities of Minho and Aveiro have long co-operated on a small scale for specific topics. In 2019 the two universities entered a strategic bilateral partnership with the goal of transforming teaching and learning in their respective institutions. A retreat on the topic organised in 2019 was so successful that three additional retreats were subsequently organised, with staff participation increasing each time, stimulating the formation of networks and a practice community across the two institutions.

The success of the bilateral initiative led to enquiries from staff in other institutions about participating. The two universities created an online inter-institutional conference on pedagogical development (*Jornadas Interinstitucionais de Desenvolvimento Pedagógico*), as a means of expanding innovative practice in teaching development to other institutions. The movement has grown since the first edition was held in 2020, and, consistently, in between sessions, more institutions express interest in being involved. While 9 universities engaged in the first session held in September 2020, by the time of the sixth session just 18 months later 17 higher education institutions contributed, including public and private universities and polytechnic institutes.

Source: Adapted from the more detailed summary of this case study contained in Annex A.

## ***A framework for institutional-level transformation of digital education***

The institution-wide vision and culture promoted above remains rare among higher education institutions. Quality improvement initiatives often only attract a limited number of already highly motivated instructors, while engaging students and institutional leadership in such activities remains challenging for many institutions (Tømte et al., 2019<sup>[75]</sup>). Furthermore, developing design principles for online education during the initial creation of a course requires a lot of planning and preparation by teaching staff, and these efforts often go unappreciated (Barquero, 2022<sup>[87]</sup>). Similar points were made multiple times to the OECD review team by higher education academic staff during the OECD project team visit to Croatia in 2022.

The improvement efforts of institutions may be more impactful if they are guided by an evidence-informed framework which sets out steps and important principles for transforming online and blended learning. Box 4.9 proposes such a framework, summarising the key points of the more detailed institution guidelines developed as part of this project (see Annex A).

### **Box 4.9. A framework for institutional-level transformation of digital education**

A framework for institution-level transformation of online and blended learning should support a co-creative process that builds a collective vision and allows for gradual, iterative progress. An 8-step cyclical approach is proposed for Croatian institutions to develop an inclusive, consultative strategy:

Step 1: Find and understand the drivers for strategy development.

Step 2: Identify resources for strategy development and implementation.

Step 3: Ensure a whole-of-institution strategic approach.

Step 4: Assess the starting point.

Step 5: Build consensus on high-level priorities and success indicators.

Step 6: Translate strategic priorities into transformative actions.

Step 7: Launch, monitor and review.

Step 8: Capture, celebrate and build on success.

Discussions should address what works well in quality digital education and what needs improvement. Each step incorporates questions and considerations intended to stimulate conversation and consensus-building while formulating a whole-of-institution digital education strategy and associated implementation plan. Specific topics to consider and discuss include academic integrity, active learning, staff and student digital capabilities, infrastructure, attitudes towards technology, learning spaces, agile curriculum design, good practice sharing, and designing inclusive learning experiences. The development level and strategic priority for each topic will vary across institutions.

Source: Adapted from the set of institution guidelines presented in Annex A.

## ***How are Croatian institutions prepared for digital transformation? Key findings from a workshop with institutions***

On January 27, 2023, the OECD project team held a workshop with representatives from Croatian higher education institutions and stakeholders, to test the draft guidelines for institutions prepared during the project activities. These draft guidelines provide advice to institutions on developing their capacity for strategic planning and collaboration to improve digital teaching and learning, and advice on investing in digital infrastructure.

In total 20 representatives from educational institutions as well as the Ministry for Science and Education, CARNET and the Agency for Science and Higher Education participated in the workshop. The selection of participants considered institutional sector, legal status, and levels of current digital maturity (as assessed by the OECD-CARNET survey of digital maturity in Croatian higher education institutions). Participants, with the support of the workshop facilitators, considered current challenges and potential strategies for moving forward with improving institutional and system-wide digital maturity in terms of leadership, infrastructure, competence, and culture.

Key findings of the workshop included:

- Many participants recognised the potential benefits of digitalisation for engaging both local and international students, and even to contribute to the long-term survival of institutions – a concern for some participants in the Croatian context.
- At the same time, participants repeatedly raised the urgent need to focus on **people** – developing not only their capacity but also their willingness to engage in strategic development processes. The most frequently cited barrier to widespread staff engagement in contributing towards quality digital education was lack of time, followed by lack of motivation (due to a sense that the time and effort spent would not be valued or rewarded).
- The workshop hosts and facilitators concluded that there is limited history in Croatia of the institution-wide strategic development and inter-institutional collaboration being promoted during the workshop, and that there is a substantial “implementation gap” between the current position of Croatian institutions and the point where whole-of-institution approaches to collaboration can be developed. On the other hand, Croatian institutions are often highly engaged in European collaborative initiatives, including in digital education committees. This demonstrates that collaboration could be stimulated if the right incentives are in place.
- While each of the participants was interested and engaged in the discussions, there was a sense of lack of empowerment for driving wider change from their individual positions. There was concern that some teachers in Croatia will be hesitant to share practices and collaborate. In many cases there is no support for teachers to share or develop digital education resources.
- The group concluded that change can only be achieved incrementally and that creating a new culture will take time. In the meantime, even small successes should be highlighted and celebrated.
- There was support among participants for establishing a system-wide group or forum that can meet regularly to share practices and build momentum for improvement. System-level supports are needed to solidify inter-institutional connections, including practical guidance and advice for the group establishment and operation, targeted funding from government, and agreements in principle for collaboration between institution managers.

## Recommendations for Croatian authorities

The analysis contained in this chapter, and the discussions at the related stakeholder seminar held in January 2023 (see Annex C), result in the following recommendations for Croatia to consider in future strategic deliberations related to digitally enhanced teaching and learning.

### ***Continue to strengthen quality enhancement as well as quality assurance***

Quality assurance agencies are aiming to balance two competing priorities when considering online and hybrid education. On one hand, there is a need to ensure standards and guidelines for online education are coherent with existing quality assurance frameworks. Integrated standards minimise administrative and operational burden and reinforce the principle that quality standards (and, consequently, learner outcomes) should be the same regardless of how an education programme is designed and delivered. On

the other hand, a large body of evidence indicates that online education may in some cases lead to poorer outcomes for students and may not always be cost-effective or efficient for higher education providers. Quality assurance agencies, therefore, remain invested in ensuring that students are not disadvantaged by studying online.

Many of the international quality assurance frameworks developed in recent years have not yet been fully embedded in the standards and practices of quality assurance agencies and higher education institutions (Volungevičienė et al., 2021<sup>[23]</sup>). Croatia's quality assurance system is designed to be aligned with best practices in the European Higher Education Area. Croatia also intends to align its criteria for the accreditation of online programmes with proposed European best practice. However, even where standards have nominally been adopted, coherent implementation may not always follow. This effectively reduces the quality assurance process to a “box ticking” exercise with limited real impact. As a result, transnational organisations are beginning to put a greater emphasis on improving implementation of the guidelines within member organisations and higher education institutions (Blackstock, 2022<sup>[88]</sup>).

National quality assurance agencies are also increasingly positioning themselves as partners to, and supporters of, quality enhancement efforts by institutions, rather than only concentrating on their regulatory functions. In Croatia, ASHE conducts a range of quality enhancement related activities in addition to its role in setting and evaluating standards and accreditation of institutions. For example, ASHE carried out extensive research into the experience of institutions and their staff during the COVID-19 pandemic to help inform future policies and practice. It conducts regular training for institutions to build their capacity for self-evaluation and organises webinars to share good practices. ASHE also collects data from higher education institutions and publishes a range of institution-level statistics and analytics.

Going forward, and aligning with best international practice, ASHE could continue to strengthen its role as a supportive partner for higher education institutions in quality enhancement processes, in tandem with its central position within the regulatory framework. For example, in the Croatian context, where there is not yet a strong endemic culture of institution collaboration at the national level, ASHE is uniquely positioned to gather information on good internal quality practices relating to digital education and find ways to communicate them for wider benefit.

### ***Develop and share a long-term vision for supporting digitalisation in the Croatian higher education system.***

Croatian public authorities have prioritised the development of digital infrastructure and competence in their current strategic investment plans for higher education, notably through the major investment foreseen in the e-Universities project. The e-Universities project is expected to run until 2025 and should lead to an improvement in the quality of digital infrastructure and digital competence across Croatian higher education institutions. However, institutions currently lack a sense of what comes next in terms of the long-term system level objectives for digitalisation in higher education and the public supports being considered to achieve it.

Institutions themselves are responsible for setting strategy for digitalisation, including investment strategy. At the same time, strategic development in higher education institutions is at least informed, if not driven, by the national and international policy agenda. In this regard, a statement of long-term goals and intentions with respect to integrating digital technologies in higher education system can act as a powerful driver for institutions to develop their own objectives for digitalisation aligned to national goals.

### ***Create space for institutions to collaborate sustainably on teaching and learning improvement***

Higher education institution staff in Croatia gave a clear and consistent message to the OECD team during interviews and workshops: they do not have the time or space in their current workload to innovate or

collaborate on issues related to teaching and learning, including digital innovation. Institution leaders have the leading role in making that space, but governments can also support and accelerate the process by providing resources and incentives for institutions to collaborate.

Furthermore, as is also the case in many other countries, there is a belief among Croatian academic staff that research activity and production is valued more highly than efforts made to develop teaching practice. Research performance is considered the key to career advancement rather than excellence in teaching and learning. Without efforts to change that perception, motivation for participating in innovative processes is likely to remain low, and it will be difficult to build momentum in transforming teaching practices.

Public resources devoted to collaboration can be allocated within the context of specific programmes and projects, as is the case with the current e-Universities project in Croatia. However, as discussed earlier in this chapter and in Annex A, experience from Ireland shows that the establishment of a national-level forum can drive substantial change in institutional culture over a relatively brief period of time and at a reasonably low cost.

Croatian higher education institutions appear to have limited experience with collaborating on a large scale on teaching and learning topics. The establishment of a national-level funded space for teaching and learning development in higher education can create a focal point for institutions to gather and discuss challenges and experiences on teaching and learning topics of common interest, including the development of digital education. Croatia should consider establishing such a body not only to stimulate collaboration and innovation, but as a public statement of the value and worth of teaching and learning in the higher education system. The Irish model (the National Forum for the Enhancement of Teaching and Learning in Higher Education) offers a relevant case study and blueprint for how this can be achieved in a country similar to Croatia in size and, until recently, institutional structure.

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# 5 Investing in digital infrastructure

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This chapter discusses the policy context and policy directions related to investment in digital infrastructure in higher education systems across the OECD and EU Member countries. It proposes general principles for maximising the benefits of investments in digital infrastructure within the Croatian higher education system. It also categorises digital infrastructure into different types and analyses each in turn, providing specific advice to be considered for each type of infrastructure.

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## Policy context: Modernisation and digitalisation of higher education in Croatia

In the past decade, global investment in educational technology is estimated to have increased more than 20-fold, from USD 0.7 billion in 2011 to USD 20.8 billion in 2022 (IDB and HolonIQ, 2021<sup>[1]</sup>). Digital technologies are an increasingly important part of education and training systems worldwide, supporting institutional planning, administrative and operational processes, the management of physical and human resources, and research activities<sup>1</sup>. Through digitalisation, it is possible to increase access to learning resources, transform teaching and learning practices, streamline business processes and improve decision-making.

Digital infrastructure in higher education is part of the overall digital landscape of a country, and a crucial pillar of the wider digital economy, defined by the OECD as follows (OECD, 2020<sup>[2]</sup>),

*The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities.*

The success of a digitalisation strategy depends on a robust foundation of connectivity and equipment, and the tools and capacities needed to use it. Tackling connectivity and equipment gaps is one of the fundamental factors for the success of digital transformation agendas in education systems (European Commission, 2022<sup>[3]</sup>).<sup>2</sup> This means the wider state of digital infrastructure partially determines the digital readiness of higher education systems, and is a key factor in the digital maturity of individual higher education institutions, along with digital leadership, digital competence and digital culture (see Chapter 3).

Croatia's higher education system has been undergoing a series of reforms, as part of a comprehensive modernisation programme. One of the aims of this programme is to improve the digital infrastructure in Croatia's higher education system, with major investments currently underway (Box 5.1).

### Box 5.1. Croatia's e-Universities project

Croatia has implemented a programme to comprehensively reform its higher education sector. This is part of the country's National Plan for Recovery and Resilience 2021-2026, a suite of reforms to modernise higher education, and improve its relevance, quality and availability to the population.

The reforms include "e-Universities", an ambitious digital transformation programme for the higher education sector. Launched in 2022, the programme aims to strengthen investment in the digital infrastructure of higher education institutions. Objectives of the programme include upgrading on-campus networks, improving Internet backbone connectivity, and investments in equipment, central provision of educational applications and resources, training and capacity-building services. A key target is for at least 90% of public higher education institutions in Croatia (comprising public universities, polytechnics, and colleges) to benefit from improvements in their infrastructure.

e-Universities also seeks to develop the digital competence of users in higher education. For this part of the project, the Croatian Academic and Research Network (CARNET) will partner with the National University Computing Centre (SRCE), the Agency for Science and Higher Education (ASHE) and the National and University Library in Zagreb (NSK).

Source : CARNET (2022<sup>[4]</sup>) e-Universities, <https://www.carnet.hr/en/projekt/e-universities/>.

During the crises prompted by the COVID-19 pandemic and the 2020 earthquakes in the Zagreb area, decisions about digitalisation needed to be made quickly and in challenging circumstances. While on-campus provision has made a welcome return, Croatia's higher education institutions are still in need of more robust Internet connectivity, computing equipment and many other digital tools. Much remains



unknown about the impact of digitalisation for teaching and learning, and, unlike investments in buildings and other physical infrastructure, the development of widely recognised standards and criteria for evaluating digital investments remains nascent. Nonetheless, in Croatia as in other countries, there is an imperative to move forward with investments, particularly in areas where the pandemic highlighted deficiencies in existing infrastructure.

This chapter brings together evidence and expert advice on the current state of digital infrastructure in higher education systems. It defines and categorises digital infrastructure, reviews recent trends in practice for each defined category, and presents important considerations for designing, scoping and implementing public infrastructure investments. The information in the report can support Croatia to make national decisions about public investments in digital infrastructure. Annex B presents a set of guidelines, based on the analysis in this chapter, to inform the development of investment strategies for digital infrastructure within individual higher education institutions.

## ***Definition and categorisation of digital infrastructure in this project***

### *Definition*

Digital infrastructure is often referenced in commercial reports and public policy documents, but rarely precisely defined. Many definitions focus only on connectivity and equipment. Taking such a narrow view risks overemphasising the technology itself rather than its use, and may result in investment that does not necessarily advance improvements in higher education provision. As a result, there is an increasing tendency towards a more holistic view of digital infrastructure, encompassing both “hard” (physical) and “soft” (non-physical) elements. The physical category includes networking, processing, and storage, while the non-physical soft category includes end-user hardware such as computers and smart devices, central applications and software services (AIIB, n.d.<sup>[5]</sup>).

To truly achieve digital transformation, building digital infrastructure must go hand-in-hand with building digital competence. User capability is also part of digital infrastructure: staff and students must be proficient in operating and benefiting from the provided equipment and software. Digital infrastructure is generally not defined to encompass pedagogy. It is often considered to be pedagogically neutral, serving only as the backbone for pedagogical development and innovation, although this is a somewhat contested view (Facer and Selwyn, 2021<sup>[6]</sup>).

A fit-for-purpose digital infrastructure in higher education systems is a constantly moving target. Objectives and standards for digital infrastructure will be adapted as higher education systems themselves evolve their technologies and pedagogies, and new skills requirements, programme designs, and delivery modes emerge.

Thus, digital infrastructure in higher education comprises the basic systems, services, and competence required for institutions to work effectively to meet their objectives for digital transformation. Bringing these considerations together, the definition used for the purposes of this report is as follows:

*Digital infrastructure brings together and interconnects physical and virtual technologies and associated supports, enabling higher education institutions to facilitate high quality education and research in an evolving digital landscape.*

### *Categorisation*

The categorisation of digital infrastructure can help to provide structure and clarity to investment strategies, by enabling the development of procurement policies and frameworks for specific classes of infrastructure. Categorisation can also help to identify where responsibility for provision sits, for example at a national level, at institutional level, or at individual level. With this in mind, and drawing on a range of other

classifications (for example (NIFO, 2022<sup>[7]</sup>; NFTLHE, 2017<sup>[8]</sup>)) for the purposes of this project, digital infrastructure is classified into five main analytical categories:

1. Networking (including long-haul, on-campus and off-campus networking)
2. On-campus technical equipment (including servers and audio-visual equipment)
3. End-user hardware (devices for students and staff)
4. Software (including end-user software and central software applications)
5. Competence and capability services for staff and students to use digital technologies.

The following sections provide more granular analysis of the infrastructure categories defined above and propose specific principles to shape investment decisions from public funds for each of these infrastructural elements. The analysis of digital competence and digital capability is generally outside the scope of this chapter but is covered in more detail in Chapters 2, 3 and 4. Nevertheless, this chapter concludes with a short reflection on the topic, underlining the importance that investment in digital infrastructure can only be fully effective when people have the capabilities to effectively engage with the available technologies.

## Effective investment in higher education digital infrastructure

This section investigates recent trends in public authorities' approaches to supporting investment and innovation in the digital infrastructure of higher education institutions. It analyses the sources of financing and provision of infrastructure from the perspective of higher education institutions. It also provides a set of general recommendations for public authorities to consider when supporting the development of digital infrastructure within higher education systems. Key reflections can be summarised as follows:

- Public authorities and institutions need to find a balance between ensuring there is adequate public investment in institutions' digital infrastructure (directly or through intermediaries such as NRENs) and avoiding the risks of overdependence on any one source of funding.
- Capital and project-based funding is the most prominent means of public investment in digital infrastructure. While capital investment enables large infrastructure projects, attention must be paid to the need for continuing recurrent funding for infrastructure support and maintenance. In some circumstances, digital equipment leasing, virtualisation and cloud-based applications are converting traditional capital investment to current expenditure, with possible implications for future funding models.
- Governments can support institutions with digital infrastructure development and procurement processes through direct provision of infrastructure, by supporting collective procurement processes, and by multiplying opportunities for knowledge sharing of procurement practices and efficacy of educational technologies.
- Public authorities need to find a balance between offering more support to institutions with less capacity for developing digital infrastructure and ensuring that more empowered institutions have the freedom to make use of public investment to serve their digital priorities.
- Governments should reserve a share of public funding to promote an entrepreneurial approach to infrastructure development, and encourage collaboration between higher education institutions, organisations in the private sector and other stakeholders.

### ***Resourcing the provision of higher education digital infrastructure***

Despite the success of the Bologna process, there remain big differences across Europe in the ways that higher education institutions are created, regulated, and funded. These differences affect the institutions' ability to raise financing from different sources (EHEA, 2022<sup>[9]</sup>). Nevertheless, most higher education institutions have several potential public and private funding streams to resource investments in digital

infrastructure. Overdependence on public funds, or indeed any one source of financing within higher education systems, creates risks. For example, many higher education institutions in Europe experienced severe difficulties following the onset of the late-2000s global financial crisis as governments in certain countries had to rapidly cut public expenditure (Ritzen, 2015<sub>[10]</sub>).

In Croatia, public funding is the largest source of income for public institutions, as for the majority of EU and OECD countries (European University Association, 2021<sub>[11]</sub>). Other vehicles available to Croatian higher education institutions for funding digital infrastructure include local budgets, tuition fees, revenue generated from research and scientific projects, as well as donations and commercial activities. All such forms of revenue are permitted by public authorities, as long as the activity remains within the boundaries of the mission and goals of the institution and does not affect the institution's credibility and independence (Eurydice, 2021<sub>[12]</sub>).

Responses to the 2022 OECD-CARNET digital maturity survey of higher education institutions indicate that the central government is not the most common source of funding for digital infrastructure in Croatian public higher education institutions (see Chapter 3). More than 80% of public institutions use their own budget as a source of funding for digital infrastructure, while about 60% of institutions use funds allocated by the central government. European Union funding is an increasingly important source of funds for digitalisation in Croatian higher education institutions, particularly for funding digital tools and technologies in research projects. The survey was not able to collect more detailed information on the respective shares of funding for digital infrastructure from each source, but still provides a basic insight into access to funding streams.

The expansion and diversification of the funding mix for digital infrastructure encourages Croatia's institutions to take a more entrepreneurial approach to their activities, to become less dependent on government funding and to potentially accumulate surpluses of revenue that could be invested in their goals for digitalisation (OECD/EC, 2019<sub>[13]</sub>).

### ***The special role of National Research and Education Networks***

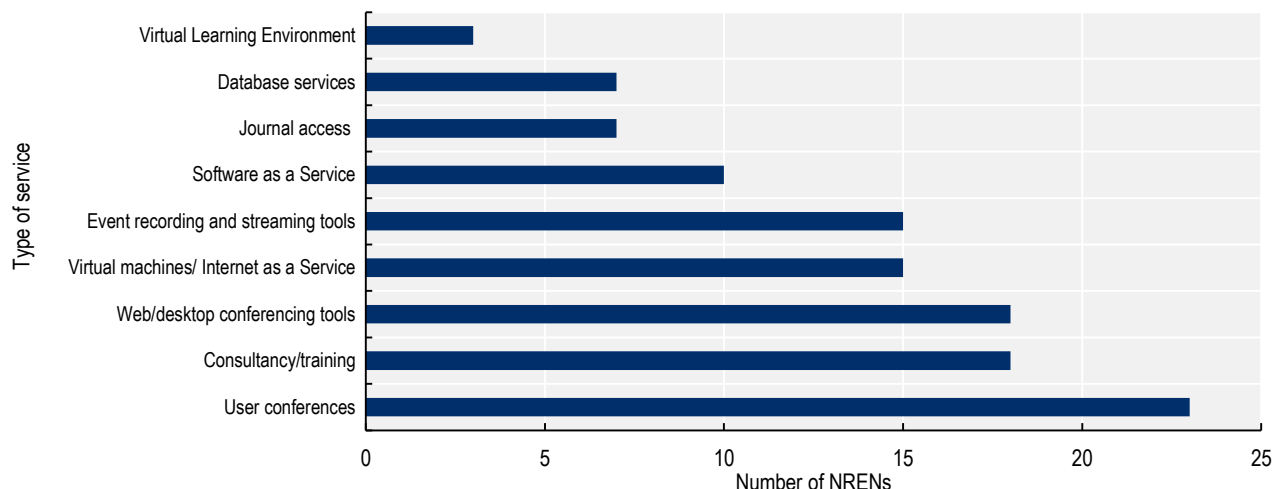
National Research and Education Networks (NRENs) – specialist national Internet service providers whose main client group is education and research institutions – play a prominent role in the development and maintenance of digital education infrastructure across OECD countries. NREN operations may be funded in several ways, including through grants from public bodies, and financial contributions from client organisations (GÉANT, 2022<sub>[14]</sub>).

In European countries, NRENs are usually the sole providers of fixed and wireless high-capacity Internet connectivity for higher education and research institutions (GÉANT, 2020<sub>[15]</sub>). However, as Figure 5.1 shows, NRENs have come to play an important role in providing higher education institutions with services that are complementary to Internet connectivity. They also frequently provide higher education systems with opportunities for improved efficiency, interoperability and economies of scale. Many NRENs in Europe now offer cloud storage, web/desktop conference tools, and other services. Finally, NRENs are increasingly collaborating with each other and sharing information educational technologies, supported by platforms such as the GÉANT Task Force on Educational Technologies (GÉANT, 2022<sub>[14]</sub>). The collective services developed and delivered by NRENs are especially beneficial to small institutions that may lack the resources and capacity to create bespoke local solutions.

CARNET is an example of an NREN providing a much wider range of services to client organisations than Internet connectivity alone. In total, CARNET provides approximately 40 distinct services to more than 200 000 users in higher education and research organisations (GÉANT, 2022<sub>[14]</sub>). CARNET played a leading role in the deployment and upgrade of digital infrastructure in Croatia's e-Schools project and plays a similarly important role in the development of the e-Universities project (Box 5.1).

**Figure 5.1. Selected services provided by NRENs in Europe**

Number providing each service, out of 26 European NRENs

Source: OECD analysis of the online GÉANT Compendium, <https://compendium.geant.org/#/>.StatLink  <https://stat.link/tu23ln>

## Policy directions for public investment in higher education digital infrastructure

Enhancing the availability of digital equipment and Internet connectivity has been central to almost all digital strategies in education in OECD countries (OECD, 2020<sub>[16]</sub>). Public authorities may draw on several financial, operational, and organisational policy levers to support investments in digital infrastructure. This section analyses potential policy directions that public authorities may choose when supporting and prioritising investments in digital infrastructure.

### ***Rethinking public funding models to meet digital infrastructure needs***

Within higher education systems, public funding for purchasing physical infrastructure has traditionally been carried out through capital funding allocations. Public capital expenditure tends to be linked to overall government financial conditions rather than conditions within education systems. As a result, the amount available for capital expenditure in higher education can vary significantly from year to year (OECD, 2019<sub>[17]</sub>). Major infrastructural projects or showcase investment tend to be triggered by application/competition among potential beneficiaries, with applications reviewed and categorised according to a set of agreed ranking criteria. Minor projects are often enabled by devolving funding so that individual institutions can carry out the work, sometimes with central guidance. Capital investments in fixed physical infrastructure have implications for current expenditure commitments. Recurrent funding needs to be anticipated and committed for maintenance contracts (though supplier maintenance and support is sometimes included in the capital cost), and local staff costs.

As with physical capital infrastructure projects, digitalisation projects tend to be funded by public authorities using one-off targeted or project-based allocations (OECD, n.d.<sub>[18]</sub>). However, digital equipment leasing, virtualisation and cloud-based applications are increasingly commonplace in higher education systems, replacing previously one-off costs for the purchase of tangible items (e.g. physical servers) with recurrent costs. Furthermore, cloud service costs can vary according to how much of the resource (e.g. processor time) is consumed, unlike the fixed costs associated with the purchase of physical on-site equipment.

Thus, planning and resource mobilisation for digital infrastructure increasingly needs to be considered as a multi-year process. This has implications for current institutional funding models operated by many public authorities, which largely provide core public funding on an annual basis based on a formula-funding methodology that does not consider the extent of digital activities or needs.

In some jurisdictions, public authorities have adopted a specific strategic position for funding digital infrastructure. In Norway, for example, the 2017-21 digitalisation strategy for the higher education sector stipulates that digitalisation should generally be integrated into the operational activities of higher education institutions, and that users of digital tools and technologies should be primarily responsible for financing digital innovations, with central funding provided for specific stimulus measures only (Box 5.2). Negotiating agreements on the locus of responsibility for different costs at the planning stages of digital infrastructure investments can support realistic forecasting of financial needs across the system.

### Box 5.2. Norway's approach to public investment in digital infrastructure

Norway's digitalisation strategy for the higher education sector (2017-2021) recognises the collective need for digitalisation strategies to be in place at both the institutional and national levels. Its sub-strategies focus on research, education, infrastructure, administrative solutions and data security (OECD, 2021<sup>[19]</sup>). The government adopts the following position with regard to financing infrastructure:

*The Norwegian Ministry of Education and Research will continue to contribute to the further improvement and expansion of state instruments for quality development and national infrastructure under the auspices of UNINETT.... The INFRASTRUCTURE scheme of the Research Council of Norway (RCN) could be a relevant source of funding for investments in and upgrades of nationally important ICT research infrastructure.*

*However, the primary principle for financing ICT infrastructure and services in the higher education sector must be that the institutions (users of the services) pay the cost of performing the tasks.*

*Digitalisation is not something that comes in addition to normal activities but must be integrated into them. The government has clear expectations that digitalisation will lead to solutions that are more efficient and better meet the needs of users, that realise benefits, and that free up resources that can further support digitalisation to improve quality. Consequently, central funding primarily caters for the financing of selected development projects and specific stimulation measures, while running costs for operation, maintenance, and innovation are financed by way of prioritisation within the usual budget frameworks. The government has established a co-financing scheme managed by Agency for Public Management and eGovernment (Difi) for small and medium-sized businesses. State enterprises, including state-owned HEIs, can apply for funding for up to 50% of the project costs. The projects must be socio-economically profitable and provide a solid realisation of benefits.*

Source: Government of Norway (2017<sup>[20]</sup>), Digitalisation strategy for the higher education sector 2017-2021, <https://www.regjeringen.no/en/dokumenter/digitalisation-strategy-for-the-higher-education-sector-2017-2021/id2571085/?ch=5>

### **Developing acquisition strategies to enable economies of scale and empower efficient and effective investment**

For education institutions to take responsibility for the acquisition of digital education infrastructure, they need sufficient information, capacity, and skills to navigate the wealth of options for digital products, services, and tools. To make decisions about infrastructure purchasing, they also require a comprehensive understanding of student and staff needs to ensure that digital tools are fit for purpose.

Procurement is a commercially confidential process between higher education institutions and suppliers. Even in the case of collective purchasing, pricing details are often withheld, and commercial confidentiality

clauses prevent the release of cost information. As a result, institutions may purchase technology that is ineffective, difficult to support locally, or incompatible with existing infrastructure. In countries with reducing populations (and therefore reducing market size), commercial technology providers may need to charge higher sales costs and experience fragmented demand for their products, potentially discouraging them from entering or remaining in the market. Developing procurement strategies at the collective or system level is essential for addressing these information asymmetries and potentially negative market forces. Furthermore, a collective approach can ensure that suppliers do not exploit the lack of information available to individual institutions about the market.

One way in which governments can bridge information gaps and support choices about available technologies and providers is through knowledge dissemination platforms that help to guide procurement decisions. In the United Kingdom, for instance, there is an education procurement guidance service that explains the benefits of using existing frameworks, proposes cost-efficient alternatives and supports compliance with the relevant procurement regulations (Gov UK, 2022<sup>[21]</sup>). In the Netherlands, SURF (the Dutch NREN) relies on a combination of peer learning and expert advice to guide digital infrastructure choices for over 100 member institutions (SURF, 2022<sup>[22]</sup>).

NRENs are important actors in procurement processes in many countries, providing purchasing frameworks tailored to higher education in areas such as dark fibre access and software purchasing. In Lithuania, for example, NRENs provide centralised hosting services such as Zoom and Moodle as well as network connectivity (LieDM, 2022<sup>[23]</sup>). Ireland's NREN HEAnet brokers hardware, software, support, and professional services on behalf of institutions, effectively streamlining procurement processes and negotiating aggregate deals from which all members can benefit (NFTLHE, 2017<sup>[8]</sup>). Several NRENs in Europe support the purchasing of cloud services, while GÉANT offers framework contracts for institutions to buy cloud services without running their own tendering process (GÉANT, 2022<sup>[14]</sup>).

Collective procurement processes for digital infrastructure can also be designed to benefit individuals. For instance, many governments have made agreements for staff and students to access preferential pricing for end-user devices and software. Such agreements also indirectly benefit higher education institutions, alleviating the pressure to provide students and staff with hardware and applications.

### ***Direct provision of common-good elements of digital infrastructure by public authorities***

An alternative model for delivering investment in digital infrastructure is through direct tendering and public authorities providing resources to higher education institutions. Such direct provision can be beneficial especially for smaller institutions with less access to financial resources from private sources, or with fewer staff with strong digital capabilities. The most common form of direct provision is provision of centralised software and applications, such as virtual learning environments or student information systems. Examples of such common-good provision can be found in the Croatian higher education system: the Computing Centre of the University of Zagreb (SRCE) supports a version of the Moodle learning management system tailored to the Croatian higher education system, which is widely used across the system. In addition, the Ministry of Science and Education provides funding for a central licence for the Microsoft 365 productivity suite, also used widely throughout the system.

Some jurisdictions offer direct provision and support of local area networks as well as backbone Internet access. Managed network services provide a viable alternative to institutions struggling to attract and maintain network engineering and maintenance staff on-site, or institutions over dependent on the presence of specific employees to ensure reliable network services (GÉANT, 2022<sup>[24]</sup>). In the United Kingdom, for example, small faculties and institutions may access a managed router service (Network Management as a Service) where the NREN takes over network management tasks (Jisc, 2022<sup>[25]</sup>). Some NRENs in Europe have also started to offer Campus Network as a Service (CNaaS), providing a fully managed local area network for higher education campuses.

## Recommendations for effective public investment in digital higher education infrastructure in Croatia

### ***Digital infrastructure investment strategies need to be tailored to the capacity, autonomy, and governance arrangements of diverse higher education institutions***

Public investment schemes for digital infrastructure in higher education systems differ from investment schemes for schools in important ways. Higher education institutions operate at a much larger scale than schools, and they are more heterogeneous, encompassing education, research, and engagement activities. This means they have more extensive and diverse digital technology needs. The two sectors also differ in terms of their level of autonomy. In comparison to higher education institutions, schools typically have less independence in defining their educational offer and operations, and are subject to common learning achievement targets, often measured through standardised assessments. As a result, schools are more of a “captive audience” for public policy initiatives in digitalisation, having limited recourse to other options for financing the development of digital infrastructure.

The design and implementation of one-size-fits-all solutions for schools is much less likely to work for higher education institutions. The more empowered position of some higher education institutions has implications for planning public investments on their behalf. Many institutions have evolved a highly proficient approach to procurement, both individually and collectively, putting them in an advantageous position with commercial suppliers. Furthermore, as managerialism increases across higher education systems, more professionalism is being injected into the evaluation of investment decisions. This means many higher education institutions have investment capabilities similar to large commercial organisations (OECD, 2019<sup>[17]</sup>). Such institutions may not benefit from publicly provided infrastructure that is inadequately tailored to their bespoke needs and not aligned with their existing support processes.

Within the context of national and supranational regulations for procurement and governance, higher education institutions are afforded different degrees of freedom in choosing suppliers for their digital infrastructure needs. In the most centralised systems, public authorities play a leading role in the procurement of infrastructure, with a state actor purchasing ICT equipment on behalf of higher education institutions. For instance, in Hungary, the procurement requests of all public higher education institutions are considered, prioritised, and fulfilled by a national agency (OECD, 2021<sup>[26]</sup>). In exercising full control over procurement, governments aim to reduce the complexity and risks of procurement, improve efficiency by avoiding duplication and ensure infrastructure meets quality and interoperability standards. Conversely, centralised services can be perceived as inflexible, slow and with limited latitude for investment in innovations or specialised items that are not highly prioritised nationally (OECD, 2021<sup>[26]</sup>).

In the most autonomous systems, by contrast, education institutions have complete freedom to decide on their digital infrastructure investments. In the United Kingdom, public institutions have full autonomy to manage their digital infrastructure, although they may use multiple national and regional procurement frameworks for educational technology through the Crown Commercial Service (Crown Commercial Service, 2022<sup>[27]</sup>), or form purchasing consortia for collaborative procurement (UKUPC, 2022<sup>[28]</sup>). Similarly, the Flemish Community of Belgium established a framework agreement with the private telecom sector and software resellers to provide better procurement conditions for educational institutions (van der Vlies, 2020<sup>[29]</sup>).

Other countries have opted for a middle ground, centralising a limited range of digital services that are subject to less personalisation and have an overarching impact on the security of the system. In Norway for instance, the Norwegian Directorate for ICT and Joint Services in Higher Education & Research (now merged into Sikt, a new service provider for the knowledge sector) offers a common ICT architecture to centralise, harmonise and standardise services related to security and access (UNIT, 2021<sup>[30]</sup>). At the same time, it gives institutions the freedom to choose services that can be tailored to their needs, such as virtual

learning environments (OECD, 2021<sup>[26]</sup>). Croatia would appear to fall into this middle ground, with a strong offer of centralised infrastructure and services provided by the Ministry of Science and Education, CARNET, SRCE and others, while institutions are free to procure additional solutions.

There is limited comparative evidence on the procurement strategies for different forms of educational technology and their impact. Decentralised procurement practices enable institutions to benefit from flexibility in choosing products and tools aligned with their specific needs. At the same time, not every higher education institution is in the favourable position described above. For example, smaller institutions or institutions with decreasing enrolments may have a reduced capacity to engage in the resourcing and procurement of digital technologies and may therefore benefit from more support from public authorities.

Future investment strategies for digital infrastructure in Croatia should reflect carefully on which elements of digital infrastructure are best provided centrally, and which are best left to individual institution decisions. Public investments stand the best chance of being effective when planned and delivered in consultation with higher education institutions, and in concert with their existing infrastructure.

***Beyond providing for basic needs, a share of public investment should be allocated to promoting innovative and entrepreneurial approaches to digital infrastructure***

Governments can rely on a mix of policy approaches to support digital innovation in educational technology. Previous OECD work has identified a number of important measures that can be taken to stimulate innovation, including: targeting regulatory burdens for start-ups, promoting diversified financing options for new entrants, mobilising the private and public sector to support digital innovation, incentivising innovation through tax credits, and policy experimentation (OECD, 2019<sup>[31]</sup>; OECD, 2020<sup>[32]</sup>).

When enrolments are falling, as has been the case in Croatia, commercial companies are less likely to invest in innovations that rely on maximising returns by scaling up rapidly to a large user base. In turn, this may lead investors to focus on existing or familiar technologies rather than on more innovative and potentially riskier alternatives (Reich, 2020<sup>[33]</sup>).

Croatian public authorities can help support the innovation ecosystem of digital education through existing and future policy instruments and public investments. Policies to boost digital innovation in education cannot be conducted in isolation. When it comes to digital infrastructure and innovation, a range of policy measures across various sectors help to shape the overall ecosystem. According to a recent evaluation, Croatia has relatively low levels of research and development activity in its enterprises, as well as resource constraints that may limit higher education institutions' capacity to innovate (OECD/EC, 2019<sup>[13]</sup>).

Regardless, even with resource constraints, public authorities can stimulate innovation by allocating a small share of public investment reserved for digital infrastructure to funding novel or experimental infrastructure arrangements. Funding programmes for experiments in digital education technology can be designed in various ways, including calls for individual institution applications, investing in innovation labs or even developing disruption vehicles for higher education digital infrastructure, similar to Denmark's Digital Disruption Task Force (OECD-OPSI, 2021<sup>[34]</sup>).

***Co-ownership of investments with beneficiaries and partnerships can spread the risks of innovation and ensure digital infrastructure addresses need appropriately***

Public financing models can and should focus on encouraging contribution and effort from both the private sector and beneficiary higher education institutions. Creating incentives for the private sector to invest in innovation for digital education requires expertise in and understanding of the educational technology market (World Bank, 2020<sup>[35]</sup>). Governments should have the means to monitor investment and developments in the educational technology industry, in order to gain an understanding of the dynamics of



the market, including the presence of potential market failures (Vincent-Lancrin, Cobo Romani and Reimers, 2022<sup>[36]</sup>).

Partnerships between diverse stakeholders can incentivise private investments, particularly for unproven technologies. For instance, partnerships between start-ups, universities, industry and government can facilitate innovation by providing start-ups with opportunities for funding as well as the chance to test tools, services, or products (OECD, 2019<sup>[31]</sup>). Governments can also encourage better collaboration between higher education institutions and developers of educational technology to ensure that new tools and equipment match the specific requirements of institutions, educators and learners. Students' and educators' involvement in the R&D/product development process is crucial to ensure digital technologies are designed with the needs of the learning ecosystem in mind.

***Potential investment choices in digital infrastructure should be evaluated according to a robust set of centrally defined criteria***

The definition and publication of criteria for evaluating and making decisions about public fund allocations should promote fair and transparent decision processes. As mentioned in the previous section, potential public capital investments in higher education are often evaluated according to a set of centrally defined criteria that consider system-level goals and objectives. Similarly, criteria for planning and prioritising investment digital infrastructure should also be defined. Many sets of criteria to evaluate public investments have been proposed by national and international bodies. Box 5.3 presents a list of potential criteria that can be used to evaluate and prioritise investments for digital higher education infrastructure, in contexts where systemic needs outweigh available budgetary resources.

Investment considerations and resulting criteria may differ according to the type of digital infrastructure investment. The following sections provide a more detailed analysis of network connectivity, on-campus technical equipment, end-user hardware, and software for higher education campuses respectively, detailing specific considerations for each type of infrastructure from a public investment perspective.

**Box 5.3. High-level decision criteria for public investments in digital infrastructure for higher education institutions**

Various criteria have been developed by national and international bodies to support effective, fair, and transparent decision-making on investments by public authorities, in a context of constrained resources, and uncertainty about the likely impact of the proposed investments. Based on a review of recent criteria specifications, including the OECD Recommendation of the Council on the Governance of Infrastructure (OECD, 2020<sup>[37]</sup>), the G20 principles for quality infrastructure investment (G20, 2019<sup>[38]</sup>), UK guidelines for investment in education technology (Crown Commercial Service, 2022<sup>[27]</sup>) and the Australasian Council of Distance Education guidelines for benchmarking technology-enhanced learning (ACODE, 2017<sup>[39]</sup>), the following high-level criteria are proposed to guide infrastructure investments:

- 1) The envisaged social impact of the infrastructure: the extent to which the infrastructure could contribute to widening equity of participation or completion, and the expected mechanism by which it will do so.
- 2) The envisaged impact of the infrastructure on the quality of higher education provision: the extent to which evidence exists that the investment will have a positive impact on the quality of higher education. Investments with little or no evidence of impact should receive an accordingly smaller share of resources, but digital investment programmes should also be allowed to promote innovation.

- 3) The extent to which the infrastructure supports stated systemic goals and objectives: how the investment affects wider policy or institutional objectives.
- 4) The number or share of users in the higher education system that will have access to or benefit from the infrastructure deployment.
- 5) The anticipated lifecycle of the infrastructure, regarding both its primary purpose and its potential to be redeployed for other uses.
- 6) The expected environmental impact of the infrastructure: how the investment might contribute to or detract from sustainability goals.
- 7) The anticipated impact of the infrastructure on the future cost base of public authorities and/or higher education institutions, in terms of potential future cost savings, or future expenditure for maintenance, support, and upgrades.
- 8) The adherence of the infrastructure to hardware or software interoperability or data portability standards, to enable integration of the planned investment with existing and future technologies and support the development of data analytics and open data.
- 9) The extent to which stakeholders and users of the infrastructure have been engaged, as a validation of proof-of-demand for the infrastructure and the fitness of the infrastructure for its intended purpose.
- 10) The proposed mitigation measures for risks associated with the infrastructure, including procedures for risk-related information-sharing and building resilience against cybersecurity hazards, loss of service, data protection risks and ethical risks.

## Investing in network connectivity

### **Introduction**

High-quality network connectivity is essential to digital learning activities, student-teacher digital interaction and the smooth running of administrative and operational systems in higher education institutions. Stable high-speed connectivity facilitates the transmission of audio-visual data for synchronous (i.e. real time) and asynchronous (i.e. self-paced) virtual interaction, including lectures, meetings and tutoring. It also facilitates easy and continuous communication across campuses, contributing to greater operational efficiency. The presence of high-speed network connectivity has been shown to support better learning outcomes (Sanchis-Guarnier, Montalbán and Weinhardt, 2021<sup>[40]</sup>), smoother transition to higher education (Dettling, Goodman and Smith, 2018<sup>[41]</sup>) and higher online learning uptake in higher education (Skinner, 2019<sup>[42]</sup>).

Adequate connectivity off-campus and adequate home technologies are particularly important for lifelong learning, which is often done (entirely or partly) online. The COVID-19 pandemic required higher education students and staff to access institutional networks more frequently from their homes or other off-campus locations, greatly increasing focus on the need for high-speed, reliable public-wired networks (including fibre) and mobile data access. In Europe, it is expected that the launch of national infrastructure and digitalisation programmes and new European targets on digitalisation for 2025 and 2030 will lead to rapid acceleration of full-fibre connectivity in the coming years (FTTH, 2021<sup>[43]</sup>). High-speed connectivity opens opportunities for learners to access education regardless of their location and can increase access to higher education for a wider range of learners.

Large, research-intensive higher education institutions have extensive data transfer demands, requiring much higher link capacity and speed than household broadband connections. Croatia has more than 90 public higher education providers, many with campuses spread across multiple buildings and/or

geographic locations. Including students and staff, it is estimated that more than 200 000 regular users need to be catered for by campus connectivity. Institutions' local area networks are usually connected through a single dedicated high-capacity core network, access to which is widely available. Wireless broadband connectivity also ensures full connectivity in large physical learning spaces on campus.

In Croatia, as in other EU countries, there is wide recognition that the socio-economic importance of higher education institutions requires them to have access to adequate high-speed connectivity as standard. The most recent Croatian national broadband plan (EC, n.d.<sup>[44]</sup>) aims to provide:

*download speeds of at least 100 Mbps to all households, with the possibility to upgrade to 1 Gbps, and 1 Gbps for government offices and public buildings such as schools and health facilities. 5G networks are to cover all main cities and towns and major highways.*

## **Recent trends in practice**

### *Trends in off-campus access to network connectivity*

While responsibility for off-campus access to network connectivity generally lies outside the remit of public education authorities and NREs, it is an important factor in learners' ability to access online education opportunities. In terms of general network connectivity, 2021 data for 38 OECD member countries shows different technology mixes across jurisdictions. Copper broadband infrastructure is rapidly being replaced by fibre networks, with fibre now comprising about one third of fixed broadband subscriptions, compared to 12% of subscriptions a decade ago (OECD, 2022<sup>[45]</sup>).

Deployment of 5G networks in EU countries also advanced rapidly during the pandemic: 5G commercial services are now available in all 27 EU member states, with 62% of Europeans covered by a 5G network in 2021 (up from 30% in 2020) (5G Observatory, 2022<sup>[46]</sup>). The new sixth generation mobile communication standard 6G is under development. Although unlikely to be widely deployed until 2030 (ABI, 2021<sup>[47]</sup>), 6G is set to substantially expand higher education institutions' ability to use the most advanced technologies in educational programmes and research, such as eXtended reality (XR) services, telemedicine, haptics and connected autonomous systems (Saad, Bennis and Chen, 2020<sup>[48]</sup>). Overall, the 2021 European Union Digital Economy and Society Index (DESI) reported that, in 2020, 87% of households had fast broadband network coverage. In addition, 71% had mobile broadband; 99.7% had 4G coverage, 51% had 5G readiness and 14% had 5G coverage; while 59% had fixed Very High-Capacity Network (VHCN) coverage (DESI, 2021<sup>[49]</sup>).

Despite this progress in coverage and take-up, substantial disparities in connectivity persist. Bandwidth contention within households and on public broadband connections has increased – a challenge not only for students on limited data plans or poor home connections, but also for those who may not have sufficient connectivity available in their area, such as in rural communities. The rural-urban gap in households with fixed broadband subscriptions across EU countries was 12 percentage points (69% versus 81%) in 2021, with 10% of households not covered by any fixed network (OECD, 2022<sup>[45]</sup>). Data from regulators in 26 OECD countries also indicates a persistent rural-urban divide in connectivity speeds: as of 2020 only 7 out of 26 OECD countries provided access to a high-speed connection to more than 80% of households in rural regions (OECD, 2020<sup>[50]</sup>).

### *Trends in on-campus network connectivity*

#### **Long haul (Backbone) networks provided by NREs**

Backbone networks are the core network for higher education, enabling higher education institutions to connect to the Internet. In EU countries, NREs are in most cases the sole providers of fixed and wireless high-capacity Internet connectivity for higher education and research institutions. A common practice is to

lease “dark fibre” cables from telecom companies, where it is feasible and cost-effective to do so (OTT, n.d.<sup>[51]</sup>). Responsibility and provision of equipment for transmitting and receiving data through the cable (“lighting up the fibre”) lies with the NREN as the owner or renter of the dark fibre. NRENS that are part of GÉANT (which interconnects 43 European NRENS), provide up to 16 different network services, the most common being IP connectivity, Eduroam (a dedicated inter-WLAN service for the education sector), updated Internet protocols (IPv6) and network monitoring. In 2020, traffic from end-users of NREN networks and services in Europe amounted to over 2 million Terabytes (Tb), over 880 000 Tb more than in 2018, a rise of around 80% in only two years.

### **On-campus wired networking**

On-campus networking includes private wired and wireless, and public networks. Higher education institutions generally run two types of wired network, a core backbone connecting buildings and campus, and networks within individual buildings. In general, the core backbone has similarities to an NREN backbone, often using dark fibre, with in-built resilience in the form of multiple routes between each node. Within buildings, Ethernet continues to be the standard wired networking technology deployed to allow computers and servers to communicate with each other. While higher education institutions were largely in crisis mode during 2020 and some of 2021, it is likely that there was little upgrading or new deployment of Ethernet on campus except to interlink servers where extra capacity was needed, and in new buildings under construction. At the same time, 100 Gbps and even higher speed Ethernet is becoming the deployable state of the art. As of 2022, 100 Gbps switch sales account for more than one quarter of total revenue in the global market (International Data Corporation, 2022<sup>[52]</sup>).

Traditionally, the default management process for campus networks uses network switching equipment to route data across a network. Such networks are expensive to install, maintain and orchestrate, requiring one or more network switches in every building and software to manage them. Given this complexity, there is a growing interest among higher education institutions in passive optical networks, which use optical splitters instead of network switches and routers. Passive networks can simplify network infrastructure while enhancing resilience (University Business, 2016<sup>[53]</sup>). At the same time, passive networks may struggle to maintain persistent high performance in certain contexts (Usman et al., 2020<sup>[54]</sup>).

It is important to note that internal wired campus networks in higher education institutions are often not designed to carry the higher speeds provided by the entry point from the NREN to institutional premises. This means upgrades to the NREN backbone are only useful if internal campus networks are adequately equipped to take advantage of the higher speeds. In reality, campus network upgrades are often carried out using a “triage” approach: as new technology becomes available it is integrated piecemeal into the existing infrastructure, and older equipment is scrapped or redeployed elsewhere.

### **On-campus wireless**

Wi-Fi allows both wireless and wired devices to connect through wireless access to a router box connected to an Ethernet network. In most cases, wireless networks on higher education campuses have evolved primarily more for social than academic purposes, allowing students and staff to stay in touch and access information continuously while on campus. The prevailing trend in higher education institutions is towards enabling wireless everywhere on campus. Wireless is now commonplace in offices, laboratories, classrooms, and public spaces.

Wi-Fi 6, formally called IEEE 802.11ax, is the newest generation for wireless LANs. It can operate in a new 6 GHz band as well as the 2.4 GHz and 5 GHz bands already in common use for wireless LANs. It also introduces some new technologies to help mitigate the issues that come with putting dozens of Wi-Fi devices on a single network (Kastrenakes, 2019<sup>[55]</sup>). In the coming years, it is likely that Wi-Fi 6 access points will continue to replace existing Wi-Fi 4 and 5 access points across campuses, while campus staff may potentially opt to move the older equipment to student-heavy areas or areas with expected light traffic.

Wi-Fi standards will also continue to evolve: the newest generation Wi-Fi 7 (802.11be) is currently at a nascent stage and is likely to take some years to embed.

The provision of an on- and near-premises wireless networking infrastructure is usually funded using higher education institutions' own resources. In some cases, local authorities may contribute funding or allow access to the local infrastructure. Campus network infrastructures often have to support public Wi-Fi as well as private institution Wi-Fi, increasing complexity and cost. Eduroam is now well-established as a secure global academic network that is made available to staff and students through their higher education institution, including in Croatia (SRCE, 2022<sup>[56]</sup>).

## Principles for public investment in network connectivity

From 2022, Croatia has commenced a substantial investment in upgrading both the CARNET backbone and on-campus networks in order to support improvements in digital maturity of higher education institutions. This includes upgrading the access network, campus network and backbone, as well as the design and implementation of passive and active networks at the campuses of higher education institutions (CARNET, 2022<sup>[4]</sup>).

It is difficult to find recent examples of similarly ambitious large-scale network upgrades in other jurisdictions. This means Croatia has limited means to learn from the experience of other countries. Regardless, the scale of the planned investment, and its stated intention to cover more than 90% of public institutions, offers substantial opportunities to improve knowledge of the status quo in higher education institutions regarding network connectivity. It also offers Croatia a unique opportunity to harmonise and align standards for network connectivity across institutions, moving campuses further away from “shanty-town” models common across many higher education campuses towards “master-plan” approaches (Jisc, n.d.<sup>[57]</sup>).

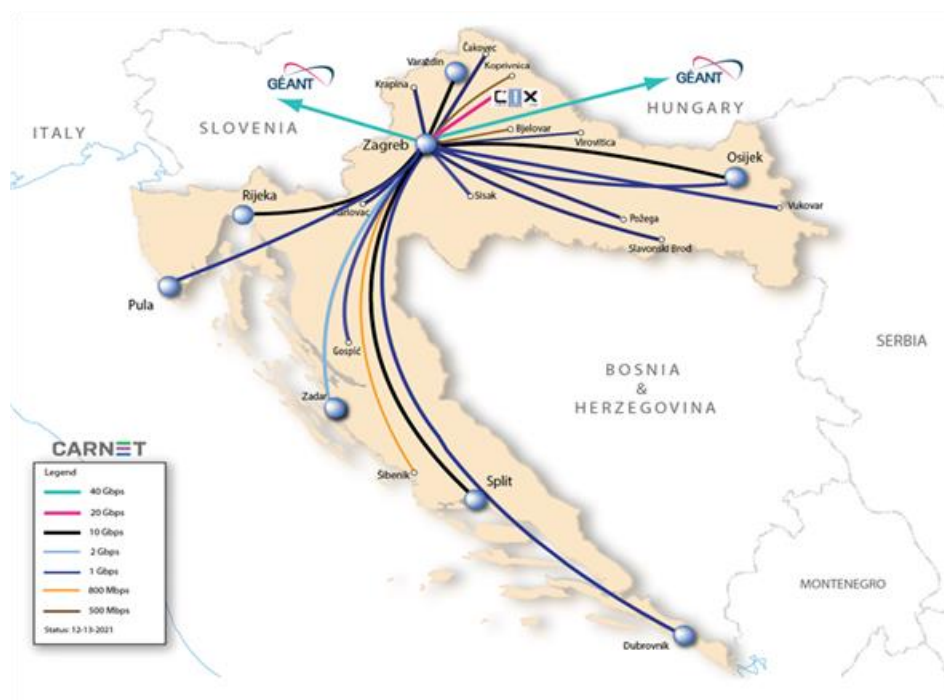
The following sections offer some principles that may serve as the starting point for developing criteria for prioritising networking projects. These principles are intended to be relevant not only for immediate investments, but also for future public investments in network connectivity upgrades in Croatia.

### ***All institutions should have access to a defined minimum standard of connectivity to the NREN backbone, and access to a clear procedure to signal and receive necessary connectivity upgrades***

A basic principle often cited to guide public infrastructure investments is that addressing the most pressing deficits and weaknesses should take priority over investments that improve on an already-adequate baseline standard (Missouri DHEWD, n.d.<sup>[58]</sup>). In Croatia, this would imply that higher education institutions in locations not currently meeting minimum prescribed standards of connectivity to the NREN backbone should be prioritised for upgrades. For example, the current CARNET network connectivity map indicates that some locations may fall short of the current national policy objective of having a minimum 1 Gbps connection per institution (Figure 5.2).

However, this general objective of 1 Gbps needs to be nuanced and balanced against other important considerations, to ensure that upgrades are calibrated for maximum investment value. Active monitoring of traffic across connections can provide the most realistic insight into the needs of institutions. Thus, while the 1 Gbps minimum connectivity standard per institution specified in national policy provides a clear basis for prioritisation, it is also important to consider traffic data in various sites over time as part of the investment prioritisation process.

Figure 5.2. CARNET infrastructure map (2021)



Source: CARNET (2021<sup>[59]</sup>), CARNET infrastructure, <https://www.carnet.hr/carnet/carnet-infrastruktura/>

When making decisions about future investments, the minimum baseline of connectivity may also need to be adjusted based on enrolment trends and estimates of the needs at the specific institution site. For example, some institutions responding to the CARNET-OECD digital maturity survey indicated they were likely to move location in the coming years. In addition, some institutions have experienced sharp reductions in enrolments in recent years, which may have implications for network traffic volume and future connectivity needs at their sites.

Various methods may be applied to reach a fair minimum connectivity standard for each site. Many approaches take a “formulaic” approach - allocating a basic amount of bandwidth per eligible person at the campus and adjusting for specific contextual factors such as volume of research activity, or the location of the institution. Alternative approaches could also be applied, based on indicators derived from actual network usage data. Regardless of the specific formula applied, what is most important is to clearly specify the criteria for establishing the acceptable minimum standard and prioritising funding to those institutions that fall below it.

### ***Upgrades to the backbone network beyond the minimum connectivity standard require a method for assessing current and likely future saturation of links***

Evidence indicates that bandwidth needs may double multiple times over the lifetime of a network (Cisco, 2020<sup>[60]</sup>). Monitoring of existing network traffic levels can provide the clearest indications of where current saturation points lie and provide a basis for estimating future bandwidth needs, to pinpoint where future upgrades are most urgently needed.

Estimates of future needs should consider an emerging consensus that distinctions can no longer be drawn between disciplines in terms of their network connectivity requirements. While there were previously substantial differences between disciplines in terms of the use of digital tools, distinctions are quickly breaking down as blended or online learning becomes commonplace in almost all subjects. In addition, with synchronous videoconferencing (Zoom, Teams etc.) becoming widespread during the era of

emergency online learning, the “new normal” expectation is for ad-hoc connectivity to be continuously available for online and hybrid meetings and events. Many institution staff reported to the OECD study team during site visits that demand for online and hybrid meetings remains high despite the full return to campus, as it is frequently perceived as more convenient for co-ordinating face-to-face meetings. The widespread use of video also evens out data usage between fields of study, given that video streaming is a much more data-intensive use of network resources than, for example, productivity tools (e.g. Microsoft Office suite).

There is also an increasing expectation across all subjects that students will require specialist software and higher computing power, which may be server- or cloud-based. Similarly, while researchers traditionally in data-intensive disciplines (such as astronomy or physics) tended to make much greater demands on the network than in other disciplines (such as pure mathematics), the increasing use of technologies such as augmented reality and virtual reality in a wide range of disciplines (creative arts, archaeology, medicine etc.) is contributing to evening out these differences. For example, an hour of YouTube video is estimated to require between 0.26 GB (lowest resolution) and 2.7 GB (4K Video) (Wiwatowska, 2021<sup>[61]</sup>). Zoom and similar online meeting software can require up to 900 MB for an hour’s conference – and more in high-definition (HD) mode (Holslin, 2021<sup>[62]</sup>), while virtual reality has been estimated to require a connection of up to 600 Mbps (Fridström, 2017<sup>[63]</sup>; Mastrangelo, 2016<sup>[64]</sup>).

Any estimation of future network connectivity requirements should account for research activity needs. In some institutions, data traffic linked to research is estimated to take up more than half of all the institution’s traffic. For example, until 2021, Imperial College London had a base load of 10 Gbps for “normal business” (teaching and administration) and 30 Gbps for “research data exchange” (Imperial College, 2022<sup>[65]</sup>).

Given the demographic context in Croatia, it is unlikely that potential future growth in student numbers would alone lead to substantially increased network connectivity requirements. In addition, the increasingly fluid and flexible nature of higher education provision may naturally lead to well-dispersed loads on the network connection, except for potential surges at certain times of the year (e.g. revision periods before exams). Developing mitigating strategies to plan for unexpected network congestion (such as prioritisation of types of network traffic) may be more impactful than trying to anticipate exact traffic patterns. Network user behaviour on campus, including during the pandemic period, has proven challenging to predict (for example, see (Evans, 2020<sup>[66]</sup>)).

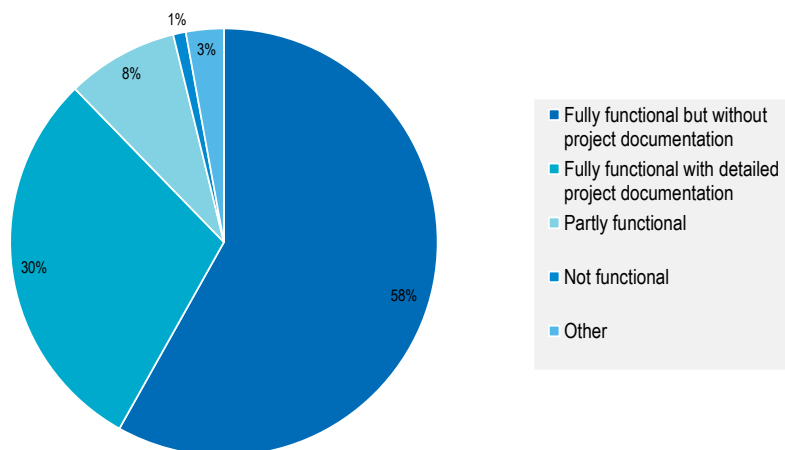
### ***Public investments in upgrading on-campus networks need a clear understanding of the status quo as a starting point***

As discussed above, Croatia is currently planning to provide most higher education institutions with network upgrades as part of the e-Universities initiative. Best practice dictates that network upgrades must begin with a full understanding of the current network structure, with a full physical and logical map of each location (Cisco, 2020<sup>[60]</sup>; Pearson, 2017<sup>[67]</sup>). A potential concern flagged by responses to the OECD-CARNET digital maturity survey is the pervasive lack of full documentation for on-campus networks. More than half of all respondents indicated that full documentation of their network was not available (Figure 5.3).

Therefore, the national development plan should begin with a thorough assessment of the status quo. CARNET should aim to have a clear understanding of the current physical network infrastructure for each higher education institution before proceeding with proposals for upgrades (and, indeed, network mapping activities are already foreseen in the first stage of the e-Universities project).

### Figure 5.3. Functional status of wired local area networks in Croatian higher education institutions

Share of institutions reporting each of the following cases, in relation to their wired local area networks



Source: 2022 OECD-CARNET Digital Maturity Survey of 95 Croatian Higher Education Institutions.

StatLink  <https://stat.link/204fah>

The institution-level infrastructure reviews in the initial stages of the e-Universities project will be essential to ensure effective investment in network upgrades in subsequent phases of the project. However, such infrastructure evaluations also have wider potential to benefit the higher education system in Croatia, through widespread synthesis and sharing of the knowledge learned from the reviews. Accessible syntheses of the current state of on-campus network provision could support the identification of gaps, systemic risks and challenges beyond the remediation measures foreseen by the e-Universities project. As an example, Jisc published a synthesis of findings from 118 infrastructure reviews carried out in the further education and skills sector, highlighting key strategic considerations, best practices, and deficits in the status quo (Jisc, 2020<sup>[68]</sup>).

#### ***Direct procurement and installation of networks as part of a public investment programme has implications for subsequent support and management***

In cases where direct provision and installation of on-campus network provision is made, consideration needs to be given to ongoing support and maintenance. Investment plans in network infrastructure improvements should include a concurrent training process for on-site staff to support and maintain the upgraded network infrastructure.

Direct provision and support of on-campus networking is a growing trend in some European countries, referred to as Campus Network as a Service (CNaaS). A CNaaS model can be a solution for institutions with limited on-site IT support capacity. It may be particularly relevant in the current context in Croatia, where many institutions reported to the OECD review team a chronic shortage of trained staff to maintain and support campus networks and IT infrastructure. CNaaS does not necessarily entail deskilling or employment loss for current on-site staff. Off-site management may be used as a complement to on-site management, or to reduce pressure and workload for on-site staff (GÉANT, 2022<sup>[24]</sup>).



### ***Investments in network architecture should aim to integrate current and emerging best practices for resilience and security***

NREN backbones form the main basis for Internet connection in higher education campuses across Europe and beyond. Given their vital role in the daily operations of institutions, it is widely considered to be best practice to make the connection as resilient as possible. The emergent standard for resilience for backbone connections is to ensure that each location has two geographically separated links to the backbone (in this case, CARNET), either directly or indirectly through another site of the organisation. Budgetary and practical considerations may prevent this standard from being fully realised across the higher education system in Croatia. However, ideally the planned upgrades should serve to advance the resilience agenda and limit the extent to which single points of failure are present throughout the system.

Within campuses, upgrades to network infrastructure should also provide increased resilience. Pervasive wireless access on campus, even in wired areas, provides one form of backup resilience in case of failures within the wired network. Other solutions for resilience include the introduction of redundancies in the network topology and adoption of emerging best practices in network Orchestration, Automation and Visualisation (OAV) that support computer-aided reactions to network failures or changes (GÉANT, 2022<sup>[69]</sup>).

Security is a recurring concern related to digital infrastructure and is becoming ever more important, in a context of continuously increasing threats (ENISA, 2020<sup>[70]</sup>). For example, in 2022, 92% of higher education institutions in the United Kingdom reported a security breach or attack had taken place in the previous 12 months (GOV.UK, 2022<sup>[71]</sup>). In the United States, the average cost per organisation of recovery from a ransomware attack has risen to more than USD 1.4 million, with higher education institutions identified as being among the slowest to recover (Sophos, 2022<sup>[72]</sup>). Cybersecurity across higher education systems will need to be further enhanced in the coming years, given the rising incidence of cyberattacks, including ransomware attacks.

A challenge specific to the higher education setting is the tendency for personal devices to be allowed a much greater level of access to campus networks than in a corporate environment, potentially increasing risks. NRENs such as CARNET play a vital role in cybersecurity by providing network monitoring, specialist support when an institution comes under attack, and a vital source of advice and notification, both for taking immediate action and monitoring emerging threats. As investments are made in network upgrades, concurrent investment in cybersecurity will be vital, as will continuous efforts to remain updated with emerging knowledge and advice on cybersecurity.

### ***Campus locations may need to be itemised and prioritised for inclusion in network upgrade plans***

Some institutions in Croatia highlighted to the OECD review team an urgent need for internal network upgrades, to replace older cabling and switches that cannot use the full potential of the backbone Internet connection. Changes in user behaviour after the pandemic are also generating more traffic on wired on-campus networks. Institution IT staff in Croatia reported more use of digital technology and connectivity during on-campus lectures, and staff and students are increasingly uploading and accessing data-intensive media on-campus, continuing habits formed during periods of emergency online provision.

In recent years there has been a surge in staff and student personal devices on campus, generating continuously increasing demand for access to campus Wi-Fi networks. A higher education campus also attracts members of the public for conferences, social visits, or open days. This requires facilities to enable Internet access to people who are not registered on their systems. Network managers therefore come under pressure to increase the number of access points and the number of devices that can connect concurrently, including in campus gathering points and public outdoor spaces. As a result, device and access management becomes more complex.

Given these continuously increasing competing demands, and limited available resources, it is likely that some central prioritisation of specific “micro-locations” on campus will have to be carried out by CARNET when making decisions about campus network upgrades. Prioritisations can be made according to the activity being carried out at the campus location, the desire for network access at the location, and the importance of the location for the mission of the higher education institution. Box 5.4 provides an example for prioritising campus locations, based on expert consensus, that could be a starting point for central priority lists.

Areas of campus that cannot be prioritised for network access will need to adapt to available network conditions. Acceptable use guidelines developed by CARNET and integrated by each institution may need to be updated to account for changes in user behaviour in recent years, or to limit some types of usage and traffic that may not be directly relevant to the mission of the institution. In a worst-case scenario, traffic shaping may be required (Froehlich, 2020<sup>[73]</sup>) to optimise campus network bandwidth by prioritising certain types of traffic, although this may be unpopular with students, and depending on the shaping strategy, raises potential concerns about Internet neutrality (Ofcom, 2010<sup>[74]</sup>).

Finally, it is possible, in the context of partial upgrades planned and managed by providers external to the institution, that proposed measures are not suitable or attractive to the higher education institution management. The reasons for this may include a lack of compatibility with existing technologies, recent upgrades having already been made using the institutions own resources or concerns about ongoing support for the upgraded equipment. In such cases, given the overall target to provide 90% of public institutions with upgraded infrastructure, institutions opting out of the centrally provided network upgrades could be prioritised for more innovative stand-alone “showcase” projects in other categories of digital infrastructure, such as on-campus technical equipment.

#### Box 5.4. Example priority list of campus location types for network upgrades

If complete campus network upgrades are not possible, priorities may need to be assigned to different campus locations. The following priority list is presented as a potential starting point for constructing national-level prioritisations for network upgrade locations in Croatia. The priority list should be adapted depending on the type of network installation under consideration (wired or wireless LAN), the available budget and the needs to specific institutions.

##### Highest-priority campus locations

- student computer laboratory where PCs with suitable monitors are provided on wired connections;
- study areas, often in a library, where large monitors, power and network access are provided
- lecture and seminar rooms;
- multimedia production rooms where academics can create material for the virtual learning environment;
- offices where IT staff, library or multimedia support staff work.

##### Medium-priority campus locations

- offices for academics where students visit for supervision and advice;
- offices for research staff engaged in data-intensive research;
- offices for administrative staff engaged in admissions, exams, etc.;
- sports halls and centres.

**Lower-priority campus locations**

- restaurants and cafes on campus;
- general library facilities such as reading areas, stacks, etc.;
- research farms;
- on-campus student accommodation.

**Campus locations that will change soon (all types)**

Where there are plans to move activities to new campus buildings in the short to medium term, the baseline approach for upgrade plans should be to rely on additional wireless networking rather than installing new cabling infrastructure direct to end-users.

Source: Elaboration based on consensus of external expert opinion. See front matter for more details.

**Investing in on-campus technical equipment****Introduction**

This discussion of on-campus hardware in higher education institutions covers two main elements: server hardware (used for storing data, software and digital files) and audio-visual equipment for the everyday activities of the institution.

The presence of high-quality, reliable on-campus technical equipment is an important prerequisite for effectively employing digital technology for teaching and learning in higher education. Demand for on-campus technical equipment has been multiplying and expanding into new areas, driven by the pandemic, but also by the deepening integration of digitalisation into all aspects of institution operations. Institutions have reacted to emerging demands and challenges in diverse ways, from investing in more powerful on-campus physical equipment, to virtualisation, depending on the equipment category. This section provides an outline of recent trends in different categories of on-campus technical equipment and proposes some principles to prioritise investments in this category of infrastructure in Croatia.

**Recent trends in practice***On-premises server hardware*

The most disruptive trend in recent years related to on-premises server hardware has been migration to the cloud. While there is a common perception that on-campus server hardware is increasingly being phased out in favour of cloud services, this has been a slow and uneven process across countries and jurisdictions (Grajek, 2016<sup>[75]</sup>). Common concerns of institutions related to migration to cloud services include security and losing control of their own infrastructure. IT departments may also be concerned about the implications for local de-skilling, as a result of outsourcing their expertise to cloud service providers. These concerns may diminish as more server applications successfully move to the cloud, and if institutions are able to create a supportive local environment for re-skilling and reorientation of the roles of local staff to work with cloud-provided services.

The availability of high-speed resilient networks in higher education through NRENs removes another concern related to cloud migration – that of ensuring continuous and reliable connectivity. Moving to the cloud means that institutions pay only for the processing and storage they require and can access additional resources such as resilience and instant expansion when required. High-powered computing (HPC) is also increasingly moving to the cloud, including in Croatia, where an advanced computer and

data cloud is being developed as a fundamental component of the national research and innovation e-infrastructure, part of the “HR-ZOO” initiative (CARNET, 2021<sup>[76]</sup>). GÉANT has set up a single market framework for institutions to buy cloud services, allowing European NRENs to collaborate to make clouds accessible. This was achieved through a pan-European tender, with GÉANT acting as central purchasing body on behalf of the NRENs and their member institutions (GÉANT, 2022<sup>[77]</sup>).

Despite the growth in cloud services, many higher education institutions still host student-facing systems on-premises, implying that recent increases in demand for online services are likely to have translated into a need to upgrade hardware. In general, on-site server hardware provisioning is in a stable mature state, with some emergent common practices related to maintaining its resilience and security. For example, institutions may run duplicate server rooms to provide site-wide infrastructure resilience. Redundancy may also be built into individual servers, depending on how critical the service is to the institution. Virtualisation is increasingly used, on the premise that abstracting the hardware layer from the operating system and applications ensures that a hardware fault does not lead to overall service failure. In Croatia, more than 75% of respondents to the CARNET-OECD digital maturity survey reported using virtualisation in the installation of their servers.

As well as managing resilience, the other main challenge related to server equipment is security. Cybersecurity is one of the most prevalent challenges facing higher education systems globally. Modern security protocols in common use include restriction of server access using multi-factor authentication (requiring two or more methods of verification before gaining access) and virtual private networks (secure connections from remote locations). End-user device management also forms a vital part of the cybersecurity portfolio, with common device requirements including a need for up-to-date operating systems and software, anti-virus software, and allowing remote access to devices in some circumstances.

While cyberattacks are the most common concern discussed publicly, it is also crucial to ensure that resources are allocated for the physical security of on-premises digital infrastructure. Investment in on-premises digital infrastructure entails evaluation and mitigation of risks such as access controls to data centres, CCTV, window guards and alarm systems. Beyond cybersecurity and physical security, other forms of risk must be considered. For example, data centres and servers must be protected from flood and fires.

One key lesson from the pandemic period is that demand can surge overnight. Future infrastructure planning may require greater recourse to server farms which can “surge-scale” (order of magnitude capacity increase) in response to spikes in demand. Such capacities cannot be economically supplied by on-premises server capacity.

### *Audio-visual equipment*

Important categories of on-campus audio-visual equipment commonly found on higher education campuses include data projectors, electronic whiteboards, monitors, cameras and microphones for video conferencing and lecture capture, and specialist devices for voting and providing feedback. Data projectors for computer screens started to achieve dominance from the early 2000s as costs of the equipment reduced and computers became more commonplace in teaching spaces. At the same time, the advent of plasma screen technology (followed by LED and OLED) led to large flat screens being installed in a greater number of rooms across campuses, as these technologies matured and became cheaper. Finally, electronic whiteboards are more usually found in schools rather than higher education institutions (Aflalo, Zana and Huri, 2017<sup>[78]</sup>). More low-tech solutions such as writeable or glass walls are often preferred for teaching in higher education institutions.

Prior to the pandemic, many campuses had invested in bespoke lecture theatres and other rooms with facilities for video conferencing or lecture capture. Since the onset of the pandemic, institutions have leaned towards investing more in hybrid teaching rooms with built-in microphones and cameras. The underlying technology to serve this need is also rapidly evolving, with bespoke “room specific” systems

built on custom hardware being replaced by PC-based systems with affordable high-resolution cameras that can track user movements.

Other supportive developments are also converging to encourage more investment in audio-visual equipment that can support hybrid teaching and learning. These include software that better encodes video to create smoother degradation of sound and video quality when bandwidth drops; new traffic shaping techniques to ensure that audio and video traffic can pass over existing networks with less jitter; instant captioning and transcription built into video conference systems; and improvements in technology for simultaneous translation of speech to other languages.

Croatian higher education institutions expressed a pressing need to improve their on-campus audio-visual equipment, both during the site visits carried out by the OECD team, and in their responses to the CARNET-OECD digital maturity survey. In particular, the survey results indicate a need for audio-visual equipment that can support the use of digital resources during lectures, and equipment that can be used for recording live lectures and hybrid teaching (see Chapter 3).

Finally, an emerging area of growing interest within higher education institutions is the use of advanced audio-visual technologies including augmented and virtual reality. Augmented reality (AR) technology enhances real world settings with computer-generated input, while virtual reality (VR) provides a fully immersive computer-generated environment. AR and VR are useful where physical exercise of an activity is not possible due to cost, availability, safety, or ethical concerns (Futurelearn, 2021<sup>[79]</sup>). VR is already being used in some subjects such as medicine, where virtual patient simulations are rapidly becoming standard elements for training medical personnel. For example, the University of Zurich developed a VR simulation as an effective and safe method of teaching bronchoscopy (Casso et al., 2017<sup>[80]</sup>).

AR and VR are also becoming more prominent in arts and humanities subjects. For instance, the University of the Arts in Philadelphia, USA has a centre for immersive media (UARTS, 2022<sup>[81]</sup>) allowing students and staff to explore technologies such as simulations, stories, performances and digital communities, virtual and mixed reality, performance motion-capture and human-computer interaction across visual and performing arts disciplines. As another example, the Netherlands Film Academy has set up a VR Academy to enable students from the Amsterdam University of the Arts to explore virtual, augmented, and mixed reality (NFA, 2022<sup>[82]</sup>).

In Croatia, staff in medical, arts and humanities faculties highlighted to the OECD review team a growing expectation to integrate VR and AR as educational technologies for students. Where such technologies exist within faculties, they tend to be allocated primarily for research projects rather than student instruction, except for medicine, where virtual patient software is fast becoming normalised.

## Principles for public investments in on-campus technical equipment

### ***All institutions should ideally have on-campus access to a professionally equipped space for developing digital teaching material***

In the post-pandemic world, there is an increasing expectation that digitalised teaching materials, including recorded teaching activities, will form an integral part of the landscape of educational provision. As a result, a high priority for public investment is ensuring each higher education institution in Croatia has an equipped space for the creation of high-quality digital teaching materials. This is a fundamental condition for students to have equal access to high-quality digitalised teaching material. Equipping spaces adequately requires not only cameras and microphones for recording presenters and their displays, but ensuring that lighting, acoustics, and soundproofing are appropriate for professional quality recordings, avoiding the need for wasteful repeated attempts to capture material.

Sharing on-campus resources for the creation of digitalised teaching materials also leads to operational challenges to ensure available spaces can meet the demand of the full cohort of staff. Efforts to reduce contention for shared audio-visual spaces may include adopting the pedagogical approaches best aligned with digital rather than in-person provision. For example, there is an emerging consensus that long lectures do not translate well to an online environment. Video recordings used for teaching may be more effective when structured in shorter chunks of 10-15 minutes ( (Bates, 2019<sup>[83]</sup>)).

***Investment strategies should evaluate and take account of the likely speed of obsolescence, given the rapid pace of development of audio-visual technology***

Not all investments in technical equipment will deliver similar long-term benefits. Lower priority should be given to investments in audio-visual equipment where an alternative software-based solution is available, where end-user devices can be used for the same purpose, or where there is a risk that the technology will soon become obsolete.

In recent years, some types of hardware designed for a specific purpose in higher education campuses have been replaced with software-based solutions. Examples include in-class voting/feedback equipment (to run question and answer sessions in a classroom), and room access systems (for checking attendance in classes). While such systems previously required the installation of specific devices, most functions can now be conducted using software (for example, a mobile phone application, or polling and feedback modules, such as the Zoom poll function or the E-Voting plug-in for Moodle (Hadorn, 2020<sup>[84]</sup>)).

Video capture hardware also continues to become smaller and more portable. In recent years, high-quality microphones and cameras have become part of the standard specification of end-user equipment, such as laptops, or are available as low-cost peripheral devices, reducing the need for institutions to invest in central stores of such equipment. As another example, portable USB video capture cards that plug into a range of end-user devices are emerging and will quite possibly simplify and streamline video recording processes in education institutions and beyond (Panopto, 2017<sup>[85]</sup>).

Governments need a forward-looking approach for investing in digital technologies, addressing not only existing requirements but also anticipating future needs. Existing digital infrastructure may require upgrades to ensure its continued effectiveness, as new software or tools emerge with higher connectivity or computing capacity requirements. Performing horizon scanning and taking stock of technological developments prior to investments can ensure that public expenditure on digital infrastructure is fit for purpose, with a reasonable foreseen period of utility and relevance. Furthermore, investments in audio-visual technologies should be made with interoperability and a potential exit strategy in mind to enable a switch to newer technology as it becomes available. This depends on avoiding overly restrictive contracts or long licensing/maintenance agreements with suppliers.

***Some emerging technologies show promise but may not yet be mature enough to prioritise for public investment***

As AR and VR use increases on higher education campuses, it is likely that provision and financing will at least partially fall within institutions' audio-visual budgets, due to the need for physical equipment to access the experience. There is currently a considerable cost to deploying AR and VR, including costs for headsets and content creation. Support staff are also often needed to maintain equipment and guide AR and VR experiences for students. These factors explain why AR and VR have so far gained only limited traction in higher education.

Before and during the pandemic, several countries began efforts to integrate advanced technologies such as artificial intelligence (AI)-enabled tools or products in their school systems. For example, Korea has been progressively introducing AI in education since 2018, expanding software education in primary and middle schools, opening AI pilot schools, and developing AI-based models for education (OECD, 2021<sup>[86]</sup>).

To date, despite recognition of the powerful potential of AI (OECD, 2021<sup>[87]</sup>), there are fewer examples of AI technologies being systematically deployed across higher education institutions and systems.

Adoption of advanced technologies brings a risk of widening inequalities between students of different backgrounds if these are more often adopted by socio-economically advantaged institutions or students, who may also benefit from better digital infrastructure conditions, and better-prepared instructors, i.e. the so-called Matthew effect (Perc, 2014<sup>[88]</sup>). Evidence suggests that even for relatively less novel or advanced technologies, equity considerations are critical, as leading-edge technology adoption is higher among the most advantaged families (Bergman, 2019<sup>[89]</sup>). In addition, AI-based deployments raise several ethical dilemmas within education systems, and, unless managed carefully, may compound an already fragmented learning ecosystem (OECD, 2021<sup>[87]</sup>).

Together, these factors indicate that some advanced technologies such as VR, AR and AI should not yet be a high priority for large-scale public investment. However, the number of use cases for these technologies is continuously increasing (Educause, 2020<sup>[90]</sup>; Educause, 2022<sup>[91]</sup>). In the interest of encouraging and promoting pedagogic innovations, consideration may be given to reserving a small share of public funding for audio-visual equipment for experimentation with initiatives using VR, AR and AI that have potential “showcase” value to the wider system.

### Investing in end-user hardware (staff and students)

Staff and students need suitable end-user hardware to access the learning technologies that are now ubiquitous in higher education. Traditionally, the digital infrastructure of the higher education sector has been better provisioned and funded than the school sector. Staff computing hardware is generally provided by the institution, and sometimes enhanced by staff Bring Your Own Device (BYOD) schemes. For students, BYOD remains the default model for end-user equipment, with shared computers usually made available on campus. Computer clusters in dedicated rooms have been standard for many years across higher education campuses, providing students with access to powerful processors, specialist software, Internet access, and printing. With the upward trend of ownership and use of end-user hardware in the home (OECD, 2017<sup>[92]</sup>), the demand on institutions to provide student computing power has changed but not necessarily diminished.

The prevailing situation internationally is reflected in Croatia, where data shows a lower ratio of on-campus equipment for students than for staff. In most Croatian institutions, there is close to a 1:1 ratio between the number of teaching staff and the number of desktop computers allocated for teaching staff (Figure 5.4).

### ***Recent trends in practice***

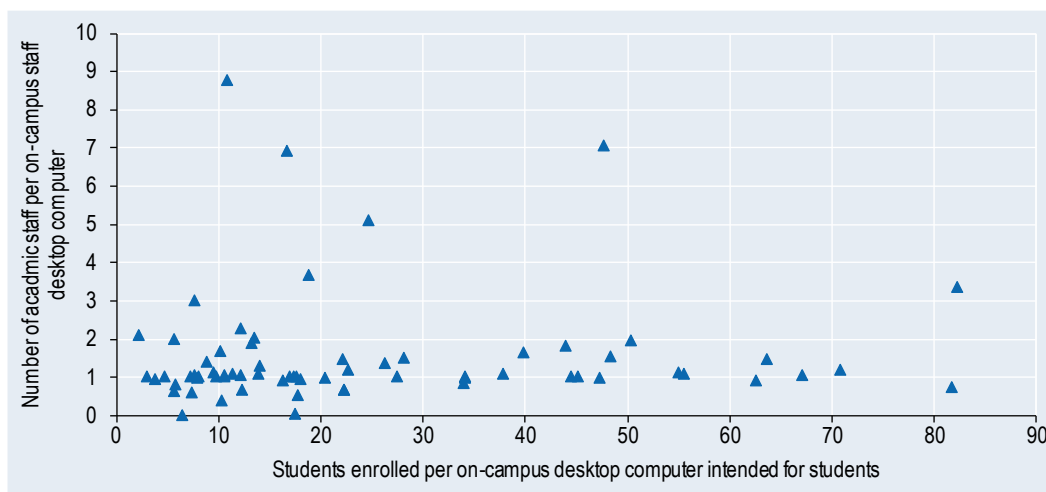
There are few comprehensive cross- and intra-country statistics about access to end-user student devices at home and on campus. In an April 2020 non-probability survey conducted by the European Students Union, among 17 000 higher education student respondents, about 10% reported some difficulties with access to a home computer, and 60% reported some difficulties securing a high-quality home Internet connection (OECD, 2021<sup>[19]</sup>). In the United Kingdom, a 2020 study of 1 416 higher education students showed that almost one in five students lacked access to a computer, laptop or tablet (Office for Students, 2020<sup>[93]</sup>). Following the pandemic, it is likely that the share of students without access to a laptop has diminished further.

Various laptop loan or purchase schemes are in operation across countries - some for many years - to ensure students' access to hardware for their studies. For example:

- In the United States, Dakota State University offers full-time freshmen a new laptop, a scheme started in 2004 (Dakota State University, 2022<sup>[94]</sup>).

- In Scotland, the University of Dundee offers laptop loans to students suffering from financial hardship or digital exclusion (Univeristy of Dundee, 2021<sup>[95]</sup>).
- To tackle digital divides during the pandemic, the government of Ireland offered a one-off EUR 17 million COVID-19 grant to support disadvantaged higher education students in accessing digital devices and an additional EUR 10 million for access support.

**Figure 5.4. Ratio of students and staff to available desktop computers on Croatian institution campuses**



Source: 2022 OECD-CARNET Digital Maturity Survey of Croatian Higher Education Institutions. N=69, including institutions who reported greater than 0 computers available for both students and staff, and with outliers removed (i.e. institutions reporting greater than 100 students per desktop computer).

StatLink  <https://stat.link/kva7qr>

Nonetheless, equitable and stable access to digital devices for education purposes varies among students. For instance, survey evidence for the United States in 2020 showed that about one in four higher education students experienced device issues during the pandemic or had to share a device with family members (EDUCAUSE, 2021<sup>[96]</sup>). BYOD as a substitute for institution-provided equipment also only works if personal devices can interoperate with the main institutional systems. Personal devices might also lack required safeguards leading to privacy and security issues (van der Vlies, 2020<sup>[29]</sup>). Finally, while most modern devices offer some built-in assistive technology, this may not be suitable for all needs. Although public funding is available in some jurisdictions, there is limited national or international evidence on the availability of end-user devices with assistive technologies suitable for students with additional needs (EPR, 2021<sup>[97]</sup>).

There is ongoing debate about whether it is more efficient to invest in laptops, desktop computers, or dockable systems using a laptop connected to peripherals such as a keyboard, mouse, and monitor. Traditionally, laptops were heavy and had limited battery life, making them “transportable” rather than portable. Modern laptops are more portable, with in-built peripherals, and have become powerful enough to run more demanding applications. The battery life of laptops has also improved over time, although in practice battery life depends heavily on the use of software programs. A greater presence of laptops on campus has implications for the provision of charging points. Concerns about safety and security may also deter students from bringing higher-specification models on campus.

Desktops have more upgrade options than laptops and are still more cost-effective when more powerful computing is required. Computer labs featuring desktop computers remain ubiquitous across campuses



for several reasons, including availability of higher-specification systems, speed of connection, managed access to specialist software and content, larger screens, and security compared with personal devices. Centrally managed student computer clusters also allow institutions to benefit from bulk purchases, which can result in even greater savings. Furthermore, desktop computing is perceived as more ergonomic than using laptops.

There is an implicit lifespan attached to the investment of end-user devices, which is often considered to be in the region of 3-5 years. Investments in end-user hardware at institution level are usually funded through general income and expenditure. Use of procurement frameworks or tenders is commonplace, and contracts may run for several years. Strong repair and warranty contracts are essential for business continuity and are normally included in procurement frameworks.

## Principles for public investments in end-user hardware

### ***Public investment in end-user devices with limited value in higher education activities should be avoided***

Certain end-user devices have demonstrably less value for higher education teaching, learning, support, and administrative activities, and should not be a priority for public investment. For example, the capabilities of smartphones and tablet-type devices have expanded in recent years and may be useful for accessing certain types of material and communications provided by higher education institutions. Many public authorities have invested in purchasing tablets for students and/or staff in school systems. However, the business case for doing so in higher education systems is less clear. In particular:

- Such devices do not always easily interoperate with the main institutional systems.
- Their lack of computing power means they may struggle with running multiple or resource-hungry applications.
- Not all functions of higher education information systems are suitable for the small screen or touchscreens.
- Smaller screens are suitable for simple forms of content consumption and interaction (for example, notifications or simple quizzes and surveys) but not for all types of content (for example, reading documents in certain formats). They are also generally not easily compatible with content creation tools for educators.
- Storage of and access to documents is required to a much greater extent by higher education students and staff but tends to be much more limited on tablets and phones.

Public investments could therefore focus on equipment that meets an agreed minimum standard for monitor size, computing power and interoperability with other digital infrastructure.

### ***Shared desktops can offer a cost-effective option for procurement at scale, and benefit a large proportion of students and staff***

Given the current funding envelope and planned near-term investment of Croatia, it appears unlikely that public authorities will directly purchase end-user equipment for students and staff on a systemic scale, for onward distribution to higher education institutions. In addition, any potential cost savings from mass procurement may be offset by the complexities of gaining widespread agreement of minimum baseline standards for end-user equipment, of establishing criteria for allocations to individual institutions, and of ensuring interoperability and compatibility with diverse existing institution technology.

However, it may be worth assessing the need for, and subsequent funding of, shared computing facilities on campuses where deficiencies in provision have been identified. Despite widespread ownership of

personal devices, shared computer labs provide a number of benefits for staff and students, including ensuring access to appropriate computing equipment and software for disadvantaged students, providing guaranteed security and compatibility of equipment, providing access to specialist software, and providing more powerful computing power than many students and staff have on their personal laptops.

In a context where higher education institutions have substantially different levels of equipment, making decisions about the allocation of funding for shared computers is complex. Potentially, an allocation could be made through a formula based on students or staff. Alternatively, allocations could be decided through calculations based on the reported status quo of equipment levels (although the difficulty of collecting and verifying such detailed data would probably create substantial administrative cost).

A more collaborative approach to working with the preferences of autonomous higher education institutions may prove to be more efficient. For example, some higher education institutions may not require investment in shared computing facilities but may need a large investment in audio-visual equipment. The number of institutions in Croatia is limited enough to potentially allow for a structured negotiation process with institutions, whereby institutions could provide assessments of their need for public funding to be allocated to one element of digital infrastructure rather than another.

### ***Beyond direct expenditure, governments could expand collaborative partnerships and collective capacity-building to effectively address equipment gaps***

Building partnerships and mobilising knowledge networks are strategies that can support further efforts to bridge equipment gaps across OECD countries. During the pandemic, central governments worked with a range of stakeholders (e.g. schools, municipalities) and private sector actors (e.g. EdTech companies, non-profit organisations, telecom firms) in collective efforts to address inequalities in students' access to digital equipment and tools (Vincent-Lancrin, Cobo Romani and Reimers, 2022<sup>[36]</sup>). While many such partnerships were motivated by the pandemic, developing and supporting more stable collaborative efforts could represent a further step in addressing inequalities.

Governments can also play an active role in supporting and establishing platforms for collective acquisition of equipment. As discussed earlier, several European countries directly offer purchasing framework agreements to higher education institutions, and in some cases education institutions are organised into co-operative structures that promote collective capacity-building for digital planning and acquisition (Estermann and Kupriyanova, 2018<sup>[98]</sup>). For example, in the United Kingdom, a charitable company, the Universities and Colleges Information Systems Association (UCISA) provides members with case studies, surveys, toolkits, best practice guides and benchmark reports to inform the development of digital capabilities. UCISA also includes a Digital Infrastructure Group that advises on technology and services between networks and end-user applications (UCISA, 2022<sup>[99]</sup>).

## **Investing in software**

### ***Introduction***

Higher education institutions deploy a diverse ecosystem of software across their campuses, intended to enhance teaching and learning, and streamline administrative and operational processes. Software in higher education comprises software intended for specific use by an end-user, such as office productivity tools, email, and field-specific software. It also includes central applications for widespread collaborative use across the organisation, such as student and management information systems, Virtual Learning Environments (VLEs), content management systems, software for lecture capture, and software for the development of teaching and learning materials.

Central applications should be a key target for public investment, given their potential for delivering systemic benefits, their utilisation by a large share of actors in the system, and their cost effectiveness. For example, the centrally provided Moodle VLE is extensively used across the higher education system in Croatia, and the OECD review team concluded from interviews with institution staff that it provided a vital resource for institutions during the recent periods of crisis.

Results from the CARNET-OECD survey of digital maturity in higher education institutions indicate different levels of maturity in the Croatian higher education system for the use of different types of end-user software and central applications. Few software application types have reached a ubiquitous “service level” across the system, and some types of software are only at a nascent stage of integration into the operations of higher education systems (Table 5.1).

**Table 5.1. Reported levels of digital maturity for common software and central applications in Croatian higher education institutions**

	% of respondents reporting at least some level of maturity	% at service level (well-planned and designed to be used by most teachers and students)	% at project level (specific activities involving a group of teachers and students)	% at initial level (experiments at the level of individual teachers)
Virtual environments for live online lectures / courses	99	73	13	8
Learning Management System or Virtual Learning Environment	85	66	6	9
Assessment and grading platform or tool	82	46	11	21
Discussion and/or feedback channels for students	76	39	16	17
Software suites for collaboration and intra-institution communication	76	43	13	16
Software for pre-recording or screencasting lectures	67	12	19	33
Digital tools for the design and development of courses	59	15	12	29
Digital tools that encourage new pedagogical practices	54	9	15	27
Tools / processes that simultaneously support online and personal participation in teaching (hyflex)	41	11	12	16
Learning Analytics	39	11	10	16
Remote exam supervision/ proctoring tools/ services	36	8	8	18
Artificial Intelligence (AI) for personalised learning	19	2	3	13
Blockchain for validating credentials	12	2	4	5

Source: CARNET-OECD survey of digital maturity in 95 Croatian higher education institutions.

## Recent trends in practice

### **End-user software**

End-user productivity software is usually provided at an institutional level and generally comprises office suites of word processing, presentation, and spreadsheets. In some cases, it also includes specialist packages for creative media, referencing, and data analysis. In higher education systems across Europe, Microsoft Office 365 has become the dominant office suite, partly because of its widespread use in business, and partly because its educational licensing schemes enable institutions to deploy it at scale, while staff and students can purchase it at an affordable price. Other software packages are more widely used in specific fields of education. For example, Adobe Creative Cloud software is frequently used in the arts and for other creative applications. Most end-user productivity software providers have moved to subscription licensing for both their institutional and private offerings.

In addition to widely used productivity and creativity suites, many specialist end-user software applications support the teaching, learning, research and administrative activities of students and staff in higher education institutions. Examples include software for coding, data science, or specialist individual creative applications. Specialist e-learning content creation tools are often used, such as Articulate (Articulate, 2022<sup>[100]</sup>) and Adobe Captivate (Adobe, 2022<sup>[101]</sup>) either as stand-alone programmes or, in some cases, to create material that can be imported into VLEs.

Although some elements of the end-user software market, such as the market for productivity software, are largely stable with few emerging disruptions, several challenges remain. A first challenge is the problem of ensuring interoperability and data portability between different types of end-user software. A lack of interoperability risks creating administrative and operational inefficiencies, increases the potential for vendor dependency, and hampers capacity to develop performance and learning analytics.

Many national and international initiatives exist to support open-source applications as an alternative to paid software, in order to democratise access and reduce reliance on commercial offerings. For example, the EU “Open-Source Software Strategy 2020-23” (EU, n.d.<sup>[102]</sup>) aims to increase the use of open-source software in government. However, there are many challenges to resolve before open-source software can become the default end-user software type deployed across institutions, including a lack of interoperability with commercial software already in use, and limited access to customer support services. In addition, many types of open-source software are rarely used in business and industry, leading to concerns within higher education institutions about the preparedness of their graduates to use standard industry software when entering the professional world.

A final challenge is the widespread use of “shadow IT”, software used by teachers and students without the awareness or acknowledgement of institution leaders. Shadow IT may cause compatibility issues with the existing infrastructure ecosystem of the institution but can also create knowledge gaps or complacency regarding the effectiveness of institution-provided software solutions.

### **Central applications**

Central applications include email, file storage applications, virtual learning environments, and software for content creation, content repositories and student management systems. Commercial providers tend to offer both email and file storage as part of a suite of services. For example, institutions using Google Suite for Education typically use cloud storage on Google Drive for file storage for both individuals and groups. Institutions using Microsoft Office 365 typically use OneDrive for file storage for individuals and Microsoft SharePoint for file storage for groups. Many higher education institutions have chosen at different times to migrate between commercial providers for this suite of services.

Central repositories are also widely used in higher education as specialised data storage solutions that can categorise and organise types of files relevant to teaching or research. For example, repositories such as D-Space are used by many higher education institutions as a content warehouse for research output (DSpace, 2022<sup>[103]</sup>). Often repositories are siloed, which limits the value of the stored information and limits transparency, even though transparency is increasingly important for compliance with data protection regulations. A lack of interoperability also limits capacity for creating integrated data warehouses and repositories that can be used to deploy services such as learning analytics.

Several related systems together form the umbrella term “student information systems”. Systems based on Customer Relationship Management (CRM) are becoming increasingly commonplace as higher education providers seek to build a lifecycle approach to student recruitment, timetabling, attendance, progression, and outcomes. Commercial providers of student information system increasingly offer cloud-based solutions, although a large share of higher education institutions maintain on-site installations (Gartner, n.d.<sup>[104]</sup>).

Finally, video hosting and streaming services were first to the market in higher education, but as lecture capture became more common, systems for previously distinct functions have merged, creating a relatively mature market (Monette, 2019<sup>[105]</sup>). Modern commercial lecture capture platforms offer integration with VLEs, privacy controls, and in-built capacity for gathering statistics. Many higher education institutions also use free video-sharing platforms (such as YouTube or Vimeo) to share content, while free or subscription services such as Zoom, BigBlueButton, Google Meet or Microsoft Teams have become standard for online meetings and videoconferencing.

Cloud services including Cloud storage, Infrastructure as a Service (IaaS), and Software as a Service (SaaS) have not been ubiquitously adapted across higher education systems. However, as with other elements of digital infrastructure, many central applications have moved to cloud-based provision, reducing the need for higher education institutions to support related hardware and software. Many prominent VLEs, such as Canvas, Brightspace and Blackboard, are already cloud-hosted and supported or rapidly moving toward that model. Moodle, a widely used open-source solution, and the most common VLE in Croatia, was traditionally locally hosted as a default, but many resellers and central providers now offer cloud-hosted versions of Moodle, so that smaller higher education institutions may benefit from Moodle without the need for server hardware.

Cloud services offer the potential to reduce digital divides, benefit from economies of scale, reduce the need to run local IT services, and grant widespread access to a more varied portfolio of resources (GÉANT, 2020<sup>[15]</sup>). However, the potential of cloud services to bridge inequalities in access relies on fast and reliable network connectivity. Without intervention, institutions with poor connectivity will fall behind in the transition to the cloud and miss out on its benefits. As discussed previously, cloud services also imply a shift in software costs, from a periodic one-off investment to the continuous payment of a subscription.

A core priority at both institution and system level is to pursue greater integration of central systems. Investments in interoperability of central applications potentially have a substantial payoff, in terms of the data that can be generated to support insights and improvements to teaching, learning and administrative processes. For example, learning analytics have the potential to transform current processes for the design and development of educational materials, and improve strategies to promote student learning and engagement.

Governments, higher education institutions and international bodies can help to surmount interoperability challenges by supporting the development and adoption of open-source software and promoting the adoption of open standards for interoperability. For example, the standards developed by 1EdTech (formerly called IMS Global Learning Consortium), cover learning platforms, learning data and analytics, and integrated assessment tools and standards (1EdTech, 2022<sup>[106]</sup>). VLEs can also ensure interoperability by adhering to common technical standards for e-Learning software products, such as SCORM (Sharable

Content Object Reference Model), which is an industry standard set of technical standards, or the emerging xAPI standard.

## Principles for investment

### ***Prioritise investment in software features that meet fundamental needs, rather than features that are unlikely to be widely used***

A fundamental risk with the purchase or provision of software is excessive expenditure on digital solutions that are not relevant for user needs or are otherwise unlikely to be heavily used. Commercial providers often develop multi-dimensional products, with increasing cost according to the extent of functionality purchased. Yet, there is some evidence that many advanced features of software packages do not provide added value to users, while potentially incurring a cost for those providing the service.

For instance, VLEs often include learning management functions that enable the transformation of teaching, as well as features that enable educators to manage administrative tasks related to traditional, face-to-face instruction. However, evidence suggests that there is significant heterogeneity in the way academics engage with these features. Academics tend to use VLEs primarily to manage the administration of classes delivered using traditional pedagogy, rather than to modify and enhance their delivery of instruction (Damşa et al., 2015<sub>[107]</sub>). For example, a large-scale study on the usage of Blackboard software in almost 1 000 institutions found that users exploited only a small fraction of its capabilities. Less than 2% used all of the functionality provided (Whitmer et al., 2016<sub>[108]</sub>). Another study in the United States found that only 40% of users engaged with advanced features of their learning management systems, despite widespread adoption of the technology (Brown, Millichap and Dehoney, 2015<sub>[109]</sub>).

Usage patterns of software features and functions may well have evolved during the pandemic period, when users were forced to rely on them to a much greater extent than previously. Nonetheless, investment of finite public funds in software is best made based on demonstrable proof of widespread need and demand for all elements of the proposed software solution.

### ***Consider investing in an open information platform that can be used to share knowledge about usage and user perspectives of educational software tools***

Continuous technological advances make it challenging to collect and share information on the diversity of digital tools and software available within higher education systems. For example, there is a lack of data on penetration and use cases for advanced technologies (e.g. AI-based educational tools) across higher education systems, often leaving institution staff to make purchasing decisions based only on information provided by vendors.

Governments can help to improve information flows by supporting the development and maintenance of databases listing available education technology tools/services, along with usage statistics and platforms for user interaction. Creating and disseminating knowledge on the type of digital tools or technology-enabled services that students, teachers, support staff and education administrators rely upon would enable a better assessment of digital divides and digital capabilities across higher education systems.

### ***Prioritise investments that can support greater access and inclusion in higher education***

Traditionally, higher education institutions have experienced multiple challenges reaching and supporting students with disadvantages or disabilities (Bong and Chen, 2021<sub>[110]</sub>). One of the most promising benefits of digital technologies is their potential to reduce inequalities in access to education and create more inclusive education systems (ICF Consulting Services Ltd, 2015<sub>[111]</sub>).

Technology has been revolutionary in supporting students with special educational needs. For example, specialised text-to-speech software can help learners with motor impairments to write by dictating text. Similarly, integrating behavioural reinforcement capabilities into commonly used software can support students with attention deficit disorders to improve time management, self-organisation, task completion and detail orientation (Mezzanotte, 2020<sup>[112]</sup>). Digital tools can also facilitate the integration of immigrant or refugee students by, for example, serving as a cultural mediator for learners of different ethnic and cultural backgrounds, for language learning, or as a communication tool (Melstveit Roseme et al., 2021<sup>[113]</sup>).

One emerging class of software uses equitable design principles to help students from different socio-demographic groups or backgrounds to progress at similar rates. In addition, early warning indicator systems, though nascent and still challenged with accuracy issues and algorithmic bias, show promise in helping educators identify students at risk of failure, while adaptive formative assessment software can support more personalised efforts to enhance student learning (Ganimian, Vegas and Hess, 2020<sup>[114]</sup>).

In line with Croatia's wider social objectives for higher education, public authorities could potentially invest part of the available funding in software that promotes equity and inclusion in higher education. This could be pursued by identifying central software or add-ins that can support a large share of the learner population, or through funding specific proposals from institutions to pilot and evaluate the effectiveness of innovative assistive software.

## The importance of digital competence

### ***Building digital capability must go hand-in-hand with investment in connectivity, equipment and software***

Although not included in all definitions of digital infrastructure, digital competence of both staff and students is fundamental to engaging successfully with digital technologies in higher education. Bridging equipment gaps is insufficient if students and staff are not empowered to effectively engage with the technologies provided. Many higher education staff members started their careers at times when the penetration of digital technologies in their workplace was limited or non-existent and have faced difficulties in adapting to the use of emerging technologies that are now vital to their role. Evidence also indicates that younger generations are more familiar with digital tools as consumers rather than as effective users to support their learning; the concept of "digital natives" (Prensky, 2001<sup>[115]</sup>) is increasingly contested (Gardiner, 2016<sup>[116]</sup>).

Public authorities have a central role to play in ensuring equitable and widespread access to building digital competence. Such access is crucial to close existing digital divides and ensure that digital education is achievable for all. Citizens need to be empowered to thrive in the digital landscape and supporting students to become more digitally competent is increasingly part of higher education agendas (DESI, 2021<sup>[49]</sup>). International-level developments are helping to spur national policies. The EU Digital Education Action Plan 2021-27 (EC, 2021<sup>[117]</sup>) sets out a range of objectives for enhancing the capability of both staff and students, focusing on basic digital skills and competences, digital literacy, computing education, knowledge and understanding of data-intensive technologies such as AI, enhancing levels of advanced digital skills in populations, and ensuring gender balance in digital studies and careers.

A significant challenge lies in determining the most effective methods for evaluating the digital proficiency of both staff and students. This requires not only measuring digital skills, but also assessing the ability of staff and students to make the most of the digital infrastructure available to them. Some NRENs and public bodies are increasingly focused on more structured and strategic approaches to building digital competence. For example, the UK NREN Jisc provides a range of digital capability services including discovery and training tools (Jisc, 2022<sup>[118]</sup>) and the Jisc Building Digital Capability service (Jisc, 2022<sup>[118]</sup>).

Croatia has been proactive in creating initiatives to develop digital capability. For example, SRCE provides a training offer to staff across the Croatian higher education system, covering different aspects of e-learning material development and delivery (SRCE, n.d.<sup>[119]</sup>). The OECD review team found that the work of SRCE is highly esteemed throughout the higher education system, and that future investment in initiatives to build digital competence will benefit from partnership with SRCE as a valued national stakeholder.

Other outputs of this project include a review of international standards, supports and practices for the delivery of high-quality digital education (see Chapter 4), and the guidelines for institutions for developing improvement roadmaps for digital education (see Annex A). Together, these provide a more in-depth analysis of how institutions can build competence for digital education as part of an institution-wide change process.



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## Notes

<sup>1</sup> The digital infrastructure for research in higher education includes text analytics systems, statistical packages, library and bibliometric packages, online access to journals, survey platforms, bibliographic databases and reference management tools.

<sup>2</sup> The enabling factors identified in the EU Digital Education Action Plan include: 1) tackling connectivity gaps; 2) tackling equipment gaps; 3) supporting education and training institutions with know-how on how to adapt and digitise in an inclusive manner; 4) addressing accessibility and availability of assistive technologies; 5) encouraging Member States to develop guidelines for digital pedagogy, drawn from best practice and experience, and upskilling their teachers; and 6) encouraging Member States to foster closer dialogue on digital education between stakeholders in the economy and education institutions.



# Annex A. Guidelines for institutions to support digital education strategy development

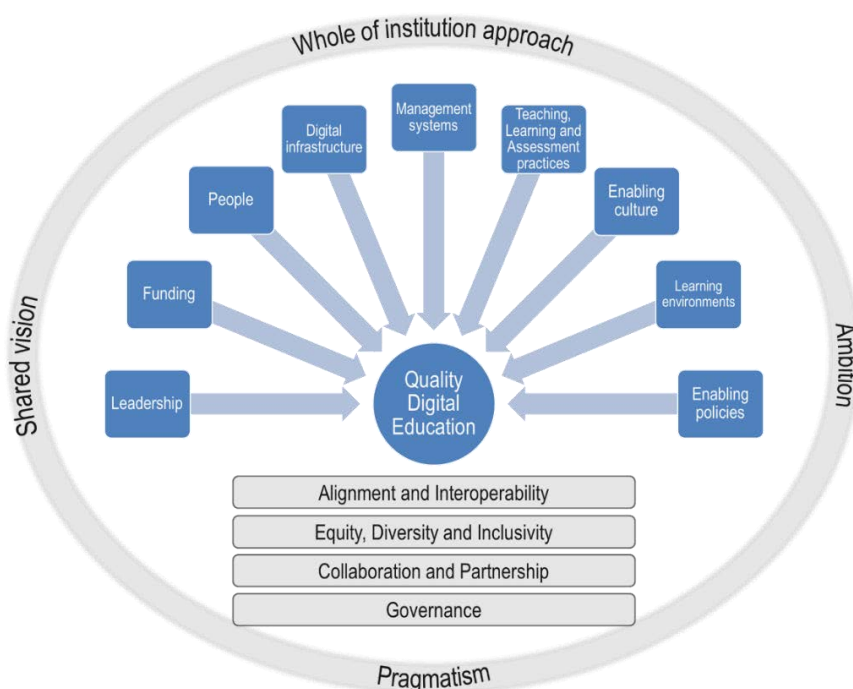
## Introduction

Digital education uses digital platforms, resources, and tools to enhance teaching, learning and assessment, and support student success. It underpins communication and connectedness, accessibility and interoperability across departments, faculties, and institutions.

The aim of these guidelines is to provide practical support for Croatian higher education institutions seeking to improve their capacity for digital education. They draw on expert advice and international experience to identify the key elements of quality digital education and provide a systematic process for developing an institution-wide vision for its improvement. They are designed to help institutions to embrace digital innovation, and to maximise its potential for improving teaching and learning.

Without doubt, high quality digital education requires significant investment, and sufficient, sustained funding is critical for success. At the same time, these guidelines emphasise the importance of other factors for the success of digital education, such as technical infrastructure, people, institution policies and practices, leadership and sectoral coherence. Quality digital education should be underpinned by commitments to the alignment and interoperability of systems and processes; to ensuring equity, diversity and inclusivity; to sharing knowledge, understanding and practice, to good governance and a culture of determination to implement sustainable change (Figure A.1).

**Figure A.1. Key elements of sustainable quality digital education provision**



An institutional strategy for quality digital education should provide a clear roadmap for enhancement, with agreed high-level priorities and indicators of success. The roadmap can inform improvement initiatives and support the deployment of high-quality digital education across all the functional areas of the higher education institution.

Developing a strategy for quality digital education can be challenging. The size of the institution, extent and effectiveness of prior investment and post-COVID fatigue are just some barriers to the process. To be successful, each institution's strategy must reflect its unique culture, context, and priorities. These guidelines promote a well-communicated, collaborative, and consultative approach to strategy development that will ensure input and ownership from the institution's staff, students, and other stakeholders. Developing an associated implementation plan will enable strategic priorities to be translated into transformative actions that support institutional change.

### *How the guidelines are structured*

These guidelines outline a stepwise approach to creating an inclusive strategy development process. Each step incorporates questions and considerations intended to stimulate conversation and consensus-building while formulating a whole-of-institution digital education strategy and associated implementation plan. Institutions should identify additional relevant topics for discussion, specific to their circumstances. Sample questions are also provided to stimulate discussion during the strategy development process. However, institutions are encouraged to take the time to identify other important, context-relevant questions.

The guidelines draw heavily on the experiences of the higher education system in Ireland in addressing the improvement of teaching and learning, including in relation to digital education. Ireland is widely recognised as a country pursuing "next practice" in this area, and it has been identified by Croatian authorities as a relevant peer country from which they can learn. The two countries share similar population sizes, have sectoral differentiation within their higher education systems (although with different governance and regulatory models), and are both striving to align with common European higher education norms and standards, such as the European Standards and Guidelines on Quality Assurance. These guidelines have been prepared in collaboration with Dr Terry Maguire, the former head of the Irish National Forum for the Enhancement of Teaching and Learning in Higher Education, considering the experiences and best practices from Ireland's higher education system.

### *Who are these guidelines for?*

Developing a strategic plan and enabling policy for digital education requires the collective effort of many people. Clear leadership and a consultative process that allows for the contributions of all stakeholders, including staff, students, and the wider community, are essential. These guidelines are designed to support institutional leaders, teaching and learning leaders, champions, innovators, staff, and students to shape their collective vision, and develop an associated strategy and implementation plan for providing quality education within their institution.

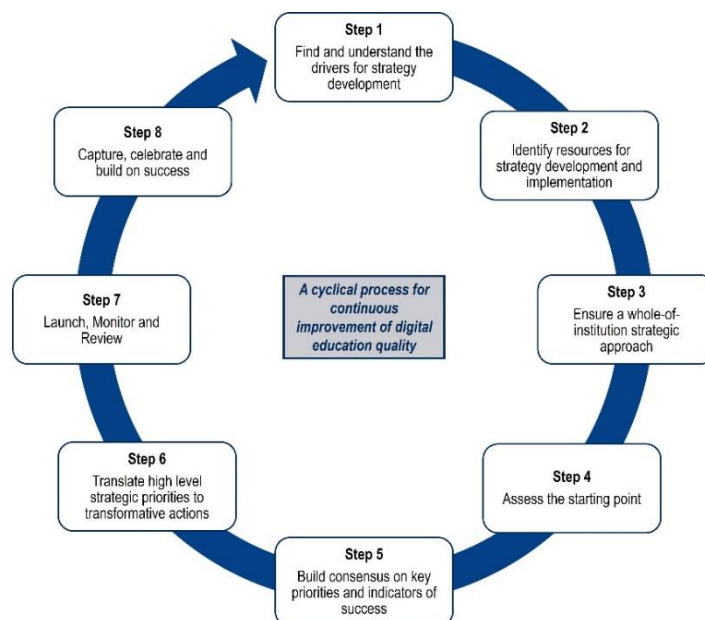
## **Taking steps towards quality digital education**

It is important that staff at all levels of the institution and their students understand why the strategy is important to them, so that they are motivated to support its development and implementation. Cultural change requires all stakeholders to share a vision for quality digital education within their institution, have a say in shaping the strategy and implementation plan, and understand their role in ensuring its success.

Promoting and implementing each element of high-quality digital education requires concerted strategic efforts on the part of institutions. Strategy development is not linear. It is a cyclical process of continuous improvement identifying key priorities, resourcing the implementation of associated enhancement

initiatives, monitoring progress, and advancing towards objectives. The improvement and development cycle can be conceived as a series of steps, as shown in Figure A.2. The final stage of the cycle marks the beginning of a new strategy development for the next strategic period, building on progress and planning for the future.

**Figure A.2. A cyclical process for developing a digital education quality strategy**



Each step of the process is discussed in detail in the following sections, including the motivation for including the step, the key topics for consideration, and questions that institution leaders, staff, and students can reflect upon to advance strategic development.

### Step 1: Find and understand the drivers for strategy development

Developing a quality digital education strategy is a time-consuming and resource-intensive process. To ensure successful adoption, the rationale and drivers for the strategy must be communicated in an accessible way to staff, students, and other stakeholders of the institution. Initial discussion should focus on building an ambitious but realistic vision for quality digital education at the end of the strategic period.

Croatia has been undergoing comprehensive reform to its higher education sector in recent years, including important updates to the legal framework governing its higher education system in 2022. Reform of the institutional funding model and the emergence of targeted funding for digitalisation are also creating a new focus on digital higher education, particularly as national authorities and institutions reflect on lessons learned during recent periods of emergency remote instruction.

At the European level, the Digital Education Action Plan 2021-2027 (European Commission, 2020<sub>[11]</sub>) is an influential policy. The action plan acknowledges the key enabling factors for effective digital education and presents a vision for enhancing digital teaching and learning at all levels of education. Furthermore, the digitalisation of public services, including education, is viewed both nationally and internationally as an essential element of digital transition.

Successful implementation of a quality digital education strategy requires the institutional strategy to be aligned with national and international policy developments. Staff, students, and other stakeholders should have a clear understanding of how policy changes may drive and influence change within their institutional context. One effective way to promote understanding is to review and summarise relevant legislation and policy in an accessible manner, and to ensure that it is effectively communicated to all stakeholders using various media. A possible title for such a communication could be "*A Short Guide for Staff, Students, and Stakeholders: Understanding the Impact of Higher Education Legislation on Our Institution.*"

Although a vision and strategy for high quality digital education will be informed by the international and national policy landscape, each institution should also consider its own specific drivers and priorities. These may include, for example:

- financial pressures/considerations;
- student profile and enrolment trends;
- staff profile;
- the ambition of the institution's leadership;
- stakeholder partnerships; and
- competition.

These considerations also need to be discussed, captured, and communicated in an accessible way to support the understanding of staff, students, and other stakeholders.

### ***Deciding on the periodicity of the strategy***

The most suitable periodicity for a digital education strategy will vary depending on an institution's context. The chosen periodicity should align with important contextual factors (such as budgetary cycles, legislative amendments, technological advancements, programme and curricular updates, and staff availability) while ensuring that the strategy remains effective and relevant throughout its lifetime.

A short-term horizon may be most appropriate for institutions aiming to quickly adapt to new developments, such as the introduction of new software or changes in regulatory requirements. Institutions seeking to make a more substantial impact on their educational offer through the use of digitalisation, build strategic partnerships or make considerable investments in digital technologies should develop strategies with a mid- or long-term time horizon.

### ***Creating tailored and accessible communications***

Staff, students and other stakeholders should be provided with information on the strategy development process. They need to be aware of the policy drivers and institutional priorities influencing the strategic development of the institution. They must know the key areas where they need to contribute, and how they can contribute. They need to be involved so they can develop ownership of the strategy, and thus support its implementation and subsequent success.

In higher education institutions, as in other large organisations, staff and students are often inundated with emails and other communications. To support the strategy development process, it is essential to develop a dedicated communication strategy with clear and concise messaging tailored to different audiences. It may also be effective to provide information about the strategy through different communication channels, allowing staff and students to choose the medium that works best for them.

### Questions for deliberation in the context of quality digital education strategy development

- Q1: What do changes in national policy mean for our institution's work in the short, medium and long term?
- Q2: What current international developments does our institution need to consider in its digital education strategy?
- Q3: Which current and future institutional priorities do we want to embed within the strategy?
- Q4: What is the best way to capture and communicate what changes in national policy, international developments and institutional priorities mean for the strategy?
- Q5: Are there other drivers we need to consider?
- Q6: What are the key messages we want to communicate to each of our audiences about quality digital education, the strategy development process and institutional vision?
- Q7: Who are we communicating with and how best can we access them?
- Q8: Who will take responsibility for the design and implementation of the communication strategy?
- Q9: What resources do we have to support the communication plan?

## Step 2: Identify resources for strategy development and implementation

A well-resourced implementation plan should accompany strategic development. It is important to identify and communicate the source and extent of resources required to progress the strategy. Once key priorities have been identified, resource allocation across these priorities and functional areas should be agreed.

The proposed strategic development's ambition will be influenced by the resources available for its implementation. Sustainable funding is necessary to ensure sustainable change, and each institution should identify the sources and levels of funding available to support the development and how it will be sustained during and beyond the current strategic period. Government funding is often ringfenced, with limited flexibility for reallocation. Many Croatian institutions benefit from funding because of involvement in, or leadership of, European projects which provide useful funding streams to support development in local contexts. Opportunities for reallocating funds within existing budgets should also be considered. Regardless of the funding source, it is crucial to label and ringfence funding for supporting the strategic development of quality digital education.

However, funding alone will not guarantee success. Providing quality digital education also requires appropriate human resources to guide the strategy's implementation. Staff allocation and recruitment strategies should reflect the institution's skills needs for achieving its digital education priorities. Workload adaptation and professional development opportunities must be available to support staff in developing their digital competence. Finally, curricular development processes must include opportunities for students to develop their digital competence as they progress through their programme of study.

### Questions for deliberation in the context of quality digital education strategy development

- Q1: What resources (people and financial) do we have within the institution to support the development and subsequent implementation of the strategy once it is finalised?
- Q2: What resources are available from external sources (e.g. CARNET, SRCE) that we could potentially access?

Q3: Are the identified resources enough to achieve our vision? How can we raise additional funds for this specific purpose?

Q4: Are there spending restrictions or existing initiatives that will need to be considered in the strategy development?

Q5: How should available resources be allocated (for example, in terms of development budget, capital expenditure, digital infrastructure, teaching and learning enhancement initiatives, supporting students and professional development)?

### Step 3: Ensuring a whole-of-institution strategic approach

To achieve strategic objectives, it is essential to foster whole-of-institution collaboration, consultation, and communication. The methods used to establish structures and processes may vary across institutions, but the goal should be to encourage engagement from both the top down and bottom up.

#### *Successful strategy starts with leadership...*

*'Leadership is neither about formulating a goal nor about defining the exact way to reach it: it is about getting people to pursue it jointly... Something historically difficult in most HEIs. Leadership is about setting the frame for others to come in'* (European University Association, 2022<sup>[2]</sup>)

Successful strategic development for quality digital education will require effective institutional leadership, through both formal and informal structures. Recent research on leadership in higher education institutions concluded that leadership at the institutional level is central to developing ownership and a sense of motivation among staff to engage in enhancement. The research advocates for strategic planning to be based on a powerful sense of transparency and empathy and efficient decision-making processes, facilitated by distributed leadership. It should be recognised that those who are not in an official leadership position can also be drivers of change (European University Association, 2022<sup>[2]</sup>).

#### *...continues with collaboration...*

A whole-of-institution approach to strategy development and implementation requires that mechanisms be put in place to foster active collaboration across all functional areas of the institution. All staff (senior management, academic, technical and professional), and students should have opportunities to collaborate and contribute to the strategy consultation process.

A positive way of ensuring a whole of institution approach is to identify an institutional lead to drive the consultation and subsequent development of the strategy. The institutional lead should be supported by an identified strategy partner from each functional area of the institution, including diverse student representation. The workload model of the lead and strategy partners need to ensure allocation of time to engage in discussion and planning in relation to the strategy consultation and development. The lead and strategy partners together can form a whole-of-institution Quality Digital Education Strategy Development Group. In bigger institutions this Strategy Development Group may benefit from having an administrative resource to schedule meetings and capture decisions and action points. Its main remit should be to:

- lead the strategy development process;
- agree the definition of terms to be used, and the values that underpin the strategy;
- provide a discussion forum for sharing of practice, ideas and approaches;
- consider institutional-level data and evidence and agree what it means for the strategy;
- scope and develop consultation processes, and build consensus on key priorities;
- identify and agree indicators of success and positive impact;
- agree the level and allocation of resources;



- compile an institutional level implementation plan to implement the key priorities; and
- monitor and review progress.

Each strategy partner works within their own functional area, consulting with staff and students and other stakeholders, as appropriate, to take stock of what is working well within their context. They should identify areas for development, build consensus on the priorities within their own context to be considered for incorporation in the strategy, and develop an implementation plan for their own functional area to support the institution in achieving its key priorities.

### *...and shared understanding & insight*

Many different and often overlapping definitions of terms are used in association with high-quality digital education, including:

- e-learning;
- online learning;
- distance learning;
- blended learning;
- hybrid learning;
- hyflex learning;
- technology enhanced learning;
- active learning; and
- technology enabled assessment.

The strategy development process should start from a discussion of the terms that will be used in the strategy and ensure there is a shared understanding of their exact definitions in the context of the institution.

Shared understanding can also be driven by widespread sharing of data and evidence. Using data effectively to inform decision making is essential to developing quality digital education, but it is also one of the biggest challenges. The organisational structure of higher education institutions, comprising individual faculties, schools or departments, leads to data being siloed and frequently inaccessible at institution level. To support evidence-based decision making there is a need to identify the range of data sets (both qualitative and quantitative) currently collected across the whole institution. These data should be collated to inform discussion and decision making.

#### **Questions for deliberation in the context of quality digital education strategy development**

Q1: What do we mean by quality digital education in our context?

Q2: What terminology are we going to use in the strategy? How do we develop an agreed understanding or definition of the terms we will use?

Q3: How do we ensure that agreed understandings and terminology are understood by staff, students and other stakeholders and embedded across all areas of the institution?

Q4: What data sets do we collect and where are they located?

Q5: What questions can our current data sets answer? (e.g. do we have an evidence base showing the current digital skills and capabilities of our staff and students?)

Q6: What kinds of professional development opportunities do we currently offer staff, with respect to digital teaching and learning?

Q7: How digitally mature is our institution? What is a realistic vision for quality digital education in our institution at the end of the strategic period?

Q8: Who are the current leaders of teaching and learning, generally in the institution and for digital education?

Q9: What leadership structure will best support the development of the strategy? How can we best build on or adapt existing structures? Are there alternative approaches that would help enhance the strategy development process?

Q10: How could an institution-wide, multidisciplinary strategic team be put in place? Who should be part of the team?

## Step 4: Assess the starting point

Prior to strategy development, the institution should take stock of the current provision of quality digital education. Current practices, approaches and policies that are working well and might inform future development should be identified. International trends in quality digital education can also be considered to ensure the currency of the strategy in the wider education context.

This stage of the strategy development process provides the institution with an opportunity to identify successes to build on as well as areas requiring further development. This is an essential stage of the process as it sets the starting point for strategic development. The process needs to be structured at an institutional level to ensure all the functional areas of the institution can inform the strategy. The Strategy Development Group (see Step 3) should scope the consultation process by developing a core set of questions to be addressed by each functional area. Functional areas should be free to interpret the questions in their own context and add further context-specific questions if appropriate.

Decisions around what constitutes quality digital education should be evidence-based and informed by feedback, participation, and involvement from various stakeholders, including students. Discipline-led academic research and research into teaching and learning practice should also be considered in the decision-making process.

Where possible, decision making should also be informed by qualitative and quantitative evaluation of the impact of teaching and learning approaches at programme, module and/or sessional level. Evidence sources could include learning analytics, student feedback focus groups, student evaluations of teaching, module feedback, staff peer review of curriculum design and peer observation of teaching.

### Questions for deliberation in the context of quality digital education strategy development

Q1: Has the institution reflected on the experience gained during the COVID-19 pandemic and identified what has been learned? Has it discussed what these learnings mean for the future of quality digital education at the institution?

Q2: What questions did the data and evidence we identified in Step 3 help us answer?

Q3: Are there additional data that need to be collected to support the development of the strategy? What is the best way of doing this?

Q4: What can we learn from both general and discipline specific teaching and learning scholarship and how can it inform our vision of what constitutes quality digital education provision?

The fundamental question for the stocktaking process is what aspects of quality digital education provision currently work well and what areas require development. The list of topics below can function as prompts to aid discussion. Topic discussion guides and additional questions for consideration have been included later in these guidelines to provide supplementary guidance for stocktaking and the strategic development process. The extent to which these aspects of quality digital education are currently developed, and the strategic priority allocated to each topic in different institutional contexts, will vary.

- academic integrity and assessment literacy (Topic 1);
- active learning using digital technologies (Topic 2);
- development of staff and student digital competence (Topic 3);
- digital infrastructure (Topic 4);
- attitudes towards use of technology to enhance teaching, learning and assessment (Topic 5);
- the design of learning spaces (Topic 6);
- digital technologies within a more agile curriculum and programme design (Topic 7);
- processes in place to share good practice, innovation and resources (Topic 8);
- designing student-centred, inclusive learning experiences (Topic 9); and
- other topics relevant to institutional context or contexts of discipline or functional unit.

## Step 5: Build consensus on high level key priorities and indicators of success

Discussion and debate in a Strategy Development Group should build consensus on the agreed vision for quality education at the institution and identify the high-level or key priorities and indicators of success to be incorporated into the strategy.

### *Balancing ambition and pragmatism*

Sustainable cultural change is a slow, incremental process that needs to be driven by achievable targets. The key priorities selected for inclusion in the digital education strategy need to be achievable, with the resources allocated, within the agreed timeframe. Institutions, therefore, must balance ambition with pragmatism in their final choice of the key priorities to be included in the strategy. The potential policy impact of the chosen key priorities must also be considered and captured so policy changes can be progressed in tandem with the implementation of the strategy.

### *Looking at priorities through different lenses*

Any strategy development must include consideration of who will be delivering, and who will benefit from, the strategy. Students and staff are not homogenous groups, yet we often talk about them as if they were. As possible strategic priorities are discussed, it is essential that they are considered through the lenses of different teacher and student profiles. Quality digital education will be interpreted differently by students and teaching staff depending on their specific characteristics and histories, field of education or research, study intensity, level of study, or the mode of delivery of the education programmes in which they are involved.

More generally, people across the organisation will hold different perspectives regarding quality digital education. Priorities for a part-time teacher will be different than those of a research-focused academic, a librarian or a financial assistant. Developing quality digital education provision requires a team-based approach involving teachers, students, education technologists, instructional designers and IT specialists to ensure pedagogical approaches and associated digital infrastructure support the development of digital capability and capacity across the institution.

The different viewpoints and perspectives to be considered in the Croatian context should be identified. These perspectives could incorporate different student or staff characteristics and demographics, for example people with disabilities, people with family/parental/caring responsibilities, people with work commitments, people living far away from the campus; people at a technological or socio-economic disadvantage, people with limited exposure to the language of instruction, people from ethnic minorities or people from an under-represented group in higher education. The use of different perspectives will help to ensure that the strategic priorities identified are applicable and relevant to a wide range of individual contexts and will support the institution in its consideration of the impact of quality digital education policies, practices and actions on all staff and students.

### Questions to consider in developing a strategy for quality digital education in our institution

Q1: What is the current profile of our students? What is the projected student profile at the end of the strategic period?

Q2: What is the current profile of our staff? In what ways might the staff profile be different at the end of the strategic period?

Q3: Who are 'those that teach' in the institution? Are librarians, technicians, supervisors as well as lecturers included in our definition?

Q4: Who are our other stakeholders? For example, professional bodies, funders, policy makers, industry, community, quality assurance agencies and national/international partners/collaborators.

## Step 6: Translate strategic priorities to transformative actions

Each functional area needs to adopt the institution-level key strategic priorities to its context and identify how it will help support the achievement of these priorities using the resources allocated. The functional area develops an implementation plan, aligned with the overall priorities identified in Step 5.

All staff, students and other stakeholders across all functional areas (including teaching, research, ICT, operational management and administration) have a role to play in helping an institution achieve the priorities outlined in its strategy.

Partners must ensure key priorities and indicators of success are communicated widely within their functional areas. They must facilitate opportunities for collaboration and discussion, identify and agree transformative actions to which they will commit, and support the institution in meeting and achieving its key priorities. It is important to clarify resource allocation to each functional area and the phasing of funding before the development of their context specific implementation plan.

Each implementation plan should be shared across the functional area and with the Strategy Development Group, who will compile the implementation plans for all functional areas into a holistic strategy and implementation plan.

## Step 7: Launch, monitor and review

The consolidated institution implementation plan can be used to monitor and review progress against key priorities. The agreed strategy and its implementation plan should be launched and widely communicated within the institution and across the higher education sector.

As discussed in Step 6, once each functional area has agreed their context-specific implementation plan, the functional area partners should share and discuss the plan with the Strategy Development Group. All the shared implementation plans should be compiled into a consolidated implementation plan, and a communication strategy for its launch should be designed and implemented.

Governance of review and monitoring processes should also be agreed to ensure oversight of progress against key priorities. Appropriate action should be taken to ensure all key priorities are met at the end of the strategic period, focusing on the impact approaches and associated indicators identified and agreed during the strategy development process.

Measuring impact associated with teaching and learning enhancement can be difficult. A narrow metrics-driven approach (for example, indicators based on test scores of students) results in a focus only on what can be objectively measured – often failing to capture other valuable, but less tangible, impacts. The long-term impact created through the investment of funding, time and effort in enhancement may not be recognised or understood, with significant ‘value for money’ going unnoticed as a result. This should be acknowledged in the strategy, while at the same time striving to identify all possible indicators of progress or challenges arising from the strategy implementation.

### Questions to consider in the context of quality digital education in our institution

Q1: Do the measures of impact defined reflect the purposes we are trying to achieve?

Q2: How can we know the impact was achieved? What kind of evidence is available or needed to evaluate the impact?

Q3: Impact evaluation needs to take a long-term view to ensure emerging, ‘slow burn’ impacts are not missed, and that initial impacts are monitored over time to establish their real value. How are the long- and short-term impacts being considered in the strategy monitoring processes?

Q4: Some impacts may not be anticipated. How will the strategy implementation adapt to unexpected impacts?

Q5: What communication methods are appropriate for each type of audience (e.g., funders, professional bodies, staff, students, community, employers)?

## Step 8: Capture, celebrate and build on success

Capturing and communicating the success of the strategy is central to ensuring staff, students and other stakeholders have a sense of achievement and ownership. During implementation, institutions should begin to identify resources for the next strategic period to continue the cycle of improvement.

If the strategy development process has been positive and inclusive, all staff, students and other stakeholders will feel a sense of ownership of the strategy and be engaged in ensuring its success. Their commitment to the implementation of the strategy and their contribution to its successful implementation should be recognised on a regular basis. Institutions should be proactive in communicating and celebrating success at all levels within the institution.

Celebrating areas where the strategy has been successfully implemented creates momentum and motivation for the next strategic period and reinforces continued commitment to enhancement of quality digital education provision. Collective reflection on the strategy development and implementation process – and the experience gained – can be a starting point for a new cycle of strategic development.

## Topic discussion guides for specific elements of quality digital education

### *Topic 1: Academic Integrity and assessment literacy*

Academic integrity is fundamental to ensuring trust and confidence in higher education systems and has emerged as key concern in relation to technology enabled assessment. Higher education institutions need to share an understanding of academic integrity and must develop policies and procedures to protect and reinforce it. Staff and students must be actively supported in their understanding of what actions and behaviours constitute ‘academic integrity’ and ‘academic misconduct;’ and be made aware of their individual responsibilities.

The pandemic restrictions meant that mainstream approaches to assessment such as in-person invigilated examinations had to be rethought, forcing higher education staff and stakeholders to consider possibilities for alternative assessment. This period has stimulated wider reflection on the purpose of assessment and the essential learning outcomes students need to achieve and demonstrate. Such discussions are a starting point for building increased assessment literacy capabilities in staff and students, and efforts should be made at institution level to maintain the momentum of progress after the end of the crisis period.

For institutions intending to make greater use of technology-enabled or technology-enhanced assessments (including remote assessments), reflection and discussion could also be focused on the potential to redesign teaching, learning and assessment processes to ensure that challenges related to academic integrity cannot arise. These processes could include, for example, greater emphasis on project-based learning, and replacing exams with evaluations based on presentations and discussions with students. Current trends in assessment include a move towards focusing on outcomes and providing authentic student assessment opportunities linked to the world of work. The increasing diversity of students also requires a greater focus on culturally responsive assessment. Students need more complex learning opportunities and more holistic, interdisciplinary assessments if they are to be equipped to tackle real world “wicked problems” (O’Neill and Padden, 2021<sup>[3]</sup>; Pineda and Winkler, 2021<sup>[4]</sup>).

Any review of assessment practices must consider programme level assessment, assessment workload and assessment bundling. It should consider how assessment is used ‘for’ learning and ‘as’ learning, as well as ‘of’ learning. Challenges to changes in assessment include the need to involve external examiners, regulators and professional bodies. These stakeholders need to be part of a redesign process that includes staff and students as partners.

#### Questions to stimulate discussion related to academic integrity and assessment strategy

- Q1: How do we currently ensure staff and students are aware of their responsibilities in relation to academic integrity?
- Q2: What are the current challenges related to academic integrity in our institution, and what is working well?
- Q3: How do/will we actively foster academic integrity as part of quality digital education?
- Q4: To what extent can we redesign the core processes of teaching and learning in order to avoid the emergence of challenges to integrity?
- Q5: What are the current approaches to assessment within and across our programmes?
- Q6: Are students, regardless of their learning mode, provided with opportunities to experience a diverse range of assessment methods including, where relevant, authentic work-based assessment, self and peer assessment?
- Q7: Are students, regardless of their learning mode, provided with a choice of assessment?
- Q8: How are staff and students supported to develop their assessment literacy?

Q9: Do current assessment and feedback practices foster partnership between staff and students?

Q10: Is data gathered by the institution through the assessment process used to inform and enhance future approaches to assessment and student learning?

### **Topic 2: Active learning using digital technologies**

Student-centred learning incorporates a commitment to active learning, which “represents a range of strategies that engage learners in “meaningful activities” and require learners to think about what they are doing. Essentially, anything that gets students interacting with each other and engaging with the lecture” (Hattie and Zierer, 2017<sup>[5]</sup>).

Active learning is an approach which can be used regardless of whether teaching and learning are occurring synchronously or asynchronously. Virtual meeting technologies and cloud-based collaboration software enable lecturers to engage students using screen sharing, breakout rooms, polling, hold-and-share whiteboards, and collaborative document development.

#### **Questions to stimulate discussion related to active learning strategy**

Q1: Is there a commitment to active learning in the institution? If so, how is it understood and communicated?

Q2: Are there opportunities for staff to share good practice in relation to active learning?

Q3: Do students get opportunities to discuss and influence active learning approaches with staff?

Q4: What active learning strategies are used to support current digital education provision?

Q5: How can learning processes be designed to put students' active learning and participation at the centre?

Q6: What kind of technologies and tools can we use to support students' active learning and participation?

### **Topic 3: Development of staff and student digital competences**

Quality digital education requires that digital technologies are used effectively to enhance teaching, learning and assessment. Teachers and learners must have the knowledge, skills, capability and confidence to engage with a range of technologies to support their respective approaches to teaching and learning. Institutions must be aware of the digital competence of both staff and students and should make provision for continuous development in a systematic way. There should be a range of potential professional development opportunities available in both formal and non-formal settings.

Teaching and learning is fundamental to higher education and its value needs to be consistently appreciated by a range of stakeholders (funders, staff, students, employers, wider community) and within the institution. It should be central to strategic development and an embedded part of the institutional culture. Higher education institutions can demonstrate the value they place on teaching and learning through a range of mechanisms including, for example:

- staff professional development;
- investment in people;
- career pathways which recognise and reward excellence in teaching;
- teaching awards;
- policy frameworks promoting teaching excellence; and
- research into teaching and learning.

These initiatives should aim to collectively create a connected and consistently supportive landscape, sending a strong message to staff, students and the wider community about the value of teaching and learning within the institution (Coton, 2021<sup>[6]</sup>).

### Questions to stimulate discussion about student and staff digital competence

Q1: What is the extent of current digital competence in our staff? If we don't know, how can we find out?

Q2: What professional development opportunities are already available to our staff? How effective have they been so far in building digital competence?

Q3: Is there a clear statement of the institutional commitment to the professional development of all staff, with associated allocation of resources?

Q4: Do our institutional workload models recognise and support continuous professional development for all staff and provide sufficient time for staff to engage?

Q5: In what ways does our institution facilitate communities of practice to provide peer support and encourage sharing of good practice?

Q6: How does our institution show it recognises and values individual and team commitment to professional development?

Q7: Are professional development opportunities responsive to emerging themes within the wider higher education landscape?

Q8: How do we ensure students are given the opportunity to develop their digital competence as they progress through their course?

Q9: How does our institution measure and reward improvements to teaching competence, including digital competence, within the academic career framework?

### Topic 4: Digital infrastructure

Although there has been significant investment in digital infrastructure in most higher education institutions over the last decades, progress in many has been slow. Most higher education institutions have made some progress towards harnessing the potential of new technologies to support access to, management of, and provision of, a range of modes of learning within their institution. At the same time, the pandemic shone a light on often-antiquated digital infrastructure and user interfaces, and the poorly integrated digital systems available to staff and students.

Quality education provision requires an integrated student management system which supports student success and meets the needs and expectations of today's students who have grown up with technology. The growing emphasis on upskilling, reskilling and lifelong learning means digital systems need to be able to flexibly accommodate different types of learner enrolments (or, indeed, multiple registrations) and to be interoperable with other institutions' systems. Digital systems should enable seamless accumulation of student credits and recognition throughout their lifelong learning journey. Developments in infrastructure also need to anticipate and provide for the potential impact that emerging technologies and contextual events could have on current infrastructure and practice.

Decisions regarding infrastructure should not be the sole responsibility of the IT department, but should involve other stakeholders, e.g. those with teaching and learning expertise, education developers, technologists, student support, administrative staff and students. Specific guidelines for institutions related to the development of digital infrastructure have been developed as part of this project and are presented in Annex B of this report.



### **Topic 5: Current attitudes towards use of technology to enhance teaching, learning, and assessment**

In Croatia and elsewhere, the pandemic accelerated the use of technology to access and assess learning and required the implementation of alternative teaching strategies. Croatia also experienced serious earthquakes in 2020 which damaged infrastructure and reinforced the crisis mode in teaching and learning. The innovations that began in 2020 in Croatia were conducted in far from ideal conditions, and, in the desire to return to normality, there may be a tendency to “overcorrect” and revert to pre-pandemic modes, abandoning all the measures taken during the emergency period.

In strategic discussions, institutions should seek to separate the benefits and adverse effects of the greater use of digitalisation during the emergency period and assess to what extent the adverse effects were observed as a result of being deployed in a crisis mode (as opposed to being carefully planned and rolled out in a systematic manner). It is important to remember that, despite the tendency to refer to the recent crisis period as a period of “experimentation” with digital technologies, substantial evidence already existed prior to the pandemic about technology-enhanced learning. There are many successful case studies and examples of good practice from which institution staff and stakeholders can learn (National Forum, 2021<sup>[7]</sup>).

Staff should understand the benefits and challenges of using digital tools in teaching, learning and assessment. Quality digital education may require a rethinking of the types of learning expertise required within the institution, such as learning technologists, who offer different skills than IT specialists or traditional teaching academics. Reflecting together on integrating new skill sets and roles into the organisation will help guide discussion about new strategies for quality digital education.

#### **Questions to stimulate discussion related to current use of technology**

Q1: What are the major motivational and demotivational factors for teachers at our institution to use technology?

Q2: What do teachers need most to use technology effectively?

Q3: Which new methods of teaching and technology use adopted during the recent crisis period are still being used? Which have been abandoned? Is the current status in line with our future vision for the use of technology in education?

Q4: Can our institution benefit from the skills and expertise of emerging higher education roles and professions, such as learning or educational technologists? If so, how can we source and integrate this type of expertise into our context?

### **Topic 6: The design of learning spaces**

How and where students learn has implications for how institutions plan the use of the physical campus. Various trends and contextual changes, including a greater use of digital technologies, should stimulate a reimagining of physical and digital spaces and the expansion of the concept of the campus to encompass both physical and digital elements. In a review process in Ireland, staff identified the need for smaller spaces to support interactions online and conversations between people; quiet spaces for lecturers to teach online or to record lectures, collaborative spaces for small groups, and optimal use of Virtual Learning Environments (National Forum, 2021<sup>[8]</sup>). Similar conclusions were drawn by institution staff in Croatia who were interviewed by the OECD review team during the current project (see Chapters 3 and 5 of this report).

Students also need appropriate spaces to learn individually or in small groups or project teams, to collaborate online and use laboratories for their learning and exploration. Students also increasingly seek to use their own digital devices to access learning and collaborate both on and off the physical campus. The design of learning spaces, therefore, needs to be tightly intertwined with planning processes related to digital infrastructure.

### Questions to stimulate discussion related to current and future use of learning spaces

Q1: What are some good examples of effective learning spaces on our physical campus and/or spaces that are being used innovatively? What spaces are underutilised, or not being used as intended? Why are these effective/ineffective?

Q2: Does our institution have digital learning spaces which are fit for purpose? How could these be improved, or used more widely?

Q3: What regulatory, safety and financial obstacles are there to using and, where necessary, redesigning spaces for new ways of learning and teaching?

Q4: What level of awareness exists across the institution about the availability and use of various physical and digital spaces? How is information shared by those who are successfully using physical and digital learning space in an innovative way?

### Topic 7: Digital technologies within a more agile curriculum and programme design

Changing demographics and evolving modes of participation in higher education, coupled with technological change, create an imperative for agile approaches to curriculum design. Strategies for quality digital education should aim to incorporate features of an agile curriculum. Table A.1 presents some important features of an agile curriculum design.

Digital technologies can play an integral role in developing more agile programmes and curricula. For example, the use of virtual space can support regular interactions with the professional world, while regular collection of data and feedback is also likely to be facilitated using digital tools. Furthermore, the proliferation of digital educational content offers new opportunities for curation and the reuse of high-quality materials to support learning goals.

**Table A.1. Features of an agile higher education curriculum design**

<p><b>Agile responses to change:</b> To prepare students for a dynamic technological world, programmes must incorporate leading-edge topics such as big data, artificial intelligence, machine learning, computational thinking, and sustainability. Students need opportunities to develop relevant skills and competencies, not only in STEM fields but also other disciplines. The pandemic has highlighted the importance of continuing professional development.</p>	<p><b>The campus is everywhere:</b> Innovative forms of delivery are being developed, including various forms of online learning. There is an opportunity for industry professionals to work more closely with faculty. Virtual spaces, such as laboratories, offer problem-solving and valuable learning, preparing students for real-world experiences.</p>
<p><b>Accumulation and accreditation:</b> Programmes should offer increased flexibility in design and delivery with an emphasis on modular learning and microcredentials.</p>	<p><b>Increased collaboration between higher education and industry:</b> Industry's fast-paced technological change may leave graduates unprepared unless there is greater partnership and collaboration with industry.</p>
<p><b>Authentic assessment and feedback:</b> Learners need authentic tasks to demonstrate learning, e.g. portfolio-based and project-based assessment.</p>	<p><b>Less, but more often:</b> Changing demographics and the need for regular reskilling make longer post-compulsory education programs unsuitable for many learners. There will be more demand for shorter courses and frequent returns to education.</p>
<p><b>Curation not creation:</b> The abundance of open educational resources and other high-quality content provide an opportunity for educators to shift their focus from creating course materials to enhancing the authenticity and quality of learning experiences.</p>	<p><b>Agility in scheduling:</b> Flexible modes of engagement, such as students working in industry while participating in educational programmes, may necessitate changes to the traditional semester structures. Higher education institutions must acknowledge and carefully consider the implications for their working practices.</p>

**Agility at the appropriate pace:** To be agile means to effectively adapt to change in a complex world, not necessarily to move quickly. This adaptation requires authentic and meaningful dialogue among stakeholders. Quality assurance is crucial and can be achieved by evolving roles in higher education, such as creating industry education liaisons.

**Leaner lifelong learning systems:** Higher education institutions have considerable experience and expertise in lifelong learning. Institutions need to enhance agility and develop leaner systems for lifelong learning (including online) to meet the needs of employers and employees. Recognition of prior learning can be used to further support learners' career paths.

Source: (National Forum, 2021<sup>[9]</sup>).

### Questions to consider related to using digital technologies for agile curriculum

Q1: What are some examples of agile curriculum and programme development happening in our institution? What are our plans regarding building agile capacities in our institution?

Q2: How are digital tools and resources supporting efforts to create more flexible and responsive programmes and curricula? How can we better harness the potential of digital technologies for this purpose in the future?

Q3: What are the limitations and opportunities for agile curriculum and programme development in the context of formal accreditation processes?

## Topic 8: Processes in place to share good practice, innovation, and resources

Supporting open education principles, practices and policies facilitates access to education and resources for students and staff. It also fosters innovative pedagogies and assessment practices, inclusivity, and equity. Open Education Resources (OER) are teaching, learning and research materials making use of appropriate tools, such as open licensing, to permit their free reuse, continuous improvement, and repurposing by others (UNESCO, n.d.<sup>[10]</sup>).

New approaches, resources and innovations in teaching learning and assessment can be created or co-created by staff and students to facilitate learning in active ways. Staff can adapt and building on shared resources and further share these adaptations to support others across the wider sector.

### Questions to consider in developing a strategy for quality digital education in our institution

Q1: How does our institution currently support and motivate staff and students to share good practice/resources?

Q2: Should a commitment to open education principles, practice and policies be embedded in our strategy for quality digital education? If so, how could we do this in practice?

## Topic 9: Designing student-centred, inclusive learning experiences

Student Centred Learning has been characterised as students having choice in how and what they learn. It is defined by the European Students' Union as "*both a mindset and a culture characterised by innovative methods of teaching which aim to promote learning in communication with teachers and learners, and which take students seriously as active participants in their own learning, fostering transferable skills such as problem-solving, critical thinking and reflective thinking.*" (European Students Union, 2015<sup>[11]</sup>).

Students' perspectives are not always deeply integrated into conversations about teaching and learning, even when they ostensibly have a "seat at the table." The Irish National Student Engagement Programme distinguishes between student voice, student engagement and student partnership.

- **Student voice** is the act of students sharing their individual and collective experiences within the learning community, expressed in formal and informal conversations.
- **Student engagement** is a process by which students and staff seek to work together to shape decision-making in higher education, building individual and collective capacity and knowledge to navigate institutional structures and cultures.
- **Student partnership** is the practice that both drives forward and emerges from meaningful student engagement. It recognises the need to re-balance power dynamics in higher education and seeks to enable a culture of change through collaboration, reciprocity and shared responsibility between staff and students (National Student Engagement Programme, 2021<sup>[12]</sup>).

Some institutions have processes in place that give students a voice, but do not provide opportunities to shape the decision making in the institution.

The Rome Communiqué (European Higher Education Area, 2020<sup>[13]</sup>) advocates for making student centred learning a reality, calling on higher education institutions to ensure education provision meets the needs of an increasingly diverse student population. Student-centred learning is a key aspect of the Bologna alignment process for degree structure and programme design, which advocates for students to be active participants in their learning and progression pathways. National indicators relating to student-centred learning must be reported from 2024 onwards (Bologna Follow-up group 4, 2022<sup>[14]</sup>).

Creating a learning environment which is fully inclusive of a diverse student population is a complex undertaking and should be pursued according to best available practices. Universal Design for Learning (UDL) is an example of a comprehensive framework designed to improve the learning experience of all students. It aims to create a culture of engagement in the increasingly diverse higher education landscape. UDL encompasses a set of principles and guidelines which together aim to develop expert learners, using a variety of teaching methods to lower barriers to learning and give all learners equal opportunities to succeed. The approach is underpinned by research in the field of neuroscience. Through using the UDL framework or similar evidence-based approaches, institutions can work to create more flexible and inclusive methods of teaching, assessment and service provision for students.

Finally, student-centred design needs to focus on non-classroom activities such as extracurricular activities and social networking. Non-classroom activities have an essential role to play in developing a sense of belonging and community and ensuring students can readily access administration services and academic staff. It therefore requires dedicated collaborative planning (National Forum, 2021<sup>[8]</sup>).

#### Questions to stimulate discussion in relation to student-centred learning, including in digital education

Q1: How is student -centred learning understood or defined in our institution?

Q2: Is our institution committed to student-centred learning? If so, how do we currently communicate that commitment? If not, should a commitment to student-centred learning be incorporated into the digital education strategy?

Q3: How well developed is staff-student partnership currently? What actions should we take to further enhance student partnership in the institution?

Q4: How can digital tools and technologies support student partnership? In what ways do they currently empower and disempower students?

Q5: How can we best support and empower students to engage in and play their role as partners, before and during their higher education experience?

Q6: How can students best be engaged in the efforts of individual teachers to experiment with new forms of teaching and learning, including using new digital technologies?

Q7: In what way are internationally recognised, evidence based, pedagogical frameworks such as UDL embedded in our teaching approaches and learning design?

Q8: Do we want to make a commitment to UDL or a similar framework as part of our current strategic development?

Q9: How do physical and digital non-classroom activities in our institution support students to develop their sense of belonging and community, and stimulate their engagement?

## The benefits of inter-institutional collaboration – case studies

### *Stronger and smarter together*

Developing high-quality digital education is a national priority for Croatia, as evidenced by the e-Universities project (CARNET, 2022<sup>[15]</sup>) and all its higher education institutions will be impacted by national developments. Where possible, it is prudent to collaborate with other institutions to learn from each other and share perspectives and developments. This is both good practice and time efficient, and helps create, develop and deepen the national higher education community. Furthermore, inter-institution collaboration provides an opportunity to make best use of the limited funding available.

When institutions and other stakeholders do collaborate effectively, they provide a powerful voice to inform national policy development and identify the level and allocation of national funding. For example, a first step in the Croatian context could be to organise an inter-institutional seminar bringing interested individuals together to discuss and summarise what national and international policies mean for the staff, students, and other institutional stakeholders in higher education in Croatia. The output from this seminar could then be shared more widely to form a starting point for further strategic planning and actions.

Case studies below from Ireland and Portugal highlight the value of collaboration and the positive outcomes that can result. In 2021 fifteen partners, from a range of stakeholders across the Irish Higher Education sector came together, facilitated by the Irish National Forum for the Enhancement of Teaching and Learning, to agree the next steps for teaching and learning in a post-Covid world. The output of this collaboration subsequently informed national policy and funding allocation (see Case Study 1).

The Portuguese Universities of Minho and Aveiro developed a strategic partnership to strengthen efforts to transform their institutional cultures regarding learning and teaching. Their aim was to scale up the impact of single-institutional initiatives and achieve their vision of nurturing a multi-institutional community through peer learning (see Case Study 2).

### Questions to consider in relation to collaboration when developing a strategy for quality digital education

Q1: What institutions with which we already have a relationship might be willing to co-create a meaningful summary of national developments and international trends and their implications?

Q2: How can we go about getting prospective partners to work with us?

Q3: Do we need a formal agreement to share any outputs across the institutions involved?

Q4: As all higher education institutions are facing the same changes, what role should our institution play in ensuring we work together, either formally or informally? Should we consider setting up a national network/group?

Q5: Who will be responsible for moving collaborative efforts forward?

### **Case Study 1: “Next Steps” Project, Ireland**

In March 2021, fifteen partners from a range of stakeholders across the Irish higher education sector agreed to work together to answer a common, persistent, and urgent question: what have we learned from the COVID-19 experience and what does it mean for the future of teaching and learning in Irish higher education? The partners in the project (entitled “Next Steps for Teaching and Learning; Moving Forward Together”) worked in their own settings to answer this question for themselves. They subsequently shared and discussed their findings to answer this question collaboratively for the sector.

The “Next Steps” project was unprecedented in Ireland in terms of the scale of, and approach to, collaboration. All partners submitted evidence-based findings from new or previous research about the experience of teaching, learning, assessing, and working through the pandemic. Project partners combined and analysed their respective findings to formulate high-level key messages, consider them in a wider context and make recommendations. They proposed a principles-based approach to stimulate further discussion and identify next steps. Their collective key findings were: (National Forum, 2021<sup>[8]</sup>)

- Positive change in teaching & learning can only occur within an enabling culture across both institutions and the wider sector.
- A deliberate emphasis on equity, diversity, and inclusion must be preserved and further developed within teaching & learning so that staff and students can succeed and thrive.
- Community and well-being are essential both for students and staff.
- Decision-making and leadership can be shared effectively across the whole institutional community.
- The ethos of student engagement and partnership are highly valued in Irish higher education. An explicit strategic focus will enable further embedding of the ethos into policies, processes, and practice.
- Teaching & learning experiences for students and staff are diversifying and evolving. Learning environments are transforming to enable mixed modes of learning and participation.
- The world of work is digitally infused and requires a commitment to lifelong learning.

The report of the project was launched in 2021 by the Irish Minister of Higher Education, Research, Innovation and Science. Its findings informed the allocation of ring-fenced public funding for higher education teaching and learning for 2022 and 2023 (National Forum, 2022<sup>[16]</sup>).

### **Case Study 2: Inter-institutional collaboration on teaching development, Portugal**

After some years of successful bilateral collaborations on co-construction of teaching enhancement initiatives, the Portuguese Universities of Minho and Aveiro entered a strategic partnership with the goal of transforming teaching and learning in their respective institutions. They organised a retreat (Docencia+) in June 2019 to bring together teachers from each institution to implement innovative approaches to their chosen pedagogy projects (Universidade de Aveiro, n.d.<sup>[17]</sup>). This first retreat brought together more than 30 teachers from each project and was so successful that the universities organised 3 additional retreats, with participation increasing each time, stimulating the formation of networks and a practice community.

The success of the Docencia+ initiative led to enquiries from staff in other institutions wanting to participate. The strategic partners envisioned the development of an online inter-institutional conference on pedagogical development (*Jornadas Interinstitucionais de Desenvolvimento Pedagógico*), as a means of expanding innovative practice in teaching development to other institutions and diversifying the portfolios of teacher training programs available nationally (Aveiro, n.d.<sup>[18]</sup>). The movement has grown substantially since the first edition in 2020, and more and more institutions are expressing an interest in getting involved. Nine universities engaged in the first session held in September 2020, and by the time of the sixth session, just 18 months later, 17 higher education institutions including public and private universities and

polytechnic institutes, took part (The Educationalist, 2021<sup>[19]</sup>). Institutions in Portugal have thus been able to create a space within the higher education system to focus on teaching and learning, through bottom-up collaborative processes.

## Additional resources to inspire strategic development

Table A.2 outlines additional case studies and recently developed resources from Ireland that may be inspiring to Croatian institutions setting out on journeys of collaborative strategic development related to digital education. Ireland is a peer country identified by Croatia as being of interest and relevance for this project and has invested in developing institutional capacity for collaborative teaching and learning projects over the past decade.

**Table A.2. Additional resources from Ireland to support enhancement in digital teaching and learning**

Title	Description	Link(s)
Teaching and Learning in Irish Higher Education: A Roadmap for Enhancement in a Digital World	Published in 2015, this roadmap outlines the vision for digital capacity in Irish higher education. The roadmap stresses that building digital capacity is much more than developing capacity for online course provision and the use of digital tools.	<a href="#">Strategic roadmap document</a>
Enhancing Digital Teaching & Learning in Irish Universities (EDTL)	EDTL was a four-year project, finishing in December 2022. The project aimed to enhance the digital attributes and educational experiences of university students through enabling the mainstreamed, integrated use of digital technologies across teaching and learning. The project developed several resources on the EDTL approach, including some written for students by students. The project also developed a professional development programme ' <i>Getting Started with Personal &amp; Professional Digital Capacity: an open course for educators in Irish Higher Education.</i> '	<a href="#">EDTL blog</a> <a href="#">EDTL project outcomes.</a>
Learning about Impact and Looking to the Future: Teaching and Learning Enhancement Fund Projects 2014-18	This report provides a high-level overview of the impact of the 32 Teaching and Learning Enhancement Fund projects funded by the National Forum for the Enhancement of Teaching and Learning up to December 2018 and shares lessons learned about achieving, sustaining, capturing and communicating impact in higher education.	<a href="#">Project Impact Report</a>
Compendium of Active Learning; Strategies for Student Engagement	A resource sharing good practices in relation to active learning.	<a href="#">Compendium document</a>
Technology-Supported Assessment Exemplars: Open version January 2021	A bank of exemplars of technology supported approaches. The bank is publicly available under a Creative Commons licence for anyone to consult.	<a href="#">Exemplars document</a>
Openteach resources	The Openteach project aims to generate new knowledge about effective online teaching practice and to harness it to support professional development of online teachers and online student learning experiences.	<a href="#">Openteach website</a>
Gateway to digital assessment Trinity College Dublin, Ireland.	Gateway to digital assessment contains a range of resources for staff and students to support effective digital assessment.	<a href="#">Strategy document</a>
Leadership and Organisation for Teaching and Learning (LOTUS) project led by the European University Association (EUA)	The LOTUS project aimed to contribute to capacity building and strategic change management for learning and teaching at higher education institutions across Europe. The project report incorporates several relevant case studies to share good practice and some especially useful recommendations for leadership in teaching and learning in universities.	<a href="#">Final report</a>

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# Annex B. Guidelines for institutions to support digital infrastructure investment

## Introduction

Croatian higher education institutions can benefit from information on best practices and principles to develop institution-level "blueprints" for smart investments in digital infrastructure. These guidelines are intended to provide such insights. They should be read and followed in conjunction with the accompanying guidelines on developing institutional strategy for high-quality digital education, also developed as part of the project (Annex A). They are based on best international practice in investing in digital infrastructure, a diagnostic report on digital maturity in Croatian higher education institutions (Chapter 3) and principles on investment in digital infrastructure in Croatian higher education prepared by the OECD as part of the project (Chapter 4). In Chapter 4, and in these guidelines, digital infrastructure is defined as follows:

*Digital infrastructure brings together and interconnects physical and virtual technologies and associated supports, enabling higher education institutions to facilitate high quality education and research in an evolving digital landscape*

Higher education institutions across Croatia vary in their governance structures, their ability to access funding streams for digital infrastructure, and the capacity and availability of their staff for professional planning and management of infrastructure projects. These guidelines can help institutions to evaluate the current status of their digital infrastructure and prepare blueprints for successful investments, accounting for resources available within the institution and resources provided centrally to Croatian higher education institutions by public authorities (for example, through CARNET). Five key elements of investment strategy are covered by these guidelines:

- linking investment approaches with the wider digitalisation agenda;
- understanding the institution's starting point;
- evaluating and prioritising infrastructure needs;
- procuring and financing infrastructure acquisition;
- planning for integration, support and maintenance.

After individually analysing each of these elements, these guidelines offer more specific factors to consider when investing in different categories of digital infrastructure (networking, on-campus technical equipment, end-user hardware, software, support and capability).

### *Who are these guidelines for?*

These guidelines are intended primarily to provide a reference to groups of decision-makers and leaders in individual Croatian higher education institutions who are responsible for making investments in different elements of digital infrastructure. Nevertheless, the guidelines stress the importance of making decisions on digital infrastructure that are aligned with wider institutional, national and international orientations for digitalisation in higher education. Alignment of strategy and investment decisions can support coherence and interoperability of technology and help to avoid the pitfalls associated with individuals or small groups

of people acting alone when making decisions about digital infrastructure. Some of the questions raised in the guidelines will therefore require wider consultation and discussion across the institution.

### *How should these guidelines be used?*

The guidelines are designed to support deliberative processes related to the investment of digital infrastructure in higher education institutions across Croatia. Their objective is not to serve as a “one-size-fits-all” prescription, but to support institutions to develop their own investment practice blueprints considering available knowledge on best practices for each element of investment. The word “blueprint” is chosen to highlight a desired convergence of good practice across the institution, where the characteristics of individual investments will vary but all investments are planned and developed according to the considerations laid out in this document.

The guidelines can be used as a tool to validate and shape proposed institution-level investment strategies, highlighting areas for improvement both in the infrastructure and in related institutional practices. They can be used to stimulate internal discussion on important issues related to digital infrastructure, and as a basis for validating and improving general investment strategies.

## Five elements of investment strategy for digital infrastructure

### *Element One: Linking investment approaches with the wider digitalisation agenda*

Digital infrastructure investment decisions should be integrated into a wider institutional plan for the improvement of digital teaching and learning. Annex A of this report provides guidelines for setting institution strategy for developing high-quality digital teaching and learning, and bringing together staff, students and institution leaders in a collaborative and cyclical improvement process. This wider improvement process can be instrumental in informing needs and priorities for digital infrastructure and can promote understanding of the resource channels available to support new investments. It is therefore recommended that these guidelines are read in conjunction with the guidelines in Annex A.

Understanding the broader context before making digital infrastructure investment decisions ensures awareness of wider policies, available support, and potential resources to harness from policy and institutional spheres. These resources may include incentives, advisory services, or access to knowledge on best practices and user perspectives on relevant technologies.

Decision-makers with a deep knowledge of the wider agenda will be able to create a better investment approach that can accurately pinpoint “where to innovate and where to follow” (Jisc, 2020<sup>[1]</sup>). Institutions have limited financial and human resources to spend on digital infrastructure, and therefore must find the best balance between aligning with wider systemic incentives and knowledge of proven technologies and creating a digital infrastructure to meet their unique needs and goals.

### Key questions for discussion and reflection

Q1 – What digitalisation strategies and policies already exist that may have implications for my digital infrastructure investment? In my institution? In Croatia? In Europe?

Q2 – Are there other types of institution or system-wide regulations or policy initiatives in place that may affect current and future digital infrastructure investment decisions (e.g. procurement, accounting, recruitment)?

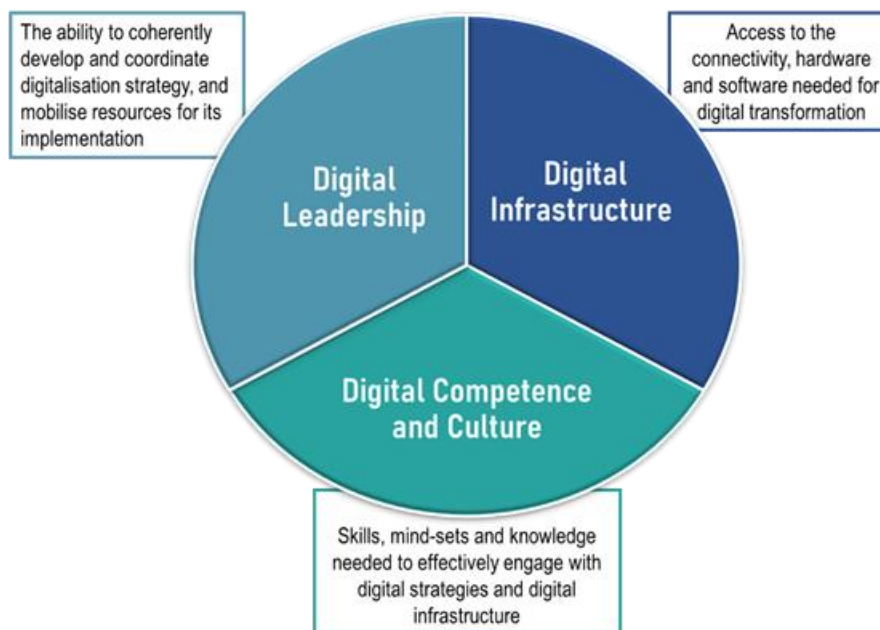
## Element Two: Understanding the institution's starting point

Each institution will undertake investments in digital infrastructure from different starting points. Some institutions may have already invested substantially in building investment capacity and strategy, particularly following the COVID-19 pandemic and 2020 earthquakes, which created a long period of forced dependence on digital teaching and learning in Croatia. Other institutions may still have very limited infrastructure, and/or limited capacity to invest resources in improvements. Others still may be dealing with substantial legacy issues from previous investments that were strategically unsound, leading to a mixture of technologies lacking interoperability and efficiency. A comprehensive assessment of the starting point of the institution's digital infrastructure is vital for assessing future needs and priorities.

In Croatia's education system, there is a growing focus on the concept of "digital maturity" of institutions. In Croatian schools, digital maturity has been defined in the national e-School project in terms of maturity across different areas, comprising ICT infrastructure, but also leadership, the use of ICT in teaching and learning, competence and culture. Croatian authorities are working on a similar concept of digital maturity for higher education institutions, and the current OECD project is providing analysis to support this concept. It advocates for a simpler and more flexible specification of digital maturity for higher education institutions compared to schools, on the basis that they tend to be more internally heterogeneous, with different levels of maturity across different departments, disciplinary areas and staff and student categories.

Three key interlinked elements of digital maturity are highlighted in the proposal developed by the OECD: digital leadership, digital infrastructure and digital competence and culture (Figure B.1). This proposal is intended as a starting point for developing a national digital maturity framework for higher education institutions in Croatia, led by CARNET as part of the national e-Universities project (CARNET, 2022<sup>[2]</sup>).

Figure B.1. A conceptual framework for digital maturity evaluation and improvement



While these guidelines are focused on digital infrastructure, an understanding of the starting point needs to also consider the presence and strength of each of the two other elements of digital maturity. Digital infrastructure alone cannot be effectively deployed without the competence of staff and students to engage with it, and their acceptance of digitalisation as an effective means of improving teaching and learning. In

turn, this competence and culture is best promoted through strong leadership and championing of digitalisation at a high level. Reflecting on these questions, as well as the current state of the infrastructure, can support the analysis of needs and prioritisation of resources.

Chapter 3 of this report, on digital maturity in Croatian higher education institutions, suggests indicators that could be used by an institution to assess its development in each of the digital maturity elements. The questions below can also be used to reflect more deeply on the status quo of the institution regarding digital maturity.

### Key questions for discussion and reflection

Q1: Where does the locus of leadership lie in digitalisation within my institution? Are there individuals with clear roles and responsibilities for leading and championing digital issues (e.g. Chief Information Officer or Chief Technology Officer)?

Q2: Who makes decisions on investment in digital infrastructure? How are such investments monitored within the institution?

Q3: What is the general attitude of colleagues and staff throughout the institution with respect to digitalisation? Is there broad scepticism, indifference or enthusiasm? What is driving these attitudes?

Q4: What is our assessment of the current quality of each element of digital infrastructure? In which areas do we currently have adequate technologies, and in which areas do we lag?

Q5: Are there risks associated with the technologies we are currently using (e.g. obsolescence, risk of technology failure, funding risks)? What will be the impact on the institution if these risks are realised? Is there broad awareness and understanding of the risks?

Q6: What have we already achieved in terms of successful technology investment and implementation? How did we do this, what were the success factors, and how can we replicate it again for future investments?

### *Element Three: Evaluating and prioritising infrastructure needs*

Following an assessment of the status quo, a clearer understanding should begin to emerge about the most urgent requirements for digital infrastructure investment. Successful acquisition of digital education infrastructure implies having sufficient information, capacity, and skills to navigate the wealth of choices of digital products, services, and tools. Infrastructure purchasing decisions should also reflect a comprehensive understanding of student and staff needs, to ensure that acquired digital tools are fit for purpose.

Evaluating needs and prioritising infrastructure investments can be carried out using different methods. If investments are planned in the context of a wider institution-level strategic development process, then feedback from that process should already provide some indication of the most urgent needs and priorities from the point of view of users. This information could be complemented in several ways to ensure that widespread views of the user base are considered. For example, a survey of users could be carried out to find out their preferences and ensure that assumptions being made about their needs reflect their actual situation. Alternatively, user groups could be consulted in workshops or seminars aimed at promoting their most pressing requirements.

As well as the stated needs of users, other forms of evaluation include assessing and comparing alternative potential investments according to a set of standard criteria. As an example, the box below proposes a set of general questions for evaluating and prioritising between alternative investments based on the OECD Recommendation of the Council on the Governance of Infrastructure (OECD, 2020<sup>[3]</sup>), the G20 principles for Quality Infrastructure Investment (G20, 2019<sup>[4]</sup>), and the United Kingdom's guidelines for investment in education technology (Crown Commercial Service, 2022<sup>[5]</sup>).

### Key questions for discussion and reflection

Q1: What is the envisaged social impact of the infrastructure? Will the infrastructure contribute to widening equity of participation or completion, and if so, how?

Q2: To what extent is the infrastructure investment linked to stated institutional or systemic goals and objectives such as its digital education strategy or teaching and learning strategy (where they exist)?

Q3: How is the infrastructure expected to improve the status quo? How will it positively affect the activities of the institution? Is the size of the investment proportional to the anticipated positive impact, as indicated by available evidence?

Q4: How many or what share of users of the institution will benefit from the infrastructure deployment?

Q5: What is the anticipated lifecycle of the infrastructure? Can it be deployed for other functions or uses once it has fulfilled its intended primary purpose?

Q6: What will be the impact of the infrastructure on environmental sustainability goals? Will it contribute to their achievement or detract from them?

Q7: What are the estimates of ongoing expenditure required to maintain, support and upgrade the equipment? To what extent is this expenditure offset by estimated cost savings associated with deployment of the infrastructure?

Q8: How does the infrastructure adhere to hardware or software interoperability or data portability standards? How well does the planned investment integrate with existing and future technologies?

Q9: To what extent has proof of demand been established for the infrastructure? How has its fitness for the intended purpose been evaluated?

Q10: Are there risks associated with the planned infrastructure (for example, security, ethical risks or risks of failure)? If so, have adequate mitigation measures been developed and validated?

### ***Element Four: Procurement and financing of infrastructure***

Decisions about infrastructure investments extend to the resourcing of the infrastructure. Raising and spending funding on infrastructure is carried out in an environment with many competing needs for financing, and in a market environment that often has asymmetric information between technology providers and buyers. Most higher education institutions have several potential public and private funding streams to resource investments in digital infrastructure. Overdependence on one source of financing creates risks, and as is the case for financing all the institution's activities, efforts should be made to cultivate as many revenue and financing streams as possible to fund digital infrastructure.

Some types of physical equipment and Internet connectivity have traditionally been provided to Croatian higher education institutions either through a direct NREN service from CARNET, or through project-based funding from public authorities. CARNET alone provides approximately 40 distinct services to more than 200 000 users in higher education and research organisations (Géant, 2022<sup>[6]</sup>). CARNET and other important actors, such as SRCE (University Computing Center of the University of Zagreb) are continuously enhancing technological, and capacity-building supports to institutions. Institutions therefore use their expertise as the first port of call when considering forms of technology enhancement. Considering additional current and future investments through the e-Universities programme, CARNET and its partners are likely to further increase the range of services they provide, and as such should represent an important primary source of advice for institutions on infrastructure projects.

As mentioned, some forms of digital infrastructure may be financed from project-based or targeted public funds. Although once-off funding provides a vital means for institutions to fund large infrastructure projects, attention must be paid to the need for continuing recurrent funding for infrastructure support and

maintenance. Planning and resource mobilisation for digital infrastructure increasingly needs to be considered as a multi-year rather than an annual process, or a singular investment in a particular type of equipment.

Another important consideration for institutions is whether the required infrastructure should be purchased and owned directly by the institution, or whether other forms of access to the technology are more appropriate or cost-effective. For many categories of infrastructure, digital equipment leasing, virtualisation and cloud-based applications are converting traditional capital investment to current expenditure with possible implications for future funding models. In this way, institutions can avoid large upfront costs, but also need to plan for perpetual recurrent expenses. The extent to which institutions can assess the relative merits of such investments may vary, depending on previous experience, access to market information and in-house expertise. This is an area in which collaboration and knowledge-sharing among institutions can pay substantial dividends.

Another area where institutions can most benefit from wider collaboration is procurement. Procurement is a commercially confidential process between higher education institutions and suppliers. Pricing details are often withheld, and buyers may have limited insight into the features and potential risks of the technology before it is purchased. As a result, institutions may purchase technology that is ineffective, difficult to support locally, or incompatible with existing infrastructure. Managing these risks requires collaboration and information-sharing among institutions, either through collective purchasing to increase buying power, or through systematically sharing user experiences of purchased technologies.

An alternative model for investing in digital infrastructure can be pursued at the system level, through direct tendering and provision of the resource by public authorities to higher education institutions. Central procurement provides opportunities for higher education institutions to acquire secure and stable high-capacity network connections with accompanying management services and tools. Such direct provision can be especially beneficial for smaller institutions with less access to financial resources from private sources, or with fewer staff with strong digital capabilities. While institutions may often communicate needs to governments or technology providers on an individual level, there is a stronger possibility that collective efforts to identify common needs and solutions will be resourced, either publicly or through more robust partnerships with educational technology providers.

Finally, partnerships between higher education institutions and those outside the sector (such as start-ups, technology companies and government) can facilitate innovation, particularly for unproven technologies. Emerging technology companies benefit from the opportunity to test novel tools or products, while institutions can have a greater role in shaping technologies to meet their specific needs (OECD, 2019<sup>[7]</sup>).

### Key questions for discussion and reflection

Q1: What sources of revenue are available for financing our digital infrastructure projects? Are there additional potential sources that are not being exploited?

Q2: How are ongoing costs for the digital infrastructure being assessed and budgeted? Is the current process adequate, and does it account for the existing and potential future conversion of capital to current expenditure, as well as support and maintenance costs?

Q3: How extensive is our current knowledge and understanding of the education technology markets from which we are intending to procure technology? What is the balance of power and information between us, as the buyer, and the technology vendors with which we engage? To what extent are we aware of the technologies being used in other institutions in Croatia and elsewhere in Europe, and their impact?



Q4: To what extent do we engage in collective procurement? What are the benefits and challenges associated with current procurement processes? How can we improve or extend collective procurement processes?

Q5: What is our current balance between directly owned technology and leased/cloud-based technology? Where would we like this balance to be? What are the advantages and disadvantages for our organisation of outsourcing?

Q6: To what extent are we able to partner with others to improve the efficiency and effectiveness of digital equipment acquisition? Who are our collaborators and potential collaborators? How can we harness the innovative capacity of other sectors to acquire technologies that meet our needs and objectives?

### ***Element Five: Planning for integration, use and support***

One of the most persistent current challenges that higher education institutions in Croatia and elsewhere are facing is the availability of staff to support and maintain digital infrastructure. The difficulty of attracting and retaining skilled staff is an ongoing concern for all types of institutions and must therefore be a key element of planning for digital infrastructure investments.

While most higher education institutions in Croatia have in-house support staff to maintain networks, physical equipment and software, an increasing number of institutions also rely on contract staff or external companies. In some European jurisdictions, institutions often outsource key functions, up to and including the provision and support of on-campus local area networks (so-called Campus Network as a Service or CNaaS).

Such externally managed services provide a viable alternative especially for institutions struggling to attract and maintain network engineering and maintenance staff on-site, or that are overdependent on the presence of specific employees to ensure reliable network services (GEANT, 2022<sup>[8]</sup>). At the same time, many institutions may be reluctant to take measures that can move the operation of essential services beyond their immediate control, or to de-skill or sideline existing staff by taking core tasks out of their hands. Institutions should carefully assess the costs and benefits of outsourcing different elements of digital infrastructure support and maintenance and seek to learn from the experiences of other institutions in Croatia and elsewhere.

Any investment in digital infrastructure only has value if the infrastructure is being used. Bridging equipment gaps is insufficient if students and staff are not empowered to effectively engage with the technologies provided. Many higher education staff members started their careers at times when the penetration of digital technologies in their workplace was limited or non-existent and have faced difficulties adapting to using emerging technologies that are now vital to their role. Moreover, in a context where research performance is often more prominently rewarded than teaching improvement, motivation to make changes may be limited. Incentives to promote engagement with new technologies, advisory supports and training are increasingly fundamental, as institutions become more digitalised. Institutions' plans for procuring new technologies need to consider the extent to which users can and will be willing and able to use the technology.

Institutions also increasingly have the option of engaging NRENS and other public bodies to help improve the digital capabilities of their staff. For example, SRCE provides a substantial training offer to staff across the Croatian higher education system, covering different aspects of e-learning material development and delivery (SRCE, n.d.<sup>[9]</sup>) and CARNET will offer comprehensive education and training of digital competence of decision makers, teaching staff and IT personnel on a national level as part of the e-Universities project.

A final important consideration is the extent to which the new infrastructure can integrate with the status quo. Ideally, this point should be widely assessed and planned for before investing. The growth of "shadow IT" (where staff ignore the technology provided by their central services in favour of an informal solution to meet their specific need) is testament to how misunderstandings can arise about the usage and

effectiveness of digital technologies. Regular monitoring of user perspectives and usage patterns is vital to ensure the technology is enhancing activities and not impeding them.

### Key questions for discussion and reflection

Q1: Are staff available to maintain and support new digital technologies? To what extent will the new technology affect (positively or negatively) their workload?

Q2: Is external provision of support services a viable or suitable option for our institution for certain types of technology?

Q3: Is training required for the new infrastructure? If so, how, when, how often and by whom will users be trained?

Q4: How will usage patterns and user perspectives of the utility of the infrastructure be assessed? How will the status quo be adapted if the infrastructure is not being used or supported as intended?

## Guidelines for specific infrastructure types

The elements listed above are applicable to all types of infrastructure investment. However, some more detailed guidelines can be specified according to the type of infrastructure investment under consideration. The following sections outline some specific guidance related to four types of infrastructure: networking, on-campus technical equipment, end-user hardware, and software. These specific guidelines reflect the analysis and conclusions drawn in the technical report on digital infrastructure prepared for this project (see Chapter 5).

### *Investing in network connectivity*

Backbone Internet networks are the core network for the higher education system, enabling higher education institutions to connect to the Internet. NRENs are in most cases the sole providers of fixed and wireless high-capacity Internet connectivity for higher education and research institutions in Croatia (through CARNET) and throughout Europe (Géant, 2020<sup>[10]</sup>). The backbone network connectivity is distributed through higher education campuses by means of on-campus networking, including private wired and wireless, and public networks.

Internal wired campus networks in higher education institutions are often not designed to carry the higher speeds provided by the entry point from the NREN to institutional premises. Upgrades to the backbone Internet connection can only be of value to higher education institutions if internal campus networks are adequately equipped to take advantage of the higher speeds provided by the upgrade. Therefore, one of the main tasks of institutions' ICT function is the maintenance and upgrade of on-campus networks.

The e-Universities project currently being rolled out by Croatian public authorities is expected to lead to campus network upgrades for most institutions. The project encompasses the upgrading of the access network, campus network and backbone, as well as the design and implementation of passive and active networks at the campuses of higher education institutions (CARNET, 2022<sup>[2]</sup>). However, it is likely that supplementary upgrades will continue to be implemented by higher education institutions, as existing equipment ages and connectivity needs evolve.

Monitoring existing network traffic levels can provide the clearest indication of where current saturation points lie and offer a basis for estimating future bandwidth needs and pinpointing where future upgrades are most urgently needed. Students are often most aware of important locations on campus where network connectivity is suboptimal, and efforts should be made to systematically gather their knowledge of the campus network. Estimates of future needs should also account for certain new realities, particularly since the onset of the COVID-19 pandemic in 2020. These realities include:

- an emerging consensus that distinctions can no longer be drawn between disciplines in terms of their network connectivity requirements. Previous differences between disciplines in terms of use of digital tools are quickly breaking down as blended or online learning becomes commonplace in almost all subjects.
- the emergence of synchronous videoconferencing (Zoom, Teams etc.) during the era of emergency online learning that has become embedded as the “new normal”, with an expectation of continuous availability of ad-hoc connectivity for online and hybrid meetings, lectures and events.
- the potential need for greater bandwidth requirements in classrooms, where teaching and learning may make greater use of live streaming or audience response systems.
- an increasing need across all disciplines for specialist software and higher computing power, in both teaching and research activities. The increasing use of technologies such as augmented reality and virtual reality in a wide range of disciplines (creative arts, archaeology, medicine etc.) is contributing to the need for more bandwidth and computational capacity.

Institutions dealing with these challenges will need to strike a balance between managing expectations of students and staff, using existing resources as efficiently as possible, and devoting resources to connectivity upgrades. Institutions’ investment plans for their connectivity infrastructure need to react to such issues as moving campus locations, or reducing enrolments, a phenomenon observed in many institutions in recent years. Network user behaviour on campus has proven challenging to predict (Evans, 2020<sup>[11]</sup>), requiring institutions to pay more attention to methods for anticipating future connectivity investments.

As mentioned in element five above, there is a growing trend in some European countries towards CNaaS, the direct provision and support of on-campus networking by an external body to the institution (including NRENs). CNaaS can be a solution for institutions with limited on-site IT support capacity and does not necessarily entail deskilling or employment loss for current on-site staff. CNaaS may be used as a complement to on-site management, or to reduce pressure and workload for on-site staff (GEANT, 2022<sup>[8]</sup>).

### Key questions for discussion and reflection

Q1: To what extent is current network connectivity able to meet the needs of users in different areas of the institution? Where and what are the challenges and bottlenecks? Could these be resolved by means other than upgrading connectivity (e.g. reorganising activities or implementing acceptable use policies)?

Q2: Which methodology is in use to predict future needs for connectivity? Does the approach account for important factors such as the growth of bandwidth intensive technologies and activities across disciplines, the requirements for online teaching, and expected surges and periods of network congestion at certain periods or times of the year?

Q3: To what extent is the current campus network infrastructure (both physical and logical) fully understood and documented? How can the documentation of the existing network be improved? How are ad-hoc technical changes managed and documented?

Q4: To what extent are existing staff trained in emerging network equipment and technologies that can support a more efficient and effective infrastructure? Are CNaaS services a viable option to alleviate pressure and ensure persistent support is available for the campus network?

Q5: In cases of outsourcing, how is the critical intellectual property of the institution identified and protected?

Q6: How resilient and secure is the current network infrastructure? What measures are in place to deal with failures or attempts to breach cybersecurity? Are emerging best practices for network management in place or under consideration (e.g., backup connections, redundancies in the network topology, computer aided orchestration and/or automation)?

### *Investing in on-campus technical equipment*

The two most common types of on-campus technical equipment are server hardware and audio-visual equipment. This section outlines some of the key considerations for institutions when planning investments in these equipment categories.

There is a common perception that, as time goes on, on-campus server hardware is being phased out in favour of cloud services, although the process is slow and uneven across countries. As server applications transition to the cloud and NRENs enhance network resilience and speed, institutions can better support staff in adapting to cloud-based services. Cloud services are more equipped to handle rapid, unforeseen surges in connectivity demand, like during the COVID-19 pandemic, which is not economically feasible with on-premises server capacity. Despite the growth in cloud services, many higher education institutions continue to host student-facing systems on-premises, necessitating upgrades to on-campus hardware due to increased online service demand.

When upgrading server hardware, resilience and security are crucial considerations, as well as cost. Cybersecurity is a significant global challenge for higher education systems, posing a prominent risk to server security. Physical security of servers is also essential, requiring on-campus measures if cloud technology isn't adopted.

Another vital category of on-campus equipment is audio-visual equipment, such as projectors, electronic whiteboards, monitors, videoconferencing and lecture capture devices, voting and feedback tools, and virtual and augmented reality technologies. A top priority for Croatian higher education institutions is ensuring access to dedicated equipment for high-quality digitalised teaching material production and hybrid or online lecture delivery.

#### Key questions for discussion and reflection

Q1: Which combination of on-campus and cloud-based server equipment is likely to best serve the institutions' current and future needs?

Q2: To what extent is existing server capacity adequate for the institutions' needs? What is the most resilient and secure means of upgrading capacity?

Q3: For on-site upgrades to server infrastructure, is there adequate provision for the security of the equipment against cyberattacks (e.g. multi-factor authentication, VPN, end-user device management protocols), and against physical risks (e.g. secure storage, access control, alarms, flood and fire protection)?

Q4: Is there adequate on-campus access to professionally equipped spaces for developing digitalised teaching material? How are views and perspectives on this question being collated? To what extent are current facilities being used, where they exist, and what are their deficiencies?

Q5: Does the planned investment in audio-visual equipment account for the estimated useful life of the technology, or the risk that the technology will quickly become obsolete? Do planned investments consider the speed at which audio-visual technology develops, and emerging technologies on the near-term horizon that may be more efficient or have a longer useful lifetime? Is there an exit strategy in place to allow for low-cost future pivots from or replacement of the planned technology?

Q6: How many current and future staff and students are likely to benefit from the audio-visual technology currently under consideration for investment, over its lifetime? Does the foreseen level of use justify the cost of the technology? Are other alternatives available, or can the cost and use of the equipment be more widely shared across other areas of the institution, or used to generate additional revenue (e.g., by hosting external events)?

### *Investing in end-user hardware (staff and students)*

Equitable and stable access to digital devices for teaching and learning purposes varies among higher education staff and students. Depending on available resources, institutions can choose between implementing widespread Bring Your Own Device (BYOD) policies or providing institution-purchased equipment to as many users as possible. BYOD as a substitute for institution-provided equipment only works if personal devices can interoperate with the main institutional systems. Furthermore, personal devices may lack required safeguards, leading to privacy and security issues (van der Vlies, 2020<sup>[12]</sup>).

Institutions can also invest across a wide spectrum of end-user devices, such as laptops, desktop computers or tablets. Modern laptops are more portable, with in-built peripherals, longer battery life, and have become powerful enough to run more demanding applications. At the same time, desktops on campus are likely to remain ubiquitous, particularly in student computer labs, for several reasons: they are more ergonomic, and offer higher specifications, higher connection speeds, managed access to specialist hardware, software and content, larger screens, and better security compared with personal devices. Centrally managed student computer clusters also allow institutions to benefit from bulk purchases, and benefit a larger number of students, compared to directly providing devices to individual students.

As with other forms of equipment, consideration needs to be given to the lifespan of equipment, after-sales support and warranty of devices, and on-campus staff support to maintain the devices and support users.

#### **Key questions for discussion and reflection**

Q1: Is current provision of end-user devices by the institution adequate to support teaching, learning, research and operational needs? How are gaps identified? Are current methods for assessing and prioritising needs adequate?

Q2: How are the identified needs translated into equipment specification requirements, and balanced against equipment costs? Can these methods be streamlined or improved?

Q3: How is the institution working to reduce the cost of purchasing end-user devices? Is the institution benefiting from or pursuing collective bulk procurement of devices with other institutions, where feasible?

Q4: What helpdesk supports are in place for students and staff using BYOD or institution-provided end-user devices? Will additional support be required in the event of further equipment purchase? If so, how will these support needs be met?

### *Investing in software*

The main categories of software in higher education institutions, as in most large organisations, are central applications intended for widespread use, and specialist applications needed by some categories of staff. The latter category can be an important priority for resources in higher education institutions, given the extent of specialised research and discipline-specific teaching that naturally forms part of their activities.

Central applications, like learning management environments, are important investment targets due to their widespread use and cost-effectiveness. In Croatia, the Moodle VLE is extensively used, with some institutions further adapting it or opting for alternative systems.

End-user software is also an important target for investment, in particular productivity software such as office suites and creative suites used for presentation and visualisation of material. Alongside widely used productivity and creative suites, numerous specialist end-user software applications support teaching, learning, research, and administrative activities for students and staff in higher education institutions. Examples include coding software, e-learning content creation tools, and specialist engineering applications.

A crucial consideration for institutions investing in software is the extent to which they can or should use free software and open-source applications. Open-source software offers low or no cost and potential customisation, but also presents challenges like interoperability issues, limited customer support, and concerns about its lack of use in the businesses and industries students will enter after graduation.

Decisions about the provision of widespread productivity software are generally more straightforward. There is a strong case for investing in such software as it is used almost ubiquitously and forms the basis for many learning experiences, work activities and communications throughout the institution. In Croatia, Microsoft Office 365 is widely used, and the Ministry of Science and Education has financed the provision of the software throughout the higher education system. Decisions become more complex for specialist software, which can be significantly more expensive and less widely used. With reliable internet connectivity, cloud services allow for continuous subscription payments instead of one-off investments, but institutions may still face unplanned cost increases.

It is therefore important for institutions to carefully examine propositions for investment in specialist software, working with users to explore planned usage of the software, looking for means to minimise costs where possible, and avoiding vendor lock-in. Investment of finite funds in software is best made based on demonstrable proof of widespread need and demand for all elements of the proposed software solution.

A final concern for institutions investing in software is the extent to which the software will integrate with existing central software and other specialist software. A lack of interoperability increases costs associated with supporting the software and limits its capacity to support insights and improvements to teaching, learning and administrative processes (e.g., for learning analytics). Institutions have a role to play in surmounting interoperability challenges, by supporting the development and adoption of open-source software where possible and promoting the adoption of open standards for interoperability. This may cover learning platforms, learning analytics, integrated assessment tools and standards (1EdTech, 2022<sup>[13]</sup>).

### Key questions for discussion and reflection

Q1: How many individuals will benefit from the software investment, and what will be the benefits, compared to the status quo? What is the cost per user, and the assessment of positive impact for the cost outlay?

Q2: Are robust open-source alternatives available for specific software packages? Alternatively, are there ways to reduce the cost of software through collaborative purchases, cloud-based subscriptions for limited times, or purchasing fewer user licences?

Q3: Are users using a wide range of the software's functionality? Can cost savings be made by purchasing a more basic version of the software?

Q4: What mechanisms exist (outside of vendor sales activities) to learn about relevant and emerging software that may be of benefit to the institution, or provide a more suitable alternative to certain existing software? How can these information flows be improved or expanded?

Q5: What forms of support are available to assist software users, from the vendor or within the institution?

Q6: What are the anticipated costs (financial or other) of exiting from the software or pivoting to different software following purchase? How can these costs be minimised?

Q7: How will the software interoperate with existing applications in the institution?

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## Annex C. Stakeholder events

### Summary of stakeholder events

Three main stakeholder events took place over the course of the project, in addition to the kick-off and closing events for the project.

The OECD team, in conjunction with the Croatian Ministry of Science and Education, organised an international expert seminar in May 2022 to discuss best practices on investment in digital infrastructure. It brought together a range of stakeholders to discuss potential principles and criteria for public investment in digital infrastructure. Three international experts on digital infrastructure in higher education (Mr. Kerr Gardiner, Dr Paul Bacsich and Dr Kevin O'Rourke) who provided intellectual support to the project presented preliminary findings of their research. Table C.1 shows the agenda for this event.

**Table C.1. Agenda for the international seminar on delivering effective investment in digital infrastructure**

Monday 23 May 2022 09:30 to 12:30 – Ministry of Science and Education (hybrid)

Timing	Topic and speakers
09:30 –10:00	<p>Opening of the seminar and remarks from project partners</p> <ul style="list-style-type: none"> <li>Welcome and opening remarks from CARNET</li> <li>Remarks from Ms Oana Dumitrescu, Directorate General for Structural Reform Support, European Commission</li> <li>Overview of the seminar by Dr Gillian Golden, Education and Skills Directorate, OECD</li> </ul>
10:00 –10:40	<p>Digital infrastructure in higher education – the state of the art</p> <p><u>Speaker: Mr Kerr Gardiner, Higher Education Consultant, KGCL.</u></p> <p><i>Mr Gardiner will present an international perspective on the state of the art of digital infrastructure in higher education, with a focus on European countries. The presentation will be followed by an opportunity for the audience to address questions to Mr Gardiner.</i></p>
10:40 –11:20	<p>National-level review of technical infrastructure in higher education – the Irish experience (virtual presentation)</p> <p><u>Speaker: Dr Kevin O'Rourke, Review Chair, Technological University of Dublin</u></p> <p><i>Dr O'Rourke will present an overview of the process and lessons learned from Ireland's National Review of Higher Education Technical Infrastructure. The presentation will be followed by an opportunity for the audience to address questions to Dr O'Rourke.</i></p>

Timing	Topic and speakers
11:20 –12:00	<p>Principles and best practices for prioritising investment in digital infrastructure in Croatia (virtual presentation)</p> <p><u>Speaker: Dr Paul Bacsich, Chief Executive Officer, Dualversity</u></p> <p><i>Dr Bacsich will propose some best-practice principles and advice for Croatia to follow with regard to investing public funds in digital infrastructure in its higher education system, with a particular focus on the prioritisation of funding for public investments on network and computing infrastructure. The presentation will be followed by an opportunity for the audience to address questions to Dr Bacsich.</i></p>
12:00 – 12:30	<p>Panel discussion – the way forward for Croatia</p> <p><u>Moderator: Dr Gillian Golden, OECD Higher Education Policy Team</u></p>

Two additional stakeholder events were held in January 2023. The first of these events was an international seminar on supporting high quality digital education. The seminar brought together experts from Croatia, Hungary, and Ireland to discuss the standards, supports and practices that can help to ensure the quality of digital higher education. Table C.2 shows the agenda for the event.

**Table C.2. Agenda for the international seminar on supporting high quality digital higher education**

Thursday 26 January 2023, 09:30 to 12:45 – Ministry of Science and Education (hybrid)

Timing	Topic and speakers
09:30 –09:40	<p>Opening of the seminar</p> <p><i>Welcome and opening remarks from the Ministry of Science and Education</i></p> <p><i>Remarks from Directorate General for Structural Reform Support, European Commission</i></p>
09:40 –10:15	<p>Emerging standards, supports and practices for digital higher education – international view of the state of play</p> <p><u>Dr Gillian Golden, OECD</u></p> <p><i>Dr Golden will present key messages from the OECD's research on the emergence of standards, supports and practices that can support the development of high-quality teaching and learning across higher education systems. An open question and answer session with the speaker will follow.</i></p>
10:15 –10:55	<p>Developing comprehensive quality assurance policies and practices for digital higher education– the Hungarian experience</p> <p><u>Prof. Valéria Csépe, Hungarian Accreditation Committee (MAB)</u></p> <p><i>Professor Csépe will present the recent experience in Hungary with development of new policies and practices to assure the quality of digital higher education. An open question and answer session with the speaker will follow.</i></p>
Coffee break 10:55 – 11:15	

Timing	Topic and speakers
11:15 – 12:00	<p>Supporting higher education institutions to build capacity for improvement of digital teaching and learning</p> <p><u>Dr Terry Maguire, former Director of the Irish National Forum for the Enhancement of Teaching and Learning in Higher Education</u></p> <p><i>Dr Maguire will share her perspective on essential elements that need to be in place to support successful improvement processes.</i></p>
12:00 – 12:45	<p>Panel discussion: recent developments and the way forward for Croatia</p> <p><u>Initial intervention:</u> Aleksandra Mudrinić Ribić, CARNET, e-University project</p> <p><i>Followed by open discussion with audience and panelists</i></p>

Refreshments will be served at the end of the seminar

A workshop for higher education institution leaders and key stakeholders also took place in January 2023. The purpose of the workshop was to pilot the draft guidelines for institutions developed as part of the project activities (see Annexes A and B). Participants from higher education institutions as well as the Ministry for Science and Education, CARNET and the Agency for Science and Higher Education attended the workshop. With the support of the workshop facilitators, they considered current challenges and potential strategies for improving institutional and system wide digital maturity – in terms of leadership, infrastructure, competence, and culture. Table C.3 contains the agenda for the workshop.

### Table C.3. Agenda for the pilot workshop with higher education institutions

Friday 27 January 2023 09:30 to 16:00, Hotel Dubrovnik, Zagreb

Timing	Topic and speakers
09:30 – 09:45	Welcome and introductions
09:45 – 10:45	<p>A model for evaluating digital maturity</p> <p><u>Session lead: Gillian Golden, OECD</u></p> <p><u>Facilitators: Dragana Kupres (CARNET), Prof. Predrag Pale (UNIZG)</u></p> <p><i>Presentation of the digital maturity model and results of its application</i></p> <p><i>Small group discussions– reflecting on the model and current position of digital maturity</i></p> <p><i>Reporting from groups and final reflections</i></p>

Coffee break 10:45 – 11:00

Timing	Topic and speakers
11:00 –12:30	<p><a href="#">Developing high quality online and hybrid education</a></p> <p><u>Session lead: Terry Maguire (external consultant)</u></p> <p><u>Facilitators: Dragana Kupres (CARNET), Prof. Predrag Pale (UNIZG)</u></p> <p><i>Presentation of the institution guidelines for the development of high quality online and hybrid education</i></p> <p><i>Small group discussions – reflecting on putting the guidelines into action</i></p> <p><i>Reporting from groups and final reflections</i></p>
<i>Lunch break 12:30 – 14:00</i>	
14:00 –14:45	<p><a href="#">Planning and executing digital infrastructure investments</a></p> <p><u>Session lead: Gillian Golden</u></p> <p><u>Facilitators: Dragana Kupres (CARNET), Prof. Predrag Pale (UNIZG)</u></p> <p><i>Presentation of the advice for institutions on investment in digital infrastructure</i></p> <p><i>Small group discussions – reflecting on putting the guidelines into action</i></p> <p><i>Reporting from groups and final reflections</i></p>
14:45 – 16:00	<p><a href="#">Bringing it all together – collaborating for change</a></p> <p><u>Session leads: Terry Maguire, Gillian Golden</u></p> <p><i>Summary of the key messages from the workshop sessions</i></p> <p><i>The importance of collaboration and working together</i></p> <p><i>Open discussion and reflection from participants</i></p>

## Higher Education

# Advancing Digital Maturity in Croatia's Higher Education System

The Croatian government views digitalisation as a way to improve access to higher education and increase its attractiveness. To this end, it is investing in modernising digital infrastructure and building capacity to effectively integrate digital technologies into the higher education sector. This report provides an account of the activities and findings of a project on assessing and improving digital maturity in Croatian higher education institutions, which was carried out by the OECD and funded by the European Union. The objective of the project was to provide support and advice to Croatian authorities as they develop their policy approach to higher education digitalisation.

This report details the activities and outcomes of the project. It reviews international best practices related to enhancing the quality of digital higher education. It also provides technical guidance to public authorities on prioritising investments in various forms of digital infrastructure. Finally, it offers guidance to Croatian higher education institutions to support their strategic development process and their investment strategies with regard to digitalisation.



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