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International Centre
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联合国教科文组织
高等教育创新中心

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Research Report on
Digital Transformation of Higher Education Teaching and Learning

International Center for Higher Education Innovation under the auspices of UNESCO
Institute of Education, Tsinghua University
April 2022

contents

Preface

As big data, artificial intelligence (AI), blockchain, 5G and other digital technologies emerge, human production and lifestyle have experienced profound changes. The rapid development of digital industrialization and industrial digitalization set new requirements for the knowledge, skills and capabilities that the labor force around the world should possess, to which higher education needs to respond. The advancement of the internet has given rise to digital thinking, distributed cognition, and knowledge dissemination and interpersonal communication via virtual space, and will eventually revolutionize the concepts, approaches and governance system of talent cultivation, making the digital transformation of higher education inevitable.

As noted in *Reimagining Our Futures Together: A New Social Contract for Education* published by UNESCO in 2021, computers and the internet are quickly changing the ways in which knowledge is created, accessed, disseminated, validated, and used. Much of this is making information more accessible and opening new and promising avenues for education. But the risks are many: learning can narrow as well as expand in digital spaces; technology provides new levers of power and control which can repress as well as emancipate; unbridled data sharing can infringe on learners' right to privacy; the digital divide between regions and communities widens due to different access to technologies. There is tremendous transformative potential in digital technologies, but we have not yet figured out how to deliver on these many promises. What does digital transformation mean for higher education and what characteristics may it have? How to promote digital transformation of higher education in different countries to better suit local conditions? What challenges may emerge? How to address the challenges? It is imperative to find answers to these questions and reach a consensus.

To respond to the challenges, the International Center for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI) and the Institute of Education (IOE) of Tsinghua University jointly conducted research, and prepared one research report—*Digital Transformation of Higher Education Teaching and Learning* and three related handbooks—*Handbook of Educational Reform through Blended Learning, Handbook of Teacher Professional Development in Higher Education,* and *Handbook of Teacher Professional Development in Technical and Vocational Education and Training.* The research report focuses on the digital transformation of teaching and learning, and tries to introduce relevant concepts, ideas, methods and challenges, and propose possible solutions for international organizations, governments, higher education institutions (HEIs), enterprises and other stakeholders to promote digital transformation of teaching and learning. The three handbooks provide theories, standards, methods, and strategies about blended teaching, teaching competency and professional development of teachers, aiming to solve "the last mile" of digital teaching and learning. With the platform of UNESCO, the report and handbooks are prepared to help countries, especially developing countries, to develop an inclusive, resilient, open, and high-quality teaching and learning system for higher education in the process of achieving the education goals of UNESCO Sustainable Development Goal 4 (SDG4) by means of digital technologies.

Consisting of nine chapters, this Report firstly introduces the background, status quo, and contents of the digital transformation of higher education teaching and learning; then elaborates on the contents, characteristics, strategies, and directions of the digital transformation of higher education teaching and learning in the following six aspects: institutional policies, strategies and support, academic program approaches, curriculum development and delivery, teachers' professional competencies, learners and their learning, and teaching quality assurance systems; then describes the challenges in promoting the digital transformation of higher education teaching and learning and proposes possible solutions; and lastly introduces how administrators and educators at certain HEIs from different countries explore the digital transformation of teaching and learning and shares their experiences.

LI Ming, CHENG Jiangang and HAN Xibin are chief editors of this Report, and HAN Wei, WANG Guobin, LIU Meifeng, SONG Jihua, SHEN Shusheng, ZHANG Tiedao, ZHAO Guoqing, ZHOU Qian, LI Meng, CHEN Xiangyu, DIAO Junfeng, CUI Yinran, LI Mei, BAI Xiaojing, etc. participated in the preparation of this Report. We would like to thank the National Commission of the People's Republic of China for UNESCO for its guidance on the preparation of this Report.

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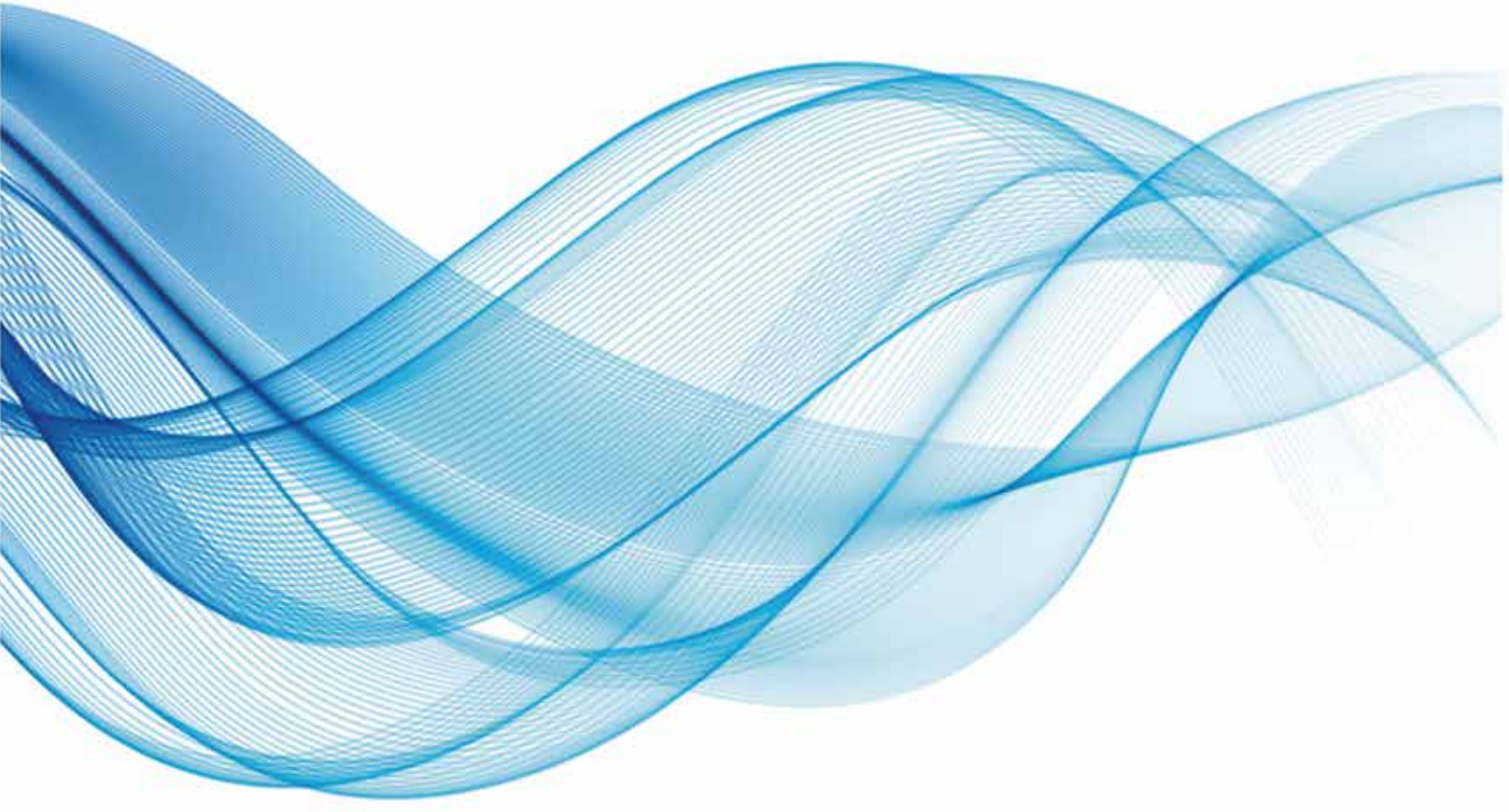
Executive Summary

of Research Report on Digital Transformation of Higher Education Teaching and Learning



The increasing innovations of digital technologies have been transforming production, lifestyle and learning in an unprecedented way. Digital transformation has spread across global higher education under the impact of diverse factors. Policy makers, education practitioners, learners, researchers and other stakeholders have been actively responding to the trend of digital transformation of higher education teaching and learning. There is tremendous transformative potential in digital technologies, but countries still face huge challenges in promoting the digital transformation of higher education teaching and learning. The International Center for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI) and the Institute of Education (IOE) of Tsinghua University jointly prepared the report *Digital Transformation of Higher Education Teaching and Learning,* trying to introduce relevant concepts, ideas, methods, challenges, and possible solutions for international organizations, governments, HEIs, enterprises and other stakeholders to promote digital transformation of education.

Digital transformation of higher education teaching and learning: contents and framework

The digital transformation of higher education teaching and learning not only requires the application of digital technologies to education, but also advocates the deep integration of digital technologies and education, and the aim is to improve the operations, strategic directions and values of HEIs and develop new education systems adaptive to the digital age. The digital transformation of higher education involves changes in institution's space, operations, strategic directions, and values, as the digital age takes on different characteristic in this regard from the industrial age. In the process, students will have greater autonomy in their learning, course selection, ability acquisition and academic certification, and HEIs will develop a stronger social resource call via the Internet, which will ultimately revolutionize the traditional teaching models of higher education and create new models.

The report proposes a two-dimensional framework to describe the system structure and progression in the digital transformation of higher education teaching and learning, and elaborates on the future developments. A HEI is a complicated system that is formed by many elements including institutional policies, strategies and support, academic program approaches, curriculum development and delivery, teachers' professional competencies, learners and their learning, and teaching quality assurance systems. While these elements interact with each other, they are also subject to external factors such as society, politics, economy and technologies. The digital transformation of education is a gradual process where digital teaching and learning in educational institutions evolves from applying digital technologies to education to full digital transformation. Based on readiness in applying digital technologies to education, the digital transformation of education comprises three stages: integration of digital technologies and teaching, early transformation, and advanced transformation. **In the stage of integration of digital technologies and teaching,** where curriculum development and delivery will not be limited by time or space, the core elements such as teaching objectives, contents, activities, assessments, and environment will be reshaped and reorganized by the integration of physical and virtual spaces. At this stage, students will enjoy more flexible learning by blending online and offline methods and HEIs will expand Internet-based teaching to promote educational reform towards blended teaching. **In the stage of early transformation,** HEIs will gain access to external resources for curriculum development, such as those from other HEIs, relevant enterprises and social organizations. At this stage, HEIs will develop individualized curriculum designs with a flexible combination of course modules from different schools and academic programs to meet diverse needs of students. **In the stage of advanced transformation,** digital technologies will completely break boundaries between HEIs, enabling connectivity between HEIs, between HEIs and society, between HEIs and enterprises, and between HEIs and other stakeholders. By that time, the sharing of academic programs, curriculum, teachers, facilities, and services will become possible, and educational resources of the whole society will be fully utilized. The traditional ivory tower of HEIs will become history, and everyone will have access to appropriate educational resources in line with their individual needs, making education equity and sustainable development possible.

Analysis of essential components for the digital transformation of higher education teaching and learning

Higher education institutions: HEIs are the initiators and guarantors of the digital transformation of teaching and learning. It is necessary for HEI leaders, administrators, teachers, technicians, off-campus supportive parties to play an active role in the digital transformation, and systematically promote the digital transformation of essential components such as objectives and plans, organizational structure, policies and norms, supportive services, technical environment, personnel's digital competencies, and cultural atmosphere.

Academic program approaches: The objectives of the digital transformation of academic programs are to provide suitable talents for society and support more personalized development of students. The digital transformation of academic programs in HEIs are characterized as follows: training objective turns from specialists to interdisciplinary talents; academic programs move from isolation to integration; HEIs pursue collaborative development rather than independent growth; and programmatic and specialized accreditation turns from rigidity to flexibility. The digital transformation of academic programs needs to be promoted in terms of professional talent training schemes, teaching resources, environment and platform for academic program development, and experimental and practical teaching bases.

Curriculum development and delivery: The core of the digital transformation of higher education teaching and learning lies in curriculum development and delivery. The integration of digital technologies into curriculum development and delivery will greatly expand the connotation of curriculum

objectives, students, curriculum contents, instruction activities, learning evaluation and feedback, teachers and instruction environment, and their relationships will also be expanded in all dimensions. The whole process of gearing curriculum development towards the social demand for talents will be restructured. The instruction system becomes more open, complex, and dynamic, instruction contents, that is, knowledge generation and dissemination, more dynamic and mass-oriented, instruction scenes, greatly expanded in time and space, and instruction forms, more diversified and blended.

Teachers: As teachers play an essential role in teaching activities, they are the key to the digital transformation of higher education teaching and learning. In the digital era, new demands on teachers' professional competencies are reflected in four aspects: the awareness, literacy, competency of integrating digital technologies into teaching, and related research. The development of teachers' digital competencies requires the guidance of government departments, collaboration among social organizations, faculty training and development in HEIs, and self-empowering learning of teachers.

Learners: The ultimate objective of the digital transformation of higher education teaching and learning is to realize better learning and development of students in the digital age. As the development of various emerging technologies reconstruct students' learning and cognition, the digital transformation of industry highlights the importance of digital literacy in students' development objectives. It is necessary to create digital and adaptive learning context, provide diversified, intelligent and open educational resources, build open and socialized learning communities, and provide personalized and precise learning supportive services to meet the learning needs of students in the digital age.

Teaching quality assurance: Teaching quality is vital to the survival and development of higher education. In the digital age, the HEI teaching quality assurance system shifts its objectives from singleness to diversity, its function from rating to early warning, its contents from decentralization to integration, its coverage of evaluation standards from phased and one-sided to whole-process and all-rounded, its method from regular sample-based to normal and full-scale, and its process from closed loop to open one.

This report contains 11 cases from nine countries, including Malaysia, Egypt, Indonesia, Kazakhstan, Morocco, Peru, the Philippines, Serbia, and China. The cases show the efforts and achievements these countries have made in actively promoting the digital transformation of HEI teaching in terms of institutional policies, academic programs, curriculum development and delivery, teachers' professional competencies, students and their learning, demonstrating the arduous and long-term nature of the transformation.

Challenges and strategies in the digital transformation of higher education teaching and learning

In the future, promoting the digital transformation of higher education teaching and learning will be a long-term and gradual process. It is bound to face many challenges, such as the digital divide brought about by technological changes, the constraints imposed by existing HEI instruction system, intuition-based thus flawed instruction management and decision-making, narrow professional fields and lack of flexible credit and degree accreditation system, differentiated teaching limited by traditional class mode and curriculum system , teachers' lack of the practical competency to deliver innovative instruction with digital methods, students deficient in self-management competency for digital learning, confusion and choice dilemma brought by fragmented learning, and the difficulty of using existing educational theories to guide complex teaching practice in the digital age.

In face with the above challenges, it is necessary for the stakeholders of higher education teaching and learning to make concerted efforts and advance the digital shift systematically.

Strategies to deal with the digital divide brought by technologies: International organizations, governments, HEIs and enterprises need to make joint efforts to continuously build the infrastructure needed to digitally transform teaching, so as to ensure that higher education can provide every learner with equal technical resources and access to information and educational opportunities. It is also important to accommodate the differences in the popularity and usage habits of educational technologies and culture differences among different regions. Digital literacy should be regarded as one of the core skills in the 21st century. Special attentions should be paid to cultivate students' rationality, empathy, creativity, and critical thinking, so as to help them resist the risks in the digital society. The digital transformation should strive to ensure that the digital technologies, tools and platforms applied in the field of education develop in the direction of supporting human rights, improving human capabilities and promoting human dignity and humanistic spirit, so as to maintain the peaceful, just, and sustainable development of the digital society.

Strategies to deal with the limitations of current HEI instruction system: Higher education policy makers, relevant administrators of educational institutions, researchers, and practitioners need to remove the limitations of thought that "technologies in an industrial society empower education and teaching" and that "the digital transformation of education is only applied to the field of education". They should deeply understand the nature of the digitally transformed higher education system, as well as the relationships between higher education and other systems such as society, economy, politics, and technology. They should also jointly formulate the vision and path of such transformation that reflects the concerns of all parties, integrate resources and services in other fields of society in cyberspace, and promote the systematic transformation of higher education.

Remedies for intuition-based instruction management and decision-making: When promoting the digital transformation of teaching and learning, higher education policy makers and HEIs should consider multiple evidence sources and polish their competencies of evidence collection and analysis. The application of big data to instruction can not only help obtain teaching information in time but also facilitate the monitoring and

dynamic adjustment of the instruction process. Digitalization of instruction management is not merely a technical upgrade of management tools and means. Its key feature lies in that digital technologies are integrated into instruction management system to establish a continuous action system including information collection, analysis and conclusion-making, consultation and argumentation, planning and decision-making, implementation monitoring, feedback and adjustment.

Strategies to address narrow professional fields and lack of flexible credit and degree accreditation system: Government departments and HEIs need to work together to formulate policies and standards to reform the credit and degree accreditation system, and adopt technologies like blockchain to promote the adoption of micro-credentialing and micro-certificate across HEIs and disciplines, so as to establish a flexible credit and degree accreditation system. Learners can go beyond the limitations of the traditional degree system, and choose and create "their own disciplines" instead of being confined to a certain HEI or discipline. International organizations should work with governments and vigorously advocate an international credit and degree accreditation system.

Strategies to address differentiated teaching limited by traditional class mode and curriculum system: Teachers and instructional designers need to improve their data literacy and cultivate their competency in applying technologies to intelligent instruction environment. They should fully integrate big data, AI teaching assistants, and other technologies into the curriculum development and delivery process, expand instruction time and space, and realize accurate whole-process analysis of learners, accurate prediction of instruction results, and accurate regulation of instruction process, with a view to meeting personalized learning needs.

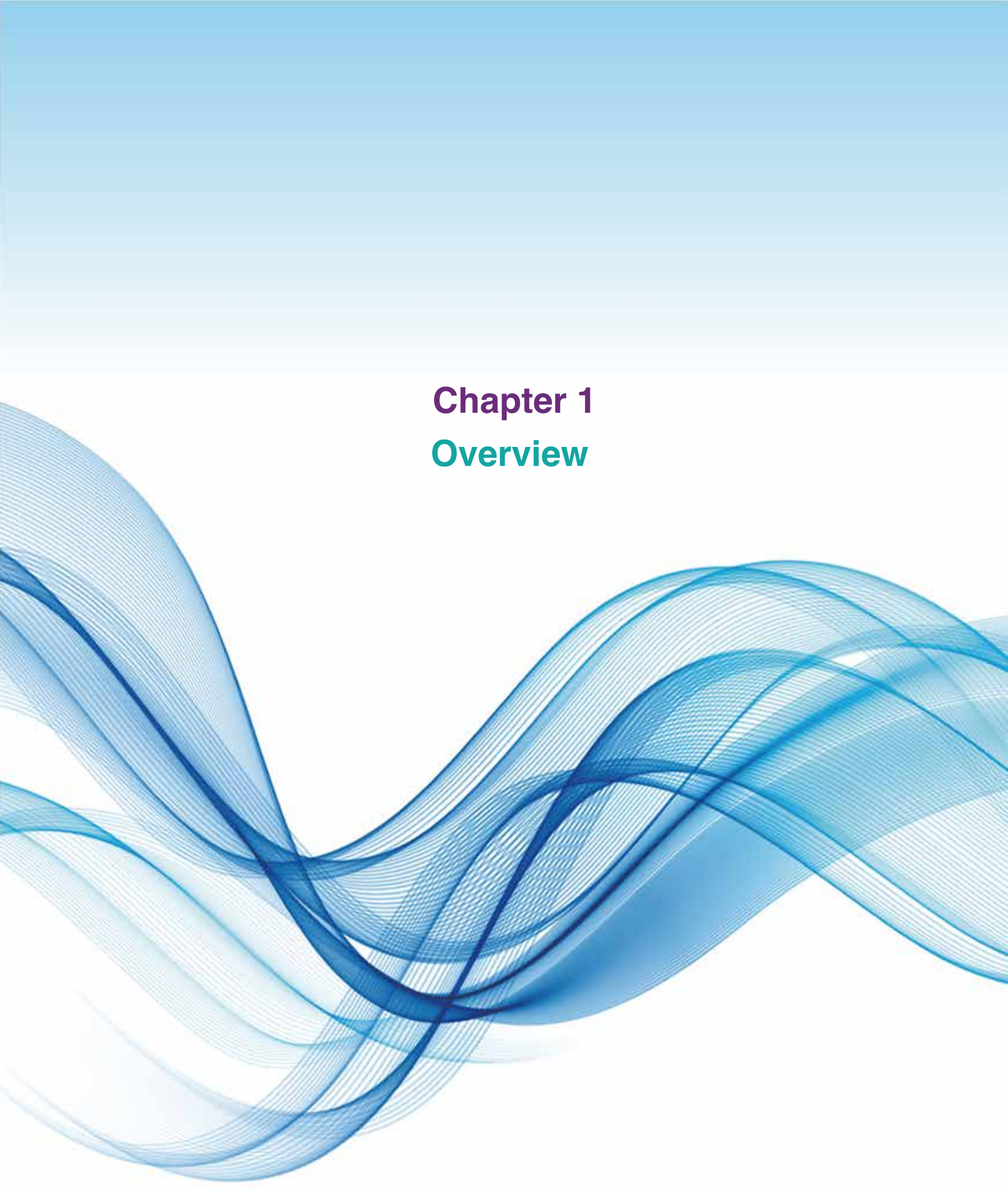
Strategies to address teachers' lack of competency to deliver innovative instruction with digital methods: The government should formulate standards over teachers' digital competencies and policies to promote such competencies. To that end, HEIs should build complete systems while social organizations can provide teachers with various resources. It is also beneficial to implement various digital competency development programs and carry out related certification. International organizations should advocate international and regional cooperation to develop online digital competency training programs (micro-credential, micro-degree, etc.), and work together to promote the continuous improvement of teachers' digital competency. Facing the impact of digital technologies, teachers should continue to innovate instruction ideas and improve digital competencies, and turn challenges into opportunities to reform traditional instruction and innovate future instruction.

Strategies to deal with students' deficiency in self-management competency for digital learning: HEI administrators should actively use digital technologies to provide support for students' independent development, such as using AI to establish prediction models that can identify employment and skills development trends, and thus helping them plan their future learning and development paths. The role of teachers should be transformed from imparting knowledge to offering academic guidance and career planning. Students should be fully self-motivated to avoid dependence on teachers and technologies.

Strategies to deal with confusion and choice dilemma brought by fragmented learning: HEI administrators, instructional designers and researchers should work together to sort out the disciplinary knowledge in higher education build an adaptive visual learning engine with function like disciplinary knowledge verification, integration and mapping navigation, solve the problem of knowledge fragmentation on the Internet, and thus support the transformation from fragmented learning to meaningful reconstruction of knowledge system.

Strategies to tackle the difficulty of using existing educational theories to guide complex teaching practice in the digital age: HEIs and researchers should change their "single-discipline and isolated" way of organizing scientific research. Instead, they should draw strength from multiple disciplines and regions and explore an effective online scientific research collaboration mechanism so as to jointly face and solve the new problems brought about by the digital transformation of teaching and learning. At the same time, attention should be paid to the data-driven evidence-based research paradigm, in order to produce new ideas, new theories and new methods that lead the digital instruction practice.

Chapter 1
Overview



1.1 Background of the Digital Transformation of Higher Education

The increasing innovations brought by digital technologies, such as mobile communications technology, AI, big data, cloud computing and Internet of Things (IoT) have been transforming production, lifestyle and learning in a profound, unprecedented and all-around way. As social changes drive reforms in education sectors, industrial transformation calls for new types of talents. There are emerging trends that digital transformation reshapes the higher education landscape.

Social changes drive reforms in education forms

Technologies develop as human civilization evolves. From stoneware to bronzeware and to ironware, the advancements in the means of production increased human productivity. As agriculture further grew, agricultural surplus became a reality. This fueled the development of industry and commerce as well as technological advancement. The industrial revolutions that ensued rebuilt production relations while boosting productivity. Then, the invention of computers and the internet ushered in information society. As human society evolves, the changes in the mode of production, communication technology and mode of communication request different types of talents, which triggered reforms in education forms (Table 1-1-1). The digital transformation of education is an inevitable outcome as human civilization moves from industrial society to information society.

Table 1-1-1 Reforms in education forms throughout modern human civilization

	Primitive society	Agricultural society	Industrial society	Early information society	Advanced information society
Mode of production	Natural resources	Small-scale production based on manual workshops	Large-scale and mass production based on urbanization	Production and knowledge innovation based on the internet	Data as an essential factor of production
Communication technology	Body language and verbal language	Papermaking and printing technique	Electronic media and technologies such as radio and television	Computer and internet	IoT, virtual reality (VR), AI, etc.
Mode of communicatio	Word of mouth	Contents separated from the speaker	"One-to-many" information communication	"Many-to-many" digital communication	Immersive communication combining virtual and real methods
Requirements for talents	Possess survival skills, familiar with tribal customs	Familiar with labor rules, good at using production tools	Possess manufacturing skills, scientific knowledge, and humanistic literacy	Possess comprehensive competencies including information literacy	Possess future-oriented innovation capability
Education form	Learn from work, parents act as teachers	Fixed teaching sites such as private schools and public schools	A system consisting of schools, classes, and courses	Deep integration between information technology and education	Digital transformation of education

Industrial transformation asks for different types of talents

Since the global financial crisis in 2008, the world economy has been in recession, leading to a rising anti-globalization sentiment. The economic globalization led by the United States and Europe has been in a deep dilemma since then.[1] New economic forms flourish as digital technologies are deeply integrated with the world economy. Especially during the COVID-19 pandemic, the digital economy quickly put in place remote healthcare, online education, distance working, contact-free delivery, ensuring the operations of global industrial chains and supply chains.[2] In 2020, the value added of the global digital economy expanded to 32.6 trillion US dollars from 30.2 trillion US dollars in 2018, up by 7.9%. The contribution of the digital economy to GDP keeps growing around the world. According to statistics of the China Academy of Information and Communications Technology (CAICT), the contribution of the digital economy to GDP in 47 countries climbed from 40.3% in 2018 to 43.7% in 2020, up by 3.4 percentage points.[3] This shows that the digital economy has become a major driver for global economic recovery and growth. As the digital economy roars, traditional industries are accelerating their pace in digital transformation, setting new requirements for talents. Higher education is under unprecedented pressure to cultivate talents that meet the increasing needs of the digital economy. The digital economy is in urgent need of interdisciplinary talents with digital competencies. In short, the industrial digitalization keeps upgrading requirements for talents, which in turn drives the digital transformation of higher education.

Technological innovations facilitate educational reforms

The emergence of computers and the internet has greatly expanded the capacity and speed of information processing by human brain. Human cognition goes beyond individual thinking as human-computer interactions become possible. It is believed that human-computer interactions will become the basic way for humans to learn about the world.[4] Higher education should enable students to adapt to this way of cognition by helping them develop digital technology-based learning habits, learning styles, learning methods, and working methods. In other words, as human relations have expanded from physical space to digital space, future education need to equip students with digital social skills and self-cognition skills based on digital space. The increasing innovations brought by digital technologies make it possible to realize such educational goals. Searching engines allow students to easily obtain massive resources and knowledge, liberating them from rote learning, cramming and other simple cognitive activities; the internet-based virtual spaces allow learners and educators in different times and places to realize synchronous and asynchronous interactions; various social media applications make the communications between students, teachers, schools, enterprises, and other stakeholders more convenient; the development of big data and blockchain can make education management and assessment more accurate and trustworthy; AI-powered smart learning partners and supervisors can provide effective support for differentiated teaching and individualized learning. In short, the increasing innovations powered by digital technologies not only impact human cognition and interpersonal relations but also build a technological base for updating learning and teaching methods, which will ultimately bring about the systematic reform of educational approaches across HEIs.

1.2 Current Research and Practices in the Digital Transformation of Higher Education Teaching and Learning

We can get a picture of the current research and practices in the digital transformation of higher education teaching and learning tackling the three perspectives of technologies, society and HEIs.[5] In terms of technologies, we focus on how digital technologies can reshape the teaching and learning process of higher education and restructure the teaching and learning models, by which technologies play a core role in higher education reforms. According to the 2021 EDUCAUSE Horizon Report® | Teaching and Learning Edition published by EDUCAUSE, the key technologies and practices that will have a significant impact on the future of teaching and learning in higher education include AI, Blended and Hybrid Course Models, Learning Analytics, Micro-credentialing, Open Educational Resources (OER), and Quality Online Learning.[6] In addition, it is believed that mobile learning, analytical technique, mixed reality (MR), AI, blockchain, virtual assistant and other technologies will also prompt teaching and learning innovations in HEIs. In their jointly released The Digital Transformation of Education: Connecting Schools, Empowering Learners in 2020, the International Telecommunication Union (ITU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the United Nations Children's Fund (UNICEF) called for strengthening national infrastructure to ensure that internet connectivity is more reliably and widely available.[7] In 2021, UNESCO published the Strategy on Technological Innovation in Education (2022–2025) to further study emerging and future technological changes and their impacts on education and support member countries to develop remote learning platforms, learning tools, open educational resources, and effective learning methods, in an effort to enable equitable and inclusive quality education and promote lifelong learning opportunities for all.[8]

As for the society perspective, our focus is on the relationship between society and higher education and global cooperation. In information society, industries and occupations are restructured, so higher education needs to equip students with digital competencies and lifelong learning abilities to better meet the needs of social development.[9] In addition, cooperation on higher education between HEIs and between countries should be enhanced. In 2020, UNESCO-ICHEI published Recommendations on Accelerating the Digital Transformation of Global Higher Education during the COVID-19 Pandemic to advocate the establishment of a multilateral cooperation mechanism for higher education and promote the sharing of public welfare resources.[10] In the same year, the International Association of Universities (IAU) released the Transforming Higher Education in a Digital World for the Global Common Good, in which the IAU calls for a human-centered, ethical, inclusive, and purpose-based digital transformation of higher education and society for the global common good; emphasizes that higher education must consider local needs and global developments and prepare students for lifelong learning; and underlines that knowledge exchanges between HEIs across the world should be enhanced and more support should be provided to the disadvantaged.[11] In 2021, the European Commission proposed to develop a high-performing digital education ecosystem and formulate effective policies to promote links with and attract talents from all over the globe.[12]

The HEI perspective reveals the questions and challenges about the core elements of education, namely institutional policies, strategies and support, academic program approaches, curriculum development and delivery, teachers' professional competencies, learners and their learning, and teaching quality assurance systems, in promoting the digital transformation of higher education. In terms of learners and their learning, the focus is on how learners can learn at any time and from anywhere[13,14] and how to build a self-directed learning environment.[15-18] Second, what abilities does learners need to possess in the digital age,[19-21] and how to certify these abilities in a more convenient and flexible way.[22,23] Lastly, how learners can employ digital tools to acquire new skills, new attitudes and new ways of thinking.[24]

As for curriculum development and delivery, the question is how to deliver courses with digital resources and expand the application of digital technologies;[25] how to develop curriculum in line with changes of the labor market;[26] how to improve students' learning experience with digital courses.[27] For instance, Stanford University launched "Stanford 2025", the Massachusetts Institute of Technology rolled out Digital Plus Programs, and California Community Colleges (CCCs) jointly launched the California Virtual Campus – Online Education Initiative (CVC-OEI), all of which aim to redesign curriculum models by integrating emerging technologies with curriculum contents and to achieve better learning outcomes and increase participation and collaboration. As for teachers' professional competencies, the focus is on what new requirements the digital transforma

tion set for teachers,[28,29] and how to help teachers improve their digital teaching capabilities.[30] In terms of academic program approaches, the focus is how to develop digital contents to meet new labor requirements. For example, New York University highlights the digital transformation of its publishing programs by changing program name and curriculum, turning its training objective to equip students with digital publishing skills. As for institutional policies, strategies and support, the focus is on how HEIs can improve their current operation modes to better support the digital transformation of teaching and learning.[31,32]

However, international organizations related to higher education, governments, HEIs, and enterprises have not reached a consensus on matters about the digital transformation of teaching and learning as they have not developed a clear understanding of this subject and some of their opinions even contract with each other, which sets back the effective digital transformation of higher education teaching and learning. This Report will elaborate on the contents and framework of the digital transformation of higher education teaching and learning, analyze characteristics and trends of the digital transformation in terms of the six core elements of education, and describe challenges in the process and propose possible solutions.

1.3 Proposing a Framework for the Digital Transformation of Higher Education Teaching and Learning

Though a consensus has not been reached on the definition of the digital transformation of higher education, agreement on many important matters has been reached.[33-36] The agreement emphasizes that the digital transformation of higher education teaching and learning is not merely the application of digital technologies to education, but the deep integration of digital technologies and education, and that the aim is to improve the operations, strategic directions and values of HEIs and develop new education systems adaptive to the digital age.[37] The digital transformation of higher education involves changes in institution's space, operations, strategic directions, and values, as the digital age takes on different characteristics in this regard from the industrial age (Table 1-3-1). In the process, students will have stronger ownership of their learning, curriculum, programs and academic certification, and HEIs will develop a stronger social resource call via the internet, which will ultimately revolutionize the traditional teaching models of higher education and create new values.

Table 1-3-1 Characteristics of the digital transformation of higher education

	Industrial Age	Digital Age
Institution's Space	Physical Places such as Classrooms and Campuses	Integration of Physical Environment and Digital Space
Institution's Operations	Modularized and Process Oriented	Integrated and Intelligence
Strategic Directions	Specialization and Popularization	Openness and Sustainability
Value propositions	Massiveness and Standardization	Individualism and Diversity

As a gradual process, the digital transformation of education starts from digitization, which refers to the transformation of physical space-based educational materials into information space-based ones. This means that the materials are no longer stored in a physical way (such as textbooks and audio tapes) but in digital formats (such as e-books and multimedia learning resources). It then evolves into digitalization, which refers to the application of digital technologies to education, such as using learning management systems to support teaching activities. At this point, technologies play a supportive and synergistic role. UNESCO defines four progression stages in applying digital technologies to education: building readiness, applying, infusing and transforming.38 In the stage of building readiness, efforts should focus on building infrastructure and developing teachers' digital competencies; in the stage of applying, it is necessary to develop high-quality digital education resources and improve learning management systems; in the infusing stage, it is important to employ digital technologies to further improve teachers' teaching competencies and innovate teaching methods based on the digital environment; in the stage of transforming, the focus should be set on fully integrating emerging technologies to reshape education ecosystems.

Focusing on teaching, one of the two core functions of higher education with the other one being research, this Report proposes a framework for the digital transformation of higher education teaching and learning (Figure 1-3-2). A HEI is a complicated system formed by many elements including institutional policies, strategies and support, academic program approaches, curriculum development and delivery, teachers' professional competencies, learners and their learning, and teaching quality assurance systems. While subject to social, political, economic and technological impacts, these elements also interact with each other.

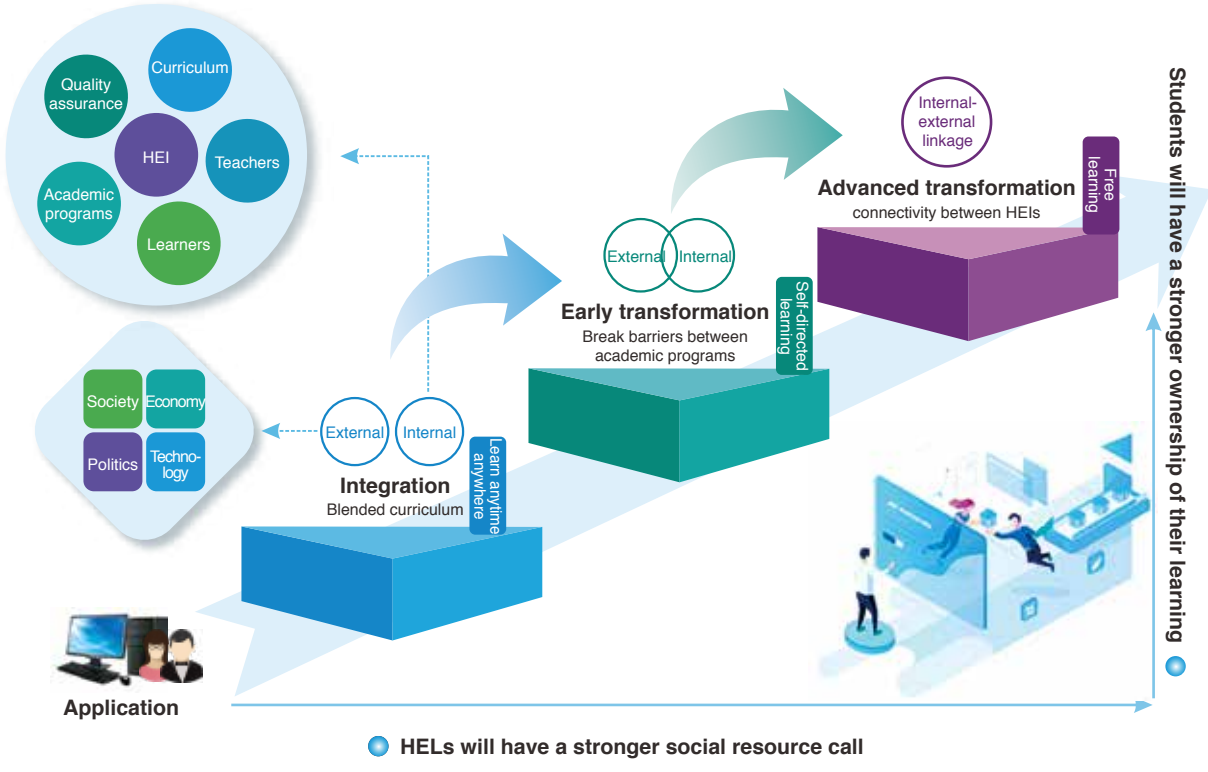


Figure 1-3-2 Framework for the digital transformation of higher education teaching and learning

Social, political, economic and technological changes can directly impact students' academic career plans, learning and cognition, prompting them to transform their learning in a digital way. To support students' digital transformation, curriculum development and delivery need to be changed and teachers need to update their professional competencies. As social and economic changes set new requirements for talents, academic programs need to be redesigned to meet the requirements. HEIs, as the operator of teaching activities, need to improve their technical system, personnel competency, organizational culture, management system, and supportive services to facilitate the digital transformation of teaching and learning. The framework proposed by this Report is defined by three progression stages, namely integration, early transformation, and advanced transformation. As the transformation progresses, students will have a stronger ownership of their learning and HEIs will develop a stronger social resource call.

In **the stage of integration,** curriculum development and delivery will not be limited by time or space, as the core elements such as teaching objectives, contents, activities, assessments, and environment will be reshaped and reorganized by the integration of physical and virtual spaces. At this stage, students will enjoy more flexible learning by blending online and offline methods and HEIs will expand internet-based teaching.

In **the stage of early transformation,** HEIs will gain access to external resources for curriculum development, such as those from other HEIs, relevant enterprises and social organizations. At this stage, HEIs will develop individualized curriculum designs with a flexible combination of course modules from different schools and academic programs to meet the diverse needs of students. Through the modularized curriculum combinations, customized and individualized contents will be provided to students in a targeted, process-oriented, and model-based way. The enterprise-HEI linkage featuring "platform resources + services" will provide enterprises with interdisciplinary talents needed for industrial digitalization.

In **the stage of advanced transformation,** digital technologies will completely break boundaries between HEIs, enabling connectivity between HEIs, between HEIs and society, and between HEIs and other stakeholders. By that time, sharing academic programs, curriculum, teachers, facilities, and services will become possible, and social resources will be fully utilized. As learners will have ownership over digital spaces, they can choose online courses and digital resources of other HEIs to meet their individualized needs. The role of teachers will not be limited to imparting knowledge, and they will also be responsible for providing students with advice on academic career planning and professional training. At this stage, students will not be limited by fixed admission or graduation time, their academic certification will be granted based on the credits they earned from modularized courses, their learning time and other relevant data. The traditional ivory tower of HEIs will become history, and everyone will gain equal access to quality educational resources, making sustainable development possible.

Chapters 2–7 of this Report will elaborate on the digital transformation of higher education teaching and learning from the following six aspects: institutional policies, strategies and support, academic program approaches, curriculum development and delivery, teachers' professional competencies, learners and their learning, and teaching quality assurance systems.

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Chapter 2

Digital Transformation:

Institutional Policies, Strategies and Support

HEIs are both the initiator and guarantor of the digital transformation of teaching and learning. Firstly, this chapter specifies the essential components of the digital transformation of teaching and learning, transformation participants and their roles in the process. It then explains the development stages and focus of the transformation, expounds the characteristics and strategies of the digital transformation of each essential component. At the end, this chapter defines the direction of future exploration.

2.1 Essential Components and Participants

Through the in-depth and coordinated transformation in technology, human resources and culture, HEIs can transform and optimize their operations, strategic directions and values, so as to realize the transformation from traditional teaching to digital teaching.1-3 In this process, HEIs should formulate clear objectives and plans and promote the digital transformation of essential components such as organizational structure, policies and norms, supportive services, technical environment, personnel competency, and cultural atmosphere.

Objectives and plans: HEIs need to make plans in line with the strategic directions of the digital transformation of teaching and learning, including transformation objectives, key tasks and supporting measures.

Organizational structure: To coordinate and promote the transformation in technology, human resources and culture, HEIs need to establish an organizational structure that can better meet the transformation needs, so as to adapt to the digitalization-powered innovations in the teaching mode and the reshaping of the teaching process, and ensure the smooth implementation of the digital transformation of teaching and learning.

Policies and norms: To deepen the digital transformation of teaching and learning and coordinate relevant efforts, HEIs need to formulate and adjust policies and norms concerning the whole teaching process including design, development, application, management, and evaluation.

Supportive services: To align personnel's digital competencies with the technical system in the digital transformation of teaching and learning, HEIs need to provide specialized supportive services,4 including teaching services for teachers and learning services for students.

Technical environment: To realize the technology transformation of HEIs, HEIs need to convert physical teaching sites and resources such as classrooms and laboratories into spaces, tools and resources based on online and offline integration.

Personnel's digital competencies: HEIs need to improve the digital teaching and teaching management competencies of relevant personnel, including digital leadership of the management, digital competencies of faculty members, digital management competencies of non-faculty staff, and digital service competencies of technicians.

Cultural atmosphere: HEIs need to gradually reach a consensus on values and create a cultural atmosphere favorable for innovation and cooperation required by the digital transformation of teaching and learning, in an effort to promote the sustainable development of the digital transformation of teaching and learning.

When Universiti Putra Malaysia promoted the reform of HEIs teaching through digital technologies, it carried out top-level design and made an overall and coordinated plan from the aspects of teaching, supportive services, infrastructure, and sustainable development of HEIs' digital transformation. Details on this regard can be seen in **Case 1** in the appendix (*Malaysia: The Use of Guiding Metrix to Align Institutional Digitalization and Management Strategies for Enhanced ICT Capacity of HEIs*).

The digital transformation of teaching and learning is not only a technological transformation but also an opportunity for institutional competency building, which requires teachers, leaders, administrators and technicians as well as off-campus supportive parties to play an active role in the digital transformation: as the implementer of curriculum, **teachers** are the main executor of the digital transformation of teaching and learning, and they should turn to digital teaching improve students' learning. **HEI leaders** play the role of "helmsman" in promoting the digital transformation of teaching and learning, determines the direction and focus of the transformation, and making decisions about the goals, participants, paths, and transformation methods. **Administrators and technicians** play a central role in connecting leaders, teachers and external supportive parties in the process of the digital transformation of teaching and learning, and are responsible for promoting and supporting teachers' daily digital teaching activities. Whether the policies of HEI leaders can be implemented and whether teachers can get effective help depend on the competencies of administrators and technicians.

Off-campus supportive parties include external enterprises and research institutions that with HEI partnership. The digital transformation of teaching and learning in HEIs needs in-depth changes in technology, human resources and culture. HEIs can be too slow to drive the transformation and may even make mistakes should they act fully on their own. Therefore, it is necessary to establish collaborative cooperative teaching digital transformation communities with off-campus stakeholders to gain support in programs, technologies and services. UNESCO-ICHEI has been active as an external stakeholder in the digital transformation of teaching and learning in HEIs around the world. It helped a HEI in Kazakhstan to improve the digital capacity of its faculty members, as shown in **Case 2** in the appendix *(Kazakhstan: Professional Development of HE Workforce).*

2.2 Developmental Stages and Focuses

The digital transformation of teaching and learning is a long-term process consisting of multiple stages.[5] The digital transformation of teaching and learning in higher education can be divided into four stages. **Unintentional stage:** At this stage, HEI leaders have no understanding of the digital transformation of teaching and learning, and HEIs barely formulate any policies related to the digital transformation. **Exploration stage:** HEI leaders develop a clear awareness of the digital transformation of teaching and learning and begin to formulate goals and plans of the digital transformation of teaching and learning. **Early implementation stage:** HEIs support the digital transformation of teaching and learning according to their goals and plans, and begin to try digital teaching with some courses. In this process, HEIs and teachers gradually gain experiences in the digital transformation of teaching and learning. **Growth stage:** HEIs develop a mature governance system and management competencies regarding the digital transformation of teaching and learning, and a considerable percentage of courses are routinely delivered in a digital way.

The essential components involved in the digital transformation of teaching and learning in HEIs take on different characteristics at different stages (Table 2-2-1).

Table 2-2-1 Characteristics of essential components at different stages of the digital transformation of teaching and learning

	Unintentional stage	Exploration stage	Early implementation stage	Growth stage
① Objectives and plans	Lack a correct understanding of the basic concept of the digital transformation of teaching	Basically recognize the role and related concepts of the digital transformation of teaching, but not set up transformation objectives based on the actual conditions of the institution	Recognize the role and concepts of the digital transformation of teaching, and set up transformation objectives based on the actual conditions of the institution	Clearly describe the role and orientation of the digital transformation of teaching in talent cultivation, and set up specific and distinctive transformation objectives
	Lack overall planning for the digital transformation of teaching	Begin to intentionally consider carrying out the digital transformation of teaching from several specific aspects, but without a solid planning document	Begin to formulate and issue relevant planning documents, and make uniform arrangements for the digital transformation of teaching	Have a clear plan for the digital transformation of teaching which has been unanimously recognized and accepted by teachers and students
② Organizational structure	Lack specialized bodies to lead and support the digital transformation of teaching	Set up a special body to lead and support the digital transformation of teaching	Set up a specialized body to lead and support the digital transformation of teaching, with HEI leaders acting as persons-in-charge	Set up specialized bodies of varying levels for the effective implementation of the digital transformation of teaching, with clear responsibilities, appropriate personnel and division of labor
③ Policies and norms	Lack policies and norms supporting the digital transformation of teaching	Have some policies and norms in place to support the digital transformation of teaching implemented	Have relatively sound policies and norms supporting the digital transformation of teaching which have been implemented at all levels across the institution	Have all kinds of teaching policies and norms of the institution compatible with the digital transformation of teaching
④ Personnel's digital competencies	Leaders lack the awareness and leadership of the digital transformation of teaching	Leaders have the awareness of the digital transformation of teaching and the preliminary leadership for the transformation, and some teachers have	Leaders, administrators, technicians and teachers have the digital competencies required for the transformation	Leaders, administrators and technicians, teachers and students have the digital competencies required for the transformation

	Unintentional stage	Exploration stage	Early implementation stage	Growth stage
⑤ Supportive services	Lack digital teaching support for teachers and students	Support services are mainly limited to digital technical support services	Also provide digital teaching and learning support for teachers and students besides digital technical support services	Support students to become active, independent and self-managed learners besides providing teachers with help in digital teaching technology and teaching skills
⑥ Technical environment	Infrastructure, equipment and resources are inadequate	The infrastructure and equipment for classroom-based digital teaching are sufficient, and the teaching resources needed by teachers and students can be effectively obtained	The digital infrastructure and equipment for carrying out digital teaching in and out of classrooms are sufficient, and the teaching resources needed by teachers and students can be effectively and conveniently obtained	The infrastructure and equipment for digital teaching in and out of classrooms are sufficient, and the teaching resources needed by teachers and students can be effectively and conveniently obtained; teachers develop and share their digital teaching resources
⑦ Cultural atmosphere	Lack the cultural atmosphere conducive to the digital transformation of teaching	Begin to create an atmosphere conducive to the digital transformation of teaching	Gradually formed the culture needed for the digital transformation of teaching which is recognized and accepted by teachers and students	A HEI-wide cultural atmosphere for the digital transformation of teaching have been formed with all teachers and students holding common beliefs on the matter, which has become the internal driving force of the digital transformation of teaching

HEIs have different focuses at different stages of the digital transformation of teaching. The transition from the unintentional stage to the exploration stage lies in the hands of leaders. To bridge the transition, they need to enhance their understanding of the digital transformation of teaching, set up transformation objectives, formulate transformation plans, build relevant bodies, issue relevant policies and norms, and build a supportive service system. The progression from the exploration stage to the early implementation stage mainly depends on teachers. They need to improve their awareness, attitude and ability of digital teaching. Administrators and technicians also need to improve their digital management and service competencies. When it comes to the growth stage, the most critical stage of the digital transformation of teaching, the focus should turn to students, and teachers need to innovate teaching modes to improve students' learning and enhance their digital learning competencies.

2.3 Policies and Strategies

The strategies and policies of HEIs for promoting the digital transformation of teaching and learning also center on realizing the digital transformation of the essential components mentioned earlier, that is, objectives and plans, organizational structure, policies and norms, supportive services, technical environment, personnel's digital competencies, cultural atmosphere and so on.

Formulate transformation objectives and plans in line with the strategic directions of HEIs

HEIs need to take the development of high-quality and inclusive digital teaching as a strategic goal and make plans to realize the goal.[6] To make effective plans, they need to assess the current situation, identify development objectives and priorities, determine budgets and resource allocations, and design action plans and implementation strategies.[7] The objectives and plans of the digital transformation of teaching and learning should be aligned with the strategic directions and values of HEIs; the current situation of digital teaching and the external environment of HEIs (such as local economic and technological development, national and regional policies on the digital transformation of education, etc.) can impact the progress and specific tasks for the digital transformation of teaching and learning.[8]

Set up specialized bodies to meet the needs of transformation

The digital transformation of teaching needs the corresponding organizational transformation, which involves changing the functions of the original bodies of a HEI and building some new specialized bodies for the digital transformation.9 The specialized bodies for the digital transformation of teaching and learning in HEIs can be divided into three categories:

Leadership bodies: A leadership body for the digital transformation of teaching and learning, with HEI leaders as its core is responsible for setting objectives and plans for the digital transformation of teaching and learning, formulating relevant policies and norms, and coordinating the changes of culture, technology and human resources in the digital transformation of teaching and learning.

Expert advisory bodies: An expert advisory body, composed of internal and external research institutions, experts and scholars specialized in information technology, education management and instructional design, as well as seasoned teachers, is mainly responsible for providing direction guidance and think tank support for the digital transformation of teaching and learning.

Implementation bodies: In terms of functions, implementation bodies for the digital transformation of teaching and learning can be further divided into teaching management bodies, supportive service bodies, instructional design/digital resource production bodies, teacher development bodies, and technology and information security bodies.

Issue policies and norms compatible with HEI values

Future higher education policies need to further consider non-traditional educational trajectories and approaches.[10] To promote the digital transformation of teaching and learning, a HEI needs to establish policies and norms that can reflect its strategic directions and values and facilitate such non-traditional educational trajectories and pathways.[11] When transforming its teaching policies and norms, a HEI needs to consider specific measures, roles, infrastructure, resources, career development, evaluation and accountability measures,[12] include the objectives of the digital transformation of teaching and learning in the policies and norms for various teaching programs , clarify the specific duties of teachers, students, administrators, and technicians in the digital transformation of teaching and learning in addition to their current duties, and add digital infrastructure to campus infrastructure policies and norms, specify the resources required for the digital transformation of teaching and learning in the policies and norms for the allocation of human resources, materials and financial resources, include the building and development of digital competencies as an important element in the policies and norms for the development of personnel's competencies, and add the assessment of the effectiveness of digital teaching to the policies and norms for the assessment of teaching quality.

Provide all-round supportive services for teaching and learning

In the process of the digital transformation of teaching and learning, it is important for HEIs to transform their services to better support teachers and students who may be overwhelmed with diversified teaching objectives, teaching resources, technical systems, teaching methods and evaluation methods. HEIs need to transform their supportive services for the digital transformation of teaching and learning as follows:

Change from single services to systematical services: HEIs need to adopt the principle of systematization to provide well-connected and integrated supportive services by linking all elements of teaching support, strengthening the connectivity between all stakeholders, and breaking the boundaries between scattered services, isolated links and separate departments.

Change from physical space to integrated space: As teaching expands from traditional physical space to the integration of physical and digital spaces in the wake of the digital transformation, supportive services need to cater for teachers and students anytime and anywhere in the integrated teaching space.

Change from single-point services to whole-process services: As digital teaching goes beyond traditional classrooms and breaks through the limitations of time, the teaching support team needs to provide whole-process services for activities before, during and after class.

Change from serving groups to serving individuals: HEIs need to move away from traditional unitary and fixed teaching services. Instead, they should provide supportive services that can meet the individual needs of teachers and students and develop personalized instructional design, curriculum management and learning evaluation by means of learning analytics and adaptive technologies.

Construct a technical environment conducive to the digital transformation of teaching and learning

Digital technologies are to support rather than replace HEI teaching.[13] To realize the digital transformation of teaching and learning, HEIs need to build a technical environment as follows:

Upgrade physical places of instruction in a digital way: Physical places of instruction such as classrooms can respond interactively to various requirements of the digital teaching space once they are equipped with digital equipment to realize the data transfer between physical space and digital space.[14]

Build an internet-based teaching environment: HEIs need to make an overall and coordinated plan to fill the gap between what the current campus network, digital facilities and equipment, learning management system software, and digital teaching resources can offer and what teachers and students really need in the process of digital transformation.[15] Details on this regard can be seen in **Case 3** in the appendix *(Egypt: Online Learning During COVID-19 Pandemic)*.

Apply new-generation digital technologies: It is believed that new-generation digital technologies such as AI, learning analytics, IoT, social robots and blockchain will deeply integrate with higher education teaching.[16] HEIs need to maintain a "developmental thinking"[17] and continue to apply new technologies to the current instructional environment.

Emphasize security and fairness: The development of technology should be planned with ethics, fairness, and justice as the core in advance instead of afterwards.[18] To ensure data security and privacy protection, HEIs, teachers and students need to participate in the development process of technical systems, and actions should be taken to raise awareness, build institutional systems, and enhance maintenance and management. Investment in network connection, digital equipment and organizational capacity of HEIs should ensure equal access to digital education for all learners.[19]

Improve personnel's digital competencies to better fulfill their duties

In order to promote the digital transformation of teaching and learning, HEI leaders, administrators and technicians, teachers and students need to master corresponding digital competencies.

HEI leaders play a key role in the digital transformation of teaching and learning.[20,21] They need to enhance their digital leadership in value perception, work coordination and performance evaluation as follows: understand the basic concepts and related knowledge of digital transformation, clarify its significance to the institutional development, understand the value of technical system and organizational system and their interactions, and determine the development objectives and plans of the digital transformation; according to transformation objectives and plans, comprehensively coordinate all HEI departments, keep them on the same page, and maintain the balanced development of technical system, organizational guarantee system and digital ability of teachers and students in an orderly manner; review evaluation opinions on each stage of the transformation and decide on the next direction of work.

Digital competencies should be the core skills of HEI administrators and technicians, and be embedded in all areas of teachers' professional development. HEIs need to prepare instruction manuals, update digital competency frameworks, certify digital skills, and create incentives to enhance personnel's digital competencies.[21]

Create a culture of innovation and collaboration in teaching and learning

Organizational culture is the sum of a set of values, beliefs, opinions and ways of thinking shared by all members of an organization and passed on to new members,[22] which can promote organizational members' identification and commitment to matters higher than individual self-interest, and has the role of guiding, regulating, uniting and motivating behavior.[23] Cultural change is an advanced level of organizational change. From a cultural perspective, the digital transformation of teaching and learning is a change of organizational culture for HEIs. The digital transformation of teaching and learning involves the reform and innovation of teaching, and a teaching culture conducive to innovation and cooperation will make the reform more systematic, profound, and long-lasting. The culture of innovation and cooperation can, internally, reshape a HEI into a learning organization and promote the continuous professional development of teachers, administrators and other personnel; externally, enable the HEI to share knowledge with other HEIs and countries and respond to all kinds of new challenges in the digital age.[24]

2.4 Summary and Future Developments

This chapter expounds the essential components of for the digital transformation of teaching and learning in higher education, including objectives and plans, organizational structure, policies and norms, supportive services for teaching and learning, technical environment, personnel's digital competencies, and cultural atmosphere, and defines the roles of different participants in the digital transformation of teaching and learning. This chapter divides the digital transformation of teaching and learning supported by HEIs into four stages: unintentional stage, exploration stage, early implementation stage, and growth stage, and explains the characteristics of each essential component at different stages; proposes strategies and policies for promoting the digital transformation of teaching and learning in HEIs, including formulating transformation objectives and plans in line with strategic directions of a HEI, setting up specialized bodies to meet the needs of transformation, issuing policies and norms compatible with HEI values, providing all-round supportive service for teaching and learning, building a technical environment to facilitate teaching reform, enhancing the personnel's digital competencies to better fulfill their duties, and creating a culture of innovation and collaboration in teaching and learning.

The digital transformation of teaching and learning in higher education is a systematic endeavor. It involves developing a digital culture within HEIs, which requires in-depth exploration from both systematic and cultural perspectives.[25]

Digital culture of HEIs: HEIs are an important carrier of cultural inheritance and innovation, but research shows that, in terms of digital transformation, HEIs is not catching up with social and technological development.[26,27] The digital age needs a compatible digital culture. It is imperative to study the digital transformation of teaching and learning in higher education from a cultural perspective, analyze the cultural scope of the transformation, and put forward the contents, paths, and methods of the cultural transformation.

Coordinated transformation in technology, human resources and culture of HEIs: The coordinated transformation in technology, human resources and culture of HEIs is the key to the success of the digital transformation of higher education teaching and learning. There is an urgent need to integrate the research results in many fields such as education management, organizational reform, teaching and learning, digital technology, and carry out the practical exploration and academic research on the digital transformation of higher education teaching and learning on the principle of systematic thinking.

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Chapter 3
Digital Transformation:
Academic Program Approaches

Academic programs are the basic unit of talent cultivation in HEIs, the design of which is impacted by social, economic, and industrial development. As digital technologies are driving industrial transformation and the digital economy has become a new engine for economic development, academic programs need to be transformed in a digital way to deliver talents required by the new economy. This chapter elaborates on the characteristics of the digital transformation of academic programs in higher education and its scope in terms of professional talent training scheme, teaching resources, environment and platform for academic program development, and experimental and practical teaching bases.

3.1 The Characteristics of the Digital Transformation of Academic Programs

Developing high-quality academic programs is crucial to the survival of HEIs, and is also their responsibility and mission. Since the arrival of the digital era, digital technologies have played an increasingly prominent role, resulting in richer dimensions, more emphasis on collaboration and greater openness in academic program development.

Training objective turns from specialists to interdisciplinary talents

In the digital age, the attributes of "professionalism" are changing. In the past, HEIs focused on equipping students with competencies of specific fields, but now they emphasize more on developing their comprehensive abilities and pay more attention to the complementarity and connectivity between talents of different specialties. HEIs also give full play to the advantages of the internet to break the boundaries of time and space between disciplines and academic programs. For instance, they encourage students to take courses offered by other schools or departments and establish interdisciplinary and inter-university study and research teams with the help of digital technologies.

First, HEIs should consider the impacts of industrial digital transformation on academic programs. The penetration of digital technologies into all walks of life is changing the way of production, living and communication. With the rapid development of digital technologies, many new sectors and industries have come into being. Therefore, HEIs need to break the old frame of thinking, keep track of industrial digitalization, recognize the nature of the fourth industrial revolution and its impact on the industries, and expand horizons in program design; they need to develop academic programs aligned with the digital transformation across industries and upgrade traditional programs in a digital way; they also need to grasp the connection between different academic programs, and enhance their integration by continuously optimizing program design based on the relationship between disciplines and academic programs, to better adapt to the digital era. **Second, HEIs should establish a credit certification mechanism in line with digital transformation.** In order to meet the graduation requirements of an academic program, students are required to earn certain credits. With the development of online teaching resources, the conditions for course-taking across academic programs and universities have gradually matured, which requires HEIs to establish a more flexible credit certification mechanism across academic programs, universities and even countries. During the COVID-19 pandemic in 2020, Zhejiang Province of China established a digital teaching and learning community for general education among HEIs, in which universities and colleges share high-quality teachers and online courses, recognize the workload of teachers teaching across schools, conduct unified assessment of students' learning outcomes, and realize mutual certification of credits across schools, details of which can be found in **Case 4** (*China: Digital Teaching and Learning Community for General Education among Zhejiang HEIs*) in the Appendix.

Academic programs move from isolation to integration

Traditionally, academic programs were developed as relatively isolated units and academic activities were limited within each program, making it hard to promote interdisciplinary development. The digital era, however, has witnessed ever-deepening exchanges and wider penetration among academic programs, promoting the emergence and development of interdisciplinary programs. **HEIs first need to establish a new community for academic program development.** They need to grasp the trends of digital industrialization and industrial digitalization, establish a cross-disciplinary and cross-university community that maintains close ties with industries and enterprises, carry out various forms of collaborative exchanges and research, dynamically adjust program design, and step up efforts to develop inter-disciplinary fields. **Second, HEIs should promote the integration of liberal arts and sciences.** China's *Declaration on the Construction of New Liberal Arts* issued in November 2020 emphasizes the need to "keep up with the new round of scientific and technological revolution and the trend of industrial transformation, actively promote the in-depth integration of digital technologies such as AI and big data with liberal arts programs, actively develop emerging liberal arts programs, promote the transformation and upgrading of the original liberal arts programs, and achieve in-depth interdisciplinary integration of liberal arts and science, engineering, agriculture, and medicine".

HEIs pursue collaborative development rather than independent growth

Traditionally, HEIs pursued the independent development and integrity of their academic programs based on their own faculty and teaching conditions. In the digital era, however, more emphasis is placed on collaborative development between different academic programs within a HEI and across different HEIs. In the context of such transformation from independent development to collaborative development, **HEIs first need to jointly develop and share the curriculum.** In academic program development, exclusive reliance on internal resources or curriculum is likely to result in constraints on talent cultivation. Extensive involvement of HEIs in the development of open online courses can promote joint development and sharing of resources among different HEIs and different academic programs. **Second, it is necessary for HEIs to collaborate with various stakeholders to achieve common improvement of research and teaching.** Taking advantage of the flexible internet-based information sharing and exchange across time and space, HEIs can conduct joint research and innovation activities with enterprises and government agencies, thereby

promoting the common progress of research and teaching. **Third, HEIs need to employ digital technologies to strengthen quality evaluation and guidance of academic programs.** In the digital era, the form of quality evaluation and guidance of academic programs has undergone a gradual transition from regular face-to-face meetings to a combination of irregular online and offline ones. This new form makes evaluation and guidance more convenient and benefits a wider range of people, offering program management personnel, all people involved in program development, and even students more opportunities to participate in the discussion of program development.

Programmatic and specialized accreditation turns from rigidity to flexibility

With digital technologies, programmatic and specialized accreditation presents new trends of development such as micro-credential and micro degree, which will lead to open and shared program development.

Micro-credentials are typically focused on a specific set of learning outcomes in a narrow field of learning and achieved over a shorter period of time. They are offered by commercial entities, private providers, professional bodies, traditional education and training providers, community organizations and other types of organizations.[1] Each course is made of certain units, each unit is made of lessons; courses can stack up to Specializations or XSeries; these can stack up to partial degrees such as micro degrees, or all the way up to full degrees. Compared with a micro degree, the number of courses required to obtain a micro-credential is more than one, but usually smaller than that required to obtain a full academic degree.[2] Micro-credentials offer great promise in helping to redesign and even reimagine more future-fit and complementary credential frameworks to enhance employability, continuous professional development, and the goal of a thriving learning society.[3] In order to fill new jobs created in new areas of economic growth and address the resulting skill gaps, many countries have initiated the micro-credentialing movement. For example, Indonesia Cyber Education Institute (ICE-I) launched free online courses. Learners can sign up for those courses and obtain the corresponding micro-credentials once they pass relevant exams, as shown in **Case 6** (*Indonesia: Online Learning Development in Higher Education*) in the Appendix. Considering the strong momentum of micro-credentials, it is necessary to develop relevant standards, so as to compare best practices and promote social recognition for micro-credential bearers and issuers. In addition, the relationship between micro-credentials and the formal education system remains to be clarified, and many questions need to be answered, such as "How should micro-credentials fit into the formal education system?", "Do micro-credentials complement or replace traditional credentials?", "How can the two coexist?", among others. There is also a need to consider stakeholders' perspectives on the future development of micro-credentials and conduct more studies on the viewpoints of employers, employees and relevant professional bodies.

Micro degree, as a type of micro-credential, is a certificate given to learners for the completion of hyper-focused higher education degree programs in a short period of time. The development of micro degrees is closely related to the changing employment situation in the digital era. We live in uncertain and rapidly changing times that create new job opportunities and bring with them risks of displacement and an urgent need for re-skilling among workers. The traditional university degree no longer offers the same job security or helps to future-proof your career. People increasingly need flexible, personalized and on-demand lifelong learning that equips them with the transversal skills and knowledge to adapt to life and work in an evolving digital society. Some argue for major system-wide disruption and the radical unbundling of traditional degrees to better recognize nano talents and bite-sized blocks of learning more relevant to the needs of society and changing nature of work.[4] In this context, micro degrees become a trend and one of the key technologies and practices that will have a significant impact on the future of teaching and learning in higher education.[5] Currently, open online education platforms including Udacity and Coursera offer micro degree courses, on the promise of a well-paying job.6 While the development of open online courses as a primary means to obtain micro degrees is important, what is more important is the design of modularized programs aimed at developing learners' higher-order thinking and the establishment of an open micro degree certification system. *The EDUCAUSE Horizon Report | 2019 Higher Education Edition* identifies modularized and disaggregated degrees as a long-term trend in higher education, noting that learners should be able to earn micro degrees through modularized programs.[7] India has set up credit banks in higher education, where students can store their academic credits earned from different HEIs digitally for earning a degree.[8] The micro degree certification system represented by credit banks collects learning process evidence of learners and records open learning outcomes with the help of blockchain technology, which is more credible, flexible, accurate and comprehensive than traditional forms of representation (such as certificates and transcripts).

3.2 The Scope of the Digital Transformation of Academic Programs

Program design and development is both a judgment of and response to the development of the times, and a prediction of and preparation for the future social changes. In the digital era, some traditional industries have been eliminated, some are being restructured, and new ones are being created. HEIs need to make adjustments and changes in terms of professional talent training schemes, teaching resources, environment and platform for academic program development, and experimental and practical teaching bases.

Professional talent training schemes adaptive to digital development

The reform of academic program systems is driven by both internal and external factors. When designing talent training schemes, HEIs should follow both the external rules of education and the internal ones. In terms of external rules, HEIs should make changes and adjustments to meet the requirements of domestic social development with an international vision. Academic programs as well as training objectives and norms should be adjusted to better adapt to the digital economy and industrial development. In terms of internal rules, it is essential for HEIs to adjust their training schemes and methods based on the objectives and norms and coordinate various elements in the talent training mode to nurture higher-quality talents in line with

the objectives. The reform of academic program systems is essentially a process of actively adapting to and fitting in with the digital era. In order to adapt to the digital transformation of academic programs, Central China Normal University has digitally restructured its professional talent training system in eight ways, including redesigning training schemes, building a digital instructional environment, improving teachers' digital competencies, developing digital teaching resources, promoting blended teaching and learning, carrying out data-based comprehensive evaluation, putting in place digital teaching management and services, and creating a digital teaching culture. Details can be found in **Case 5** *(China: Restructuring of Talent Training System Through Deep Integration of Digital Technologies in Central China Normal University)* in the Appendix.

Digital teaching resources

Digital teaching resources, as a basic component of academic program development in the digital era, can greatly expand the scope and upgrade the capacity of academic programs in serving society. Digital teaching resource libraries for specific academic programs serve as holistic support for professional talent cultivation, the development of which involves the following steps. The first step is to determine the architecture of resource library. Under the architecture, there should be the structure of academic programs, job and occupational standards, curriculum, teaching faculty, conditions for practices, management mechanism, HEI-enterprise cooperation, teaching and research outcomes, and comprehensive resources. The second step is to investigate program needs to guide the planning and development of the resource library. Resources required for teaching should be fully investigated based on the characteristics and needs of the specific programs to determine the focus of teaching resource development. The third step is to determine the method of resource development. Digital teaching resources can be self-developed, introduced, or shared. To be more specific, HEIs may develop teaching resources for internal use on their own, introduce high-quality general education courses and some specialized courses from home and abroad, and share high-quality domestic and global open education resources. The fourth step is to determine the form of teaching resource library. Digital teaching resource library should be developed with program characteristics and needs considered to support blended teaching and learning, promote independent, ubiquitous and personalized learning, and realize the industry-HEI-research integration. The fifth step is to build a collaborative resource development team. The development of digital teaching resources relies on the collaboration between faculty, specialized teaching management team, and professional educational technology R&D and production team.

In order to realize joint development and sharing of digital teaching resources across HEIs and academic programs, **first of all, it is necessary to develop unified standards and exchange spaces for sharing resources.** The specific measures include establishing unified standards for developing shared resources to facilitate resource access and use; following the conditions of the Creative Commons (CC) licenses to protect the copyright of resource developers; breaking down barriers between HEIs to ensure a smooth intra-school linkage mechanism and inter-school collaboration; developing spaces for resource sharing based on characteristics of the specific academic programs and industrial needs to promote collaboration between HEIs and the corresponding industries or enterprises. **Second, establish a sound system for the management of shared resources.** The specific measures include developing relevant assessment and evaluation mechanisms to evaluate the quality of resource development and results of resource sharing; and introducing a number of policy incentives based on outcomes and the degree of contribution to encourage greater initiative, deliver higher-quality digital teaching resources, extend the life cycle of the sharing process, and promote the sustainable sharing of digital teaching resources. **Third, adopt "customized" digital teaching resource sharing.** Relying on digital teaching resource sharing platforms, students can have access to "personalized and customized" resources to meet their different needs, which can help realize collaborative learning, lesson preparation, management and innovation between teachers and students and between universities and enterprises, thus improving teaching effects.

Digital instructional environment and cyber learning space

It is important to create digital instructional environment and cyber learning space to support the development of top-notch academic programs, for which the following three measures can be taken. First, build classrooms featuring great display, interaction, intelligent analysis, practical operations and other functions to facilitate teacher-student communication, context-aware learning and adaptive teaching. Second, develop digital environment for experiments and practices using computer simulation and VR technologies, combined with site layout, by which real experimental environment and working environment can be imitated to support teaching activities such as experiments, practical training, and assessment and appraisal. Third, build a cyber learning space equipped with learning tools and resources to enable differentiated teaching, personalized learning, and big data-based dynamic assessment beyond time and space limits.

Experimental and practical teaching bases

Experiment and practice bases are important places for carrying out teaching activities. Such places are expected to meet certain requirements, maximize the efficiency of teaching resources, and at the same time provide production and technology R&D services for enterprises and offer various training and services for society. In the digital era, efforts can be made in the following four aspects to build experiment and practice bases.

First, establish digital training bases through HEI-enterprise collaboration. Digital technologies can be used to build online space for HEI-enterprise communication and establish relevant mechanisms, so that part-time teachers and enterprise personnel may participate in teaching activities in a more flexible way, thereby narrowing the gap between practical teaching and job requirements, facilitating HEI-enterprise collaboration, and realizing teaching based on industry-HEI-research integration.

Second, establish training bases for specialty groups through inter-HEI collaboration. Digital technologies can be employed to optimize inter-HEI communication and resource sharing, encourage related specialties from different HEIs to establish specialty groups together, and help develop core skills, and set up online training bases that support shared practical training and multi-functional training centers, so as to expand the capacity of academic programs in serving society.

Third, focus on establishing VR-powered training bases. VR technologies can be utilized not only to establish virtual simulation laboratories to facilitate teaching and practices, but to build digital industry-HEI-research-application collaborative innovation centers through collaboration between HEIs and enterprises.

Fourth, build innovation and entrepreneurship bases. With the help of digital platforms, HEIs can collaborate with enterprises to build innovation and entrepreneurship communities featuring "teaching workshop + students' achievements + business incubation + market-oriented enterprises" to transform teaching outcomes into products that the market needs, help students launch their learning and practice products on entrepreneurship platforms, transform entrepreneurial achievements into technological innovations that enterprises need, thus promoting HEI-enterprise achievement matching. For instance, Stanford University has established the Stanford Entrepreneurship Network with a collection of member organizations including Center for Entrepreneurial Studies (CES), Center for Social Innovation (CSI) and Office of Technology Licensing (OTL), which coordinates and manages innovation and entrepreneurial activities and has designed many relevant courses with disciplinary barriers removed. Babson College's Arthur M. Blank School for Entrepreneurial Leadership has established extensive ties with technology parks, entrepreneurial associations, small business development centers and entrepreneurial training institutions to gather resources for innovation and entrepreneurship education. China's Ministry of Education has designed multi-level innovation and entrepreneurship programs for university students, and many universities have included innovation and entrepreneurship courses in their curricula. Nanjing Normal University's comprehensive practice credit program, for example, encourages students to earn innovation and entrepreneurship credits.

3.3 Summary and Future Developments

The digital transformation of academic programs in HEIs are characterized as follows: training objective turns from specialists to interdisciplinary talents; academic programs move from isolation to integration; HEIs pursue collaborative development rather than independent growth; and programmatic and specialized accreditation turns from rigidity to flexibility. Its scope includes professional talent training schemes, teaching resources, environment and platform for academic program development, and experimental and practical teaching bases.

The goals of the digital transformation of academic programs are to provide suitable talents for society and support the more personalized development of students. More exploratory efforts need to be taken to realize the goals.

The digital transformation of higher education teaching and learning needs systematic efforts. It involves developing a digital culture within HEIs, which requires in-depth exploration from both systematic and cultural perspectives.[9]

Flexibility of programmatic and specialized accreditation: The digital transformation of academic programs has seen new trends such as micro-credential and micro degree, which will give rise to open and shared academic programs. However, to shift from the traditional degree accreditation system to the open micro degree accreditation system, higher education policy makers, practitioners and researchers need to take concerted efforts to explore how to restructure the education system and quality assurance system.

Dynamic alignment of academic programs and the market: The digital transformation is reshaping society, labor market and work. The mismatch between what the market wants and what workers can offer get both employers and graduates in trouble, with the former unable to find suitable talents and the latter unable to secure suitable jobs. Therefore, more efforts are needed to explore policies, mechanisms and technical support for dynamic alignment of academic programs and the market.

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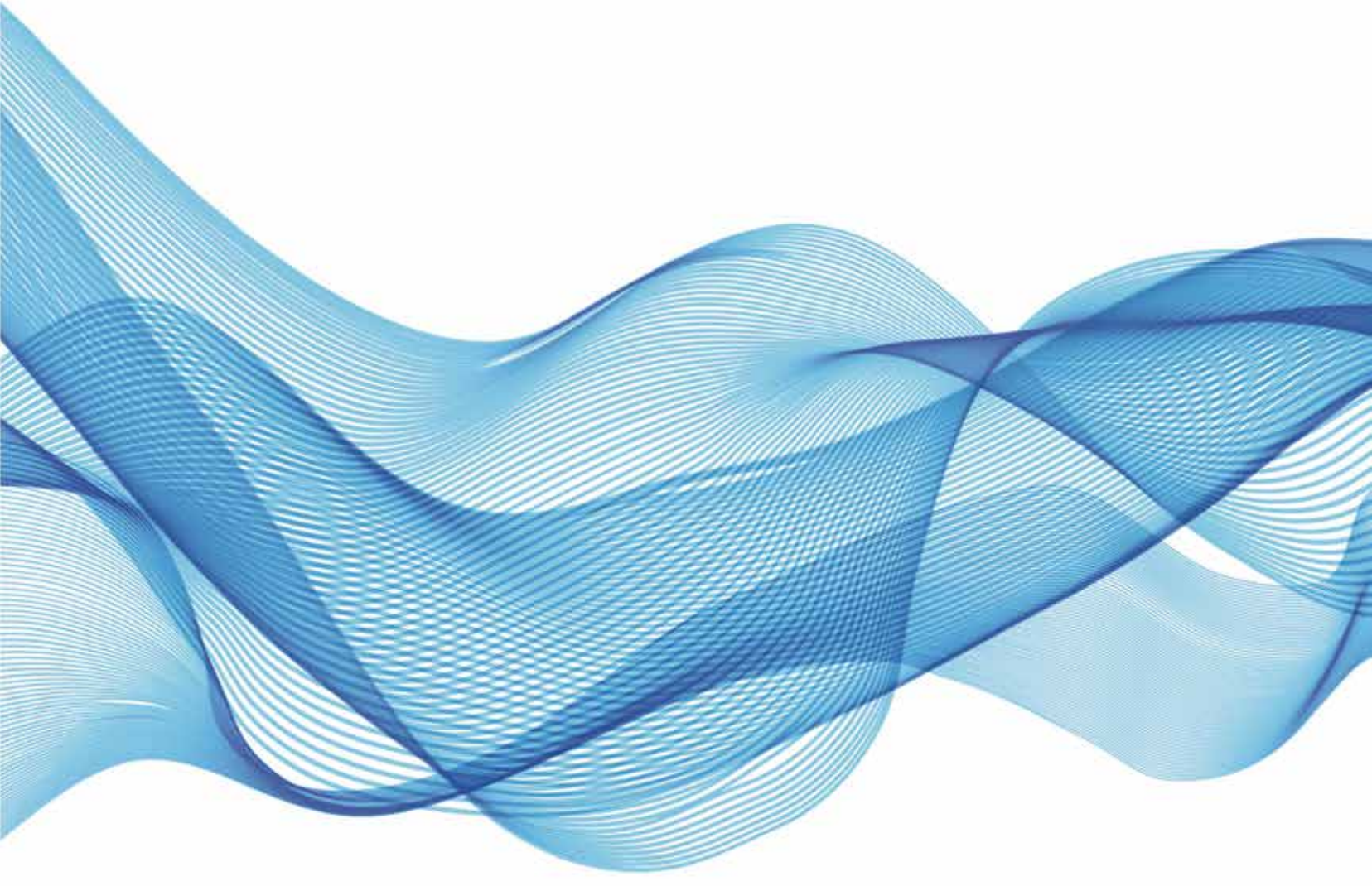
Chapter 4

Digital Transformation:

Curriculum Development and Delivery



The core of digital transformation of higher education lies in curriculum development and delivery. The integration of digital technology into curriculum development and delivery can provide students with a richer learning environment, more flexible learning activities and more immediate evaluation feedback, so as to reduce teachers' burden, and enhance students' competencies.[1,2] Compared with traditional face-to-face model and online-only model, this blended model, combining both the physical and virtual spaces can better improve students' academic performance[3], motivation[4], satisfaction[5], and learning attitude [6], and meet their psychological needs[7]. This chapter describes how digital transformation changes key dimensions of curriculum development and delivery and their relationships in teaching and learning, how the curriculum development process is restructured, and how the instructional design and delivery is transformed in a multifaceted way.

4.1 Multifaceted Changes of Key Dimensions and Their Relationships in Teaching and Learning

The scope of key dimensions in teaching and learning has been greatly expanded

Teaching and learning are a complex dynamic system with various dimensions, including curriculum objectives, students, curriculum content, teaching activities, learning assessment and feedback, teachers, and teaching environment, etc. In the process of digital transformation, the scope of these elements will be expanded accordingly (as shown in Figure 4-1-1).

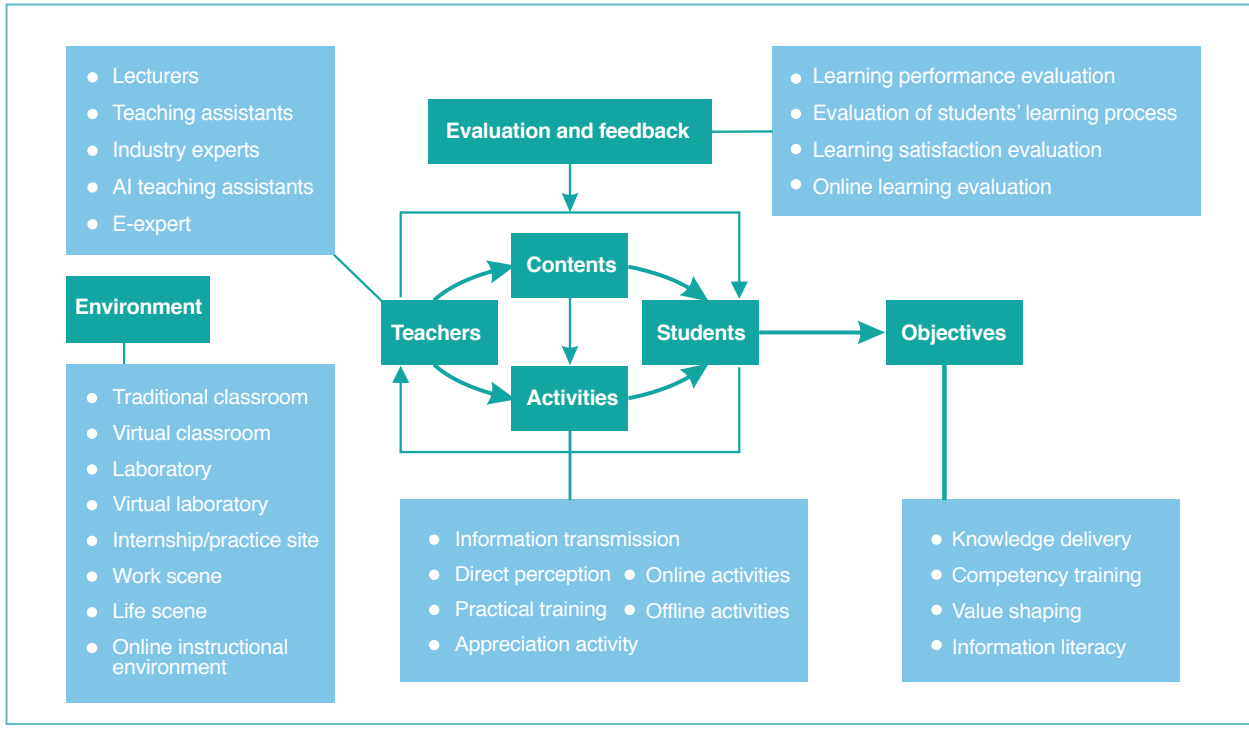


Figure 4-1-1 Key dimensions and their relationships in the digital transformation of teaching and learning

Curriculum objectives: Equipping students with the skills and abilities needed in the digital age and preparing them for the 21st century. 21st century skills are the core competencies that students need to master in the information society, including learning and innovation skills, digital literacy skills, and career and life skills.[8] To respond to the booming digital economy as well as rapid development of AI and digitalization of enterprise production, HEIs need to pay more attention to the new challenges to career development so as to better prepare students. They should take developing students' digital competencies as one of the core objectives of curriculum development and delivery to better prepare them for the evolving job market. For instance, to cope with automated workflows, students need to master digital equipment and skills. To adapt to the digital transformation of the world, students must strengthen their self-management and learning abilities and make data-driven decisions. To fit into an international work environment, students need to develop international thinking and action skills.[9]

Curriculum contents: Changing from fixed and structured knowledge to dynamic, open, unstructured and diverse contents. As big data, internet and other technologies advance, knowledge has been increasing and updating more quickly. Curriculum contents become more closely linked with social life and production, especially with the development of the latest science and technology, and they are delivered by means of multimedia. Systematic, high-quality and dynamic digital open instruction resources have become an important source of curriculum contents.

Teaching activities: Changing from face-to-face instruction limited to specific physical space to diversified instruction combining both the digital and physical spaces. Diversified electronic devices and technical systems such as smart phones, tablet, e-schoolbags, online instruction platforms and video conference systems provide strong support for carrying out various teaching activities. Teaching activities are longer limited to fixed schedule and fixed site. Courses now can be delivered both online and offline covering pre-class, in-class and after-class activities. Teaching has changed from teacher-centered delivery by teachers to diverse interactions that are student-oriented. Various digital tools and digital instruction combining the digital and physical spaces provide students with richer and more timely cognitive and emotional support during teaching activities.

Learning assessment and feedback: Changing from static and summative assessment to dynamic, diverse, formative and big data-supported assessment and feedback. As new technologies such as mobile internet, cloud computing, big data, data mining, learning analytics and AI emerge, new methods for learning assessment keep springing up, making it possible to use big data generated in the teaching process to carry out multi-dimensional analysis, process evaluation and dynamic feedback. The sources of assessment and feedback include teaching and learning behaviors, physiological signals of teachers and students, psychological awareness activities, facial expressions and other information; the contents of assessment and feedback include students' daily academic records and behaviors, learning satisfaction, information and effect of teachers' teaching process, etc. The assessment and feedback can be made via more convenient paths, making it possible for teachers to give guidance in a timely, accurate and individualized manner. Meanwhile, the forms of assessment and feedback become more diverse, and the automatically generated visuals form can help teachers analyze students' learning behaviors and learning effect in a multifaceted way, thereby promoting the timely improvement of teaching and learning.

Teachers: Changing from the role of one-way imparting knowledge to supporting students' autonomous, cooperative, and inquiry-based learning with technology. Details about digital transformation of teachers' competencies are introduced in Chapter 5 "Digital Transformation: Teachers' Professional Competencies".

Students: Changing from passive receivers to autonomous learners supported by digital technology. Details about digital transformation of students' role are described in Chapter 6 "Digital Transformation: Learners and their Learning".

Teaching environment: Changing from closed physical space in school to borderless and multi-channel connected physical and virtual spaces. The teaching environment has changed from traditional physical spaces to cyberspace for blended learning, allowing learners to get access to continuous services with any device, in any form and at any place, thus enabling them to learn anytime and anywhere on demand; the real-time collection, capture, analysis and processing of information on physical environment and equipment status can give learners scientific and reasonable evaluation, and share high-quality learning resources and the most suitable learning tasks in real situations.[10] The teaching environment with versatile digital teaching and learning tools can provide students with personalized and intelligent green learning environment, support real-time and non-real-time interactive communications across time and space, support diversified, intelligent and personalized teaching activities, and support personalized teaching resources sharing and evaluation supported by multiple data.

The relationship between key dimensions in teaching and learning become more complicated

Reasonable allocation of the key dimensions in teaching and learning is the key to improving the quality of curriculum development and delivery. In the digital age, due to the rapid development of media technology, an important dimension in the curriculum development and delivery system, the scope of the key dimensions of teaching and learning has changed, and their relationships have also become more diverse.

Under the context of digital transformation, to meet the new requirements for talents brought by social, economic, and technological developments, curriculum objectives need to be updated regularly and dynamically. Based on Constructivism and Connectivism learning theories, as learning theories advance, a lot of online information and fragmented knowledge may be included as knowledge, which expands the scope of curriculum contents and changes the mode of delivery, making teachers no longer the only source of information. At the same time, curriculum objectives and curriculum contents have also changed the relationship between teachers and students: teaching is no longer limited to knowledge imparting by teachers to achieve curriculum objectives, which can be seen through the widespread practices of flipped classrooms and blended learning. Moreover, curriculum objectives and contents can be generated or created by teachers and students at any time. With the inclusion of AI teaching assistants in the category of teachers, the cognitive style of digital native students has changed from individual cognition to internet-based group cognition and distributed cognition, and the relationships among the above dimensions will become more complicated.

Teaching environment is a particularly important dimension of the teaching system as it can impact the teaching effect. In the process of digital transformation, teaching environment keeps changing dynamically. Given that, teachers should be able to monitor and adjust the relationships between the environment and various dimensions, so as to achieve the best teaching outcomes in specific situations. Once a certain type of teaching environment (including physical environment and cyberspace) is established, teachers' digital instruction awareness and competencies can influence their ways to deliver curriculum contents (such as the selection and production of digital resources) and to design instruction activities (such as VR simulation training activities), which will in turn impact to what extent curriculum objectives are met. In the meanwhile, the delivery of learning evaluation and guidance needs to be supported by various technologies and subject to the instructional environment. For example, during the COVID-19 pandemic, teachers and students have to move from in-person learning to remote learning from home. Such changes in teaching environment affected students' skill acquisition. Experiments, internships and practical training courses were either suspended or downgraded to experimental video watching. However, with the help of simulation scenes created with virtual simulation technology, teaching activities can become more diversified, personalized and intelligent. In the teaching process, the data of teachers and students' teaching and learning can be collected in real time unbiasedly, and such data can be used for course evaluation. Therefore, teaching activities can be adjusted according to the real-time evaluation results to enhance teacher-student and student-student interactions.

4.2 Restructuring the Cycle of Curriculum Development Process

The digital transformation of the development of theoretical courses in higher education lies in the integration of new technologies into the development process and the change from face-to-face courses to blended courses, which involves building more digital instruction resources and promoting resource sharing, providing teachers with blended course development templates to reduce the difficulty of development, and providing online learning space and digital instruction tools. For practical courses such as medicine and engineering, their development is restructured based on process, starting from the change of new posts in the digital age (as shown in Figure 4-2-1).

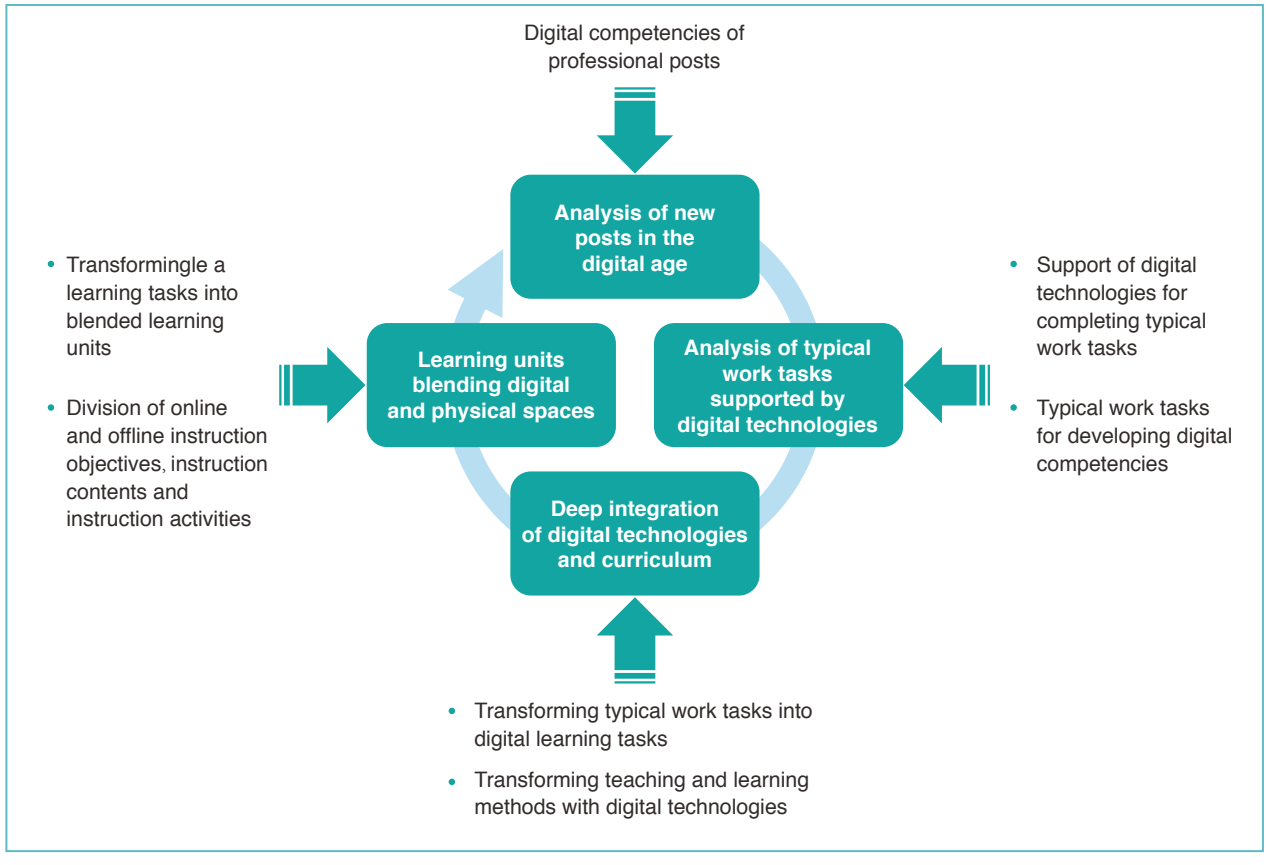


Figure 4−2−1 Digital transformation of curriculum development based on working process

Analysis of new posts in the digital age: digital technologies have had a great impact on traditional industries, giving rise to new posts and changing the competencies required by existing posts. When analyzing the abilities required by posts relevant to specific curriculum, the focus should be on fully exploring what digital competencies professional posts require in addition to traditional skills, such as digital occupational skills, digital learning abilities and comprehensive digital literacy.

Analysis of typical work tasks supported by digital technologies: This involves analyzing how digital technologies can support the delivery of typical work tasks, and what work tasks require digital occupational skills, digital learning abilities and comprehensive digital literacy.

Deep integration of digital technologies and curriculum: This involves transforming typical work tasks supported by digital technologies into learning tasks, and considering how digital technologies can support students to conduct work process-oriented learning and develop occupational competencies.

Organization of blended learning units: This involves transforming learning tasks into blended learning units combining both the physical instructional environment and online learning space and dividing curriculum objectives, curriculum contents and instruction activities into online and offline ones.

Evaluation of blended courses: This involves collecting the whole-process data of teaching and learning, so as to evaluate students' learning process and results objectively and accurately.

A case from Serbia shows how an HEI managed to develop blended courses driven by post tasks through cooperating with internship units. Through Learning management systems, students were able to gain access to all online resources remotely and complete their onsite internship. For details, please refers to **Case 7** *(Serbia: Internship Program Supported by LMS)* in the appendix.

4.3 The Multifaceted Transformation of Instructional Design and Delivery

In the delivery of digital instruction, many aspects including instructional system, instructional contents, teaching scenarios and instructional methods will change.

Instructional system becomes more open, complex and dynamic

Driven by rapid development of digital technologies, relationships in teaching and learning have transformed from a simple linear association of "one-to-one" or "one-to-many" to a nonlinear relationship of "many-to-many". It becomes a complex network of self-organization, emergence and uncertainty.[11] Compared with traditional teaching and learning, digital approaches follow different rules. They not only evolved from a linear and orderly system to an open, complex and dynamic system, but also shift the understanding of educational laws from traditional linear thinking to non-linear thinking. Instructional behaviors are recorded as data by means of digital technologies such as the internet, so that teachers can assess and provide evidence-based guidance to learners in a timely manner, making teacher-student interactions more comprehensive and intensive.

Instructional contents: knowledge generation and dissemination become dynamic and mass-oriented

Due to various digital technologies including internet, the content and structure of knowledge have changed significantly. The traditional knowledge is generated in the textbook based on the wisdom of human being as abstract, re-structured, logical and text-confined content. In the digital age, the production of knowledge is no longer limited to any individual, but generated into content based on group wisdom facilitated by the internet. Instead of "produced first, disseminated later", knowledge now is produced and disseminated synchronously, which reflects the change of how individual improve the value of knowledge under the internet environment. Knowledge itself has become fragmented, dynamic and individual-based.[12] Knowledge now can be stored in a way of networked and multi-structured, which has made it easier for learners to understand, integrate, memorize and apply. The new knowledge also spread faster with larger scale to engage a wider audience with more personalized expressions.

Teaching scenario is breaking through the limitations of time and space

Teaching Scenario has developed from synchronous instruction to synchronous or/and asynchronous instruction open on demand through breaking time limits. Students can conduct synchronous learning of the same content at the same time guided by teachers, or asynchronous learning of self-paced learning contents at any time chosen by themselves. Synchronous blended learning generally requires teachers and students to have specific tools (such as live streaming platform, interactive e-learning tools, etc.). By integrating traditional learning and e-learning to make it happen at the same time and space, teachers can better understand students and give timely feedback, through interactions with students in real time by pictures, words and voices.[13]

Teaching Scenario supports teacher-student interactions at anytime and anywhere through breaking location restrictions. Instruction can be conducted face-to-face or remotely. Teachers make decisions on the flexibility of on-campus learning based on actual needs. Therefore, teachers can design different percentages of face-to-face instruction and online instruction in one semester, as well as the scale of classes, so as to deliver instructions at anywhere supported by technologies. For example, during the COVID-19 pandemic, international students who cannot return to university campus is able to learn synchronously at home using video instruction system or/and learn asynchronously with the help of learning management systems. For example, The Smart Interactive Classroom of Tsinghua University in China, can provide learning support globally for oversea students through its learning terminals. It allows students to interact with distant learners from different countries and regions by connecting teaching and learning activities in different places.

Expanding the instructional space from on-site instruction in physical spaces to blended learning merged to virtual learning environment. Traditional instruction activities mostly took place in physical spaces (such as classrooms, training rooms, etc.). As technology applications (such as e-learning platform, video conference system, etc.) become more advanced, online learning activities are continuously integrated into daily instruction. In other words, blended learning as a combination of learning in virtual and real spaces has become the new normal, promoting the development of instruction to be digital-wised, scenario-based and better-presented.

Instructional Methods is shifting to diversified blended learning

Blended learning not only retains tutor's face-to-face supervision and learning atmosphere but also increases the learner's autonomy and flexibility of online learning. Students can switch learning methods anytime and anywhere, maintaining the continuity of learning process. Teachers can access to Open Educational Resources (OERs) of diverse ready-to-use content with lower cost, and develop curriculum contents and instructional activities with flexibility based on needs of students. For example, immersive online interaction classroom is a new internet-based classroom, as application of cloud computing technology, blended reality, voice interaction, voice recognition, video analysis, AI and other cutting-edge technologies.[14] It provides students a facilitating learning environment which are immersive, practical and interactive through applying virtual reality and creating scenarios of instructional content. This will improve the learning experience of teacher and student when remote interaction happens. It also features AI-assisted learning resources recommendation based on learning data analysis, to facilitate students' independent learning, personalized learning and mobile learning during instruction and realizes two-way flows of information exchange between teachers and students.

The development of intelligent technologies promotes the collaboration between AI teaching assistant systems and real teachers. AI teaching assistant systems can collect and analyze data on learning behaviors of student and generate feedback back to teachers, so that teachers are able to adjust instructional strategies in time and recommend suitable learning materials and learning paths for students. Table 4-3-1 presents an example of instructional delivery based on human-computer collaboration.

Table 4-3-1 An example of instructional delivery based on human-computer collaboration[15]

Stage	Characteristics of digital transformation	Instructional behavior	Teachers	AI teaching assistant systems
Pre-class	**Teachers:** lead instructional design, participate in analysis and decision-making, and design learning activities and resources. **AI teaching assistant systems:** visually present data for teachers based on valuable information facilitated by technologies, as reference and recommend tailored instructional contents and resources to learners.	Conduct graph-based learner analysis	●	○
		Conduct data-based learner analysis	●	○
		Design instructional activities	●	○
		Develop personalized instructional resources	●	○
		Deliver instructional resources and assignments	○	●
In-class	**Teachers:** act as main facilitator during instructional delivery and help students connect knowledge points to build a complete knowledge system, and impart skills. **AI teaching assistant systems:** assist teachers in presenting instructional contents vividly and collect students' dynamic data comprehensively; accurately identify learning gaps of students and put forward preliminary solutions; provide reference for instructional evaluation of teacher and guidance of personalized learning.	Impart knowledge, skills and values	●	○
		Present instructional contents vividly	○	●
		Monitor students' status dynamically	○	●
		Identify and address learning gaps	○	●
		Provide personalized learning guidance	●	○
		Conduct visualized instruction evaluation	○	●
		Create technology-powered scenarios	○	●
		Provide simulation experiments	○	●
		Conduct remote interactions across space	○	●
After-class	**Teachers:** design after-class learning services according to different learning levels of learners. **AI teaching assistant systems:** assist teachers in generating tailored assignments that can meet different needs of individual learners and recommend relevant resources to learners; assess homework for learners and generate a comprehensive analysis report.	After-class assignments and learning resources recommendation	○	●
		Review of assignments with the help of intelligent technology	○	●
		Intervene learning emotions and attitudes	●	○
		Provide guidance on social connection	●	○
		Monitor and improve physical health	○	●
Notes	"●" refers to a leading role, and "○" refers to an auxiliary role.			

4.4 Summary and Future Developments

This chapter discusses in the context of teaching and learning in digital transformation of higher education, how the key dimensions of teaching and learning expand in an all-round way. It includes how curriculum development is restructured, and how the instructional design and delivery transformed in a multifaceted way with reshaped instructional system, instructional contents, teaching scenarios and instructional methods. Although digital technologies are integrating into curriculum development and delivery in an increasingly diverse approach, while more and more HEIs launched institutional action plans on the digital transformation of teaching and learning.[16,17] However, there are still several issues to be further addressed:

Explore new structures and modes of instruction: As digital technologies are integrated into curriculum development and delivery, the scope of curriculum objectives, instruction activities, teachers, students, instructional environment and other dimensions and their relationships in teaching and learning have changed, which will lead to a series of new problems when they are reconstructed. For example, in a digital scene, how will the activities, processes and strategies of teaching and learning be adjusted? How can we realize better human-computer collaboration? What new modes of instruction have emerged with the development of technology, or what adjustments have been made to the existing modes? How can we help students realize knowledge integration and transfer and develop high-order thinking in the interconnected learning space? Given that, it is necessary to explore new structures and modes of instruction to adapt to the digital transformation of higher education teaching and learning.

Understand the complex patterns of digital teaching and learning and promote personalized learning: The rapid development of technology promotes the interactions between teaching and learning to turn from the simple model of "one-to-one" or "one-to-many" to the complex model of "many-to-many", which intensifies the uncertainty, and disorder of teaching and learning behaviors and make them more network-reliant and multi-layered.18 New patterns of teaching and learning need to be explored. For example, what patterns do differentiated teaching and personalized learning have in the process of digital transformation? How can we distinguish the cognitive characteristics and patterns of different students with the help of big data analysis? For different types of students, how can curriculum development and delivery support personalized learning? All these need to be further studied and discussed, so as to strengthen our understanding of teaching and learning patterns in the digital transformation and promote individualized instruction.

Identify value of digital technologies and analyze the relationships between human and technology in curriculum development and delivery. The widespread application of digital technologies in instruction may bring teachers into the dilemma between technology worship and technology fear. In the process of digital transformation of curriculum development and delivery, it is imperative to clarify the relationships between human and technology, guide stakeholders to correctly understand the value of technical tools, and enable teachers to develop an ownership over technology use according to instruction needs.

Curriculum development and delivery, as the foundation and carrier of instruction activities in higher education, are the core of digital transformation of teaching and learning. This Report suggests that relevant researchers and practitioners objectively recognize the positive role of digital technologies in improving curriculum development and delivery, work out systematic solutions to transform curriculum development and delivery with digital technologies, and test the solutions in practice, in an effort to realize the ultimate goal of "supporting the sustainable development of education with emerging technologies".[19,20]

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Chapter 5

Digital Transformation:

Teachers' Professional Competencies

Teachers are the drivers of teaching and the key to the digital transformation of higher education. This chapter clarifies what constitute teachers' digital competencies, and expounds the characteristics and strategies of development of teachers' digital competencies.

5.1 New Demands in Teachers' Digital Competencies

Higher education in the digital age has created new demands for teachers' competencies. New additions to teachers' competencies brought about by digital technology are reflected in four aspects: awareness, literacy, capacity and research of integrating digital technologies into teaching. The digital transformation of teaching and learning is a long-term process, and teachers' digital competencies follow a dynamic development process that comes in 3 stages: acquisition, deepening and creation (as shown in Figure 5-1-1).

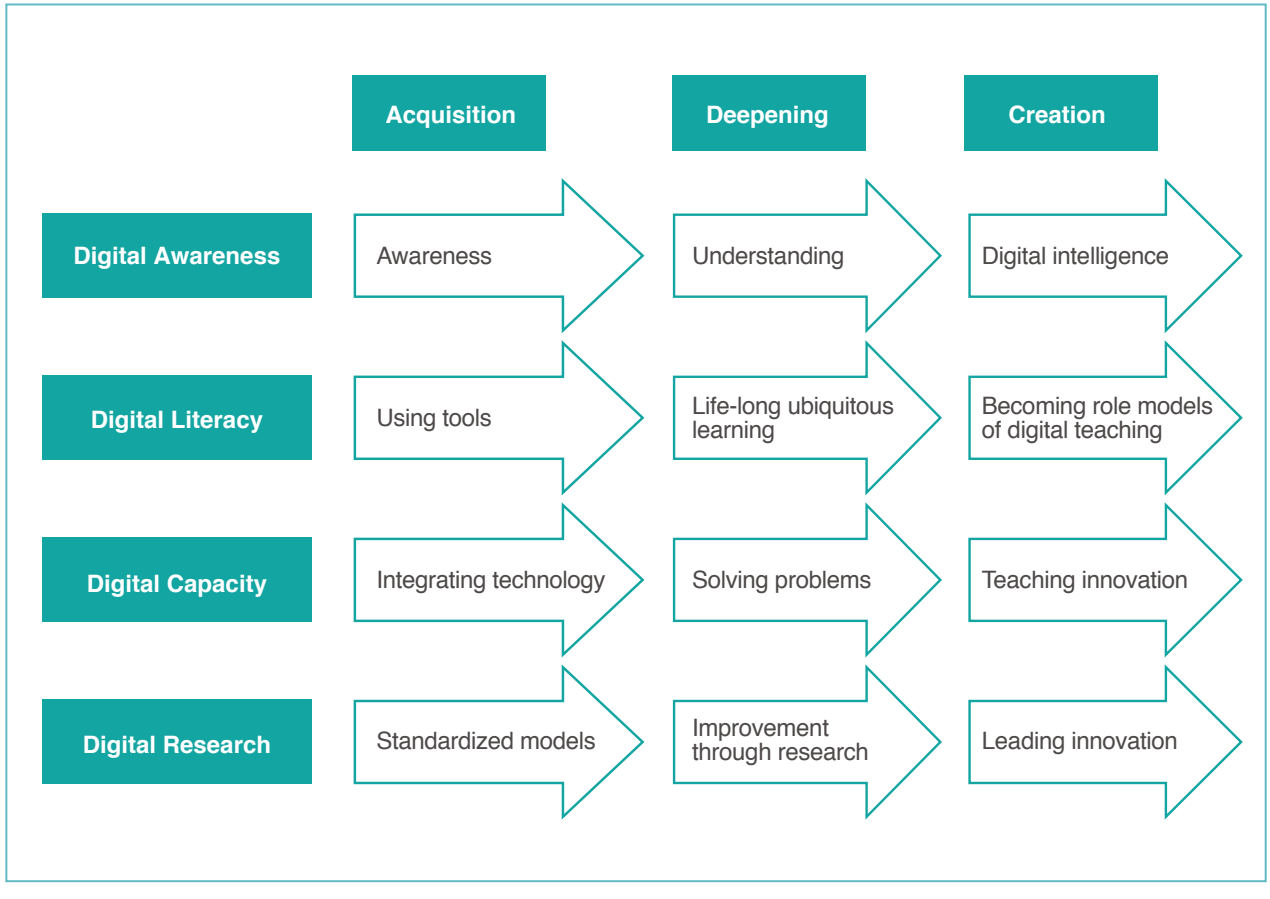

Figure 5-1-1 Framework of Teachers' Digital Competencies in Higher Education

Digital awareness transformation: from awareness to digital intelligence

Compared with traditional teaching, teachers in the digital age must have the awareness to incorporate digital technology to improve the quality of teaching. In the acquisition stage, teachers become aware of the importance of digital technology in teaching; in the deepening stage, teachers master relevant knowledge and methods of ICT-based teaching, and start to practice innovative teaching. In the innovation stage, teachers develop ideas and methods to innovate and update teaching models. These ideas and methods demonstrate how, in the digital age, people are able to apply technology to achieve competencies beyond their inherent potential, which involved digital intelligence.

Digital literacy transformation: from using tools to becoming role models of digital teaching

Digital literacy of teachers is a prerequisite for helping learners develop core competencies of the 21st century.1,2 In addition, teachers also need to have professional literacy to integrate digital technology into teaching.3 In the acquisition stage, teachers obtain a preliminary understanding of common digital technology tools (such as office software, online teaching platforms, visualization tools, popular social media apps, etc.). In the deepening stage, teachers use various open online courses, user-generated content from social media, etc. to carry out professional learning on smart devices, and develop the habit of lifelong learning. In the innovation stage, teachers develop the ability to flexibly apply various digital technology tools. Technology becomes "invisible" and teachers become role models for digital teaching and learning.

Digital capacity transformation: from integrating technology to teaching innovation

In the acquisition stage, teachers could master one way of integrating technology into curriculum as part of the digital teaching. In the deepening stage, teachers accurately diagnose problems in teaching, solve problems with the help of digital technology, so as to improve teaching continuously. In the innovation stage, teachers flexibly apply digital technology to innovate teaching models, and help students cultivate higher-order thinking skills, as well as the ability to explore, cooperate and independently construct their knowledge base.

Digital research transformation: from standardized models to leading innovation

In the acquisition stage, teachers learn to conduct research based on standardized models as a part of the teaching process, so as to diagnose problems in teaching and improve accordingly. In the deepening stage, teachers design suitable teaching methods based on characteristics of courses and instructional conditions, in order to continuously improve teaching models and methodologies. In the innovation stage, teachers explore teaching patterns through research, deeply reflect on teaching, innovate teaching models, and encourage other teachers to develop together through sharing and communication.

5.2 The Characteristics of Teachers' Digital Competency Development

The development of digital competencies of higher education teachers is a complex and systematic project, the influencing factors of which are not limited to the level of higher education in a country or a region, or the policies with regard to teacher competency development, but also the society's understanding and investment in the development of teacher competencies, as well as the organization and management model of a university or college. In addition, the role assigned to a teacher, their foundation of digital competencies and intrinsic motivation are also factors to consider. The development of digital competencies of higher education teachers has the following characteristics in the aspects of objective, actor, content, format and evaluation.

Differentiation of objectives: Objectives of developing digital competencies of teachers in higher education are getting increasingly stratified, which involves objectives on three levels - the government and society expect their talent training objectives to be achieved; universities wish to provide high-quality education; and teachers seek to fulfil their potential - all of which hinge on improving teachers' digital competencies. As a result, objectives of teachers' digital competency development are different across countries, regions, and different types of institutions (research-oriented universities, teaching-oriented universities, liberal arts colleges, etc.).

Coordination among actors: The main actors in the development of teachers' digital competencies include the civil society, government authorities in education, higher education institutions, and individual teachers. In order to achieve the objective of developing digital competencies, it is necessary for all actors involved to cooperate closely: the civil society, including foundations, academic societies, and private institutions provide funds, resources, and platforms, etc.; higher education institutions establish organizational and institutional structure, formulate rules and regulations, manage capital and human resources, and develop competency development programs to promote the development of digital competencies; teachers learn, practice, share and reflect with the support of other participants, to achieve improvement in their digital competencies.

Content standardization: The content of digital competency development for teachers in higher education should be determined in accordance with the regional, national, and university's standards framework for digital competencies. The framework is not only the basis for the development of competency, content and resources, but also the basis for assessing and certifying teachers' digital competencies. Based on the characteristics of the disciplines offered and the real needs of teachers, Yangzhou University has clarified the core elements of digital competencies that teachers need to improve upon, and established a practical plan for enhancing teachers' digital competencies, which was centered around the needs of the university, classroom teaching, and problem solving. The detailed plan can be found in **Case 8** of the Appendix *(China: Yangzhou University Teachers' Blended Teaching Ability Training).*

Diversity in formats: Teacher's Digital Competency Development can be delivered in various formats, such as consultation and coaching, courses and lectures, workshops, seminars, support services (resources and technical support), as well as incentives, evaluation and funding for teaching. The development of digital technology has also brought more innovations to competency development, such as personalized learning

and reflection for teachers based on online learning platforms; peer learning and evaluation based on online communication tools; digital resources for competency development; scientific management and decision-making of competency development based on education data mining; teaching-research cooperation between teachers and experts based in learning community, etc.. For example, Pontificia University Católica del Perú (PUCP) has taken a series of measures to train teachers, in particular by encouraging teachers' online self-learning, which brought about great results. For more information, please refer to **Case 9** in the Appendix *(Peru: Design and Implementation Process of Online Teaching and Learning to Ensure Continuity and University Education Quality).*

Comprehensive Evaluation: Teacher's Digital Competency Development requires well-rounded effect analysis based on various review methods such as external, internal, peer, and self-review, covering a variety of aspects, such as response evaluation, learning evaluation, behavior evaluation, and achievement evaluation.[4] Learning analysis based on big data plays an important role in evaluating teacher's digital competency development.

5.3 The Strategies for Teachers' Digital Competency Development

Guiding policies of government departments

Education authorities in some countries have issued policies to guide the enhancement of teachers' digital competencies teachers in higher education. In 2016, the Ministry of Education of China issued the Education Informatization "13th Five-Year Plan", which included establishing and improving standards for teachers' digital competencies, incorporating digital competency training in the curriculum of teacher education, and including digital competency in the education quality evaluation of higher education institutions, primary and secondary schools, as well as performance review of principals.[5] The Tanzanian government released the Education and Training Policy of 2014, which aimed to cultivate skilled talents capable of advancing and contributing to the country's development goals. The country then established ICT Competency Standards for Teachers in Tanzania, which was based on the UNESCO ICT Competency Framework for Teachers) (UNESCO ICT-CFT) and consisted of six modules, namely understanding ICT in the classroom, curriculum and assessment, pedagogy, ICT, organization and administration, and teachers professional development.[6]

Collaboration among social organizations

Social organizations include foundations, academic societies, associations, and private institutions which provide teaching competency certification and various resources for teachers' competency development, and implement competency development projects.

Enhancing teachers' digital competencies based on micro-credentials: Digital competency certification is a means of evaluating teaching competency. The methods and formats for certifying teachers' digital competencies are getting increasingly modular and open. Launched by Digital Promise in 2014, Micro-credentialing serve as an innovative certification system for teachers. The system provides teachers with the opportunity to obtain micro-credentials, allowing them to be recognized for competencies obtained at any time. As an emerging teacher professional development strategy, micro-credentialling for teachers help the education system to continuously identify, capture and share the best practices of American teachers, allowing all teachers to identify and learn new skills and improve their competencies. The system evaluates teachers based on their practical performance and certifies teachers' competencies, regardless of when and where they acquired these competencies, through formal or informal learning.[7] Quality Matter (QM), an online education quality assurance institution, was established to promote and improve the quality of global online education and learning. For willing participants, QM organizes a series of flexible workshops on online teaching competencies, and issue QM Teaching Online Certificates to participating teachers. This digital certificate proves that the recipient has acquired seven competencies related to online teaching.[8]

Enhancing teachers' digital competencies based on cross-regional exchange platforms: In terms of international exchange platforms, the Chinese government collaborated with UNESCO in 2012 to establish the UNESCO-China Funds-in-Trust Project (CFIT) dedicated to African education development and committed to "enhancing teacher education for bridging the education quality gap in Africa".[9] In terms of cross-regional exchange platforms, the Professional and Organizational Development (POD) Network in Higher Education was established in the United States in 1974, with members including teachers, teacher development specialists, graduate students, and university administrators. The institution provides services for teachers across the region to publish articles, organize conferences, provide consulting, and organize awards.[10] In terms of cross-university exchange platforms, founded by the Institute of Education of Tsinghua University in 2002, the "Tsinghua Education Information Forum" continues to focus on key issues of improving teachers' digital competencies, with nearly 10,000 participants attending its sessions, including ICT in Education experts, as well as directors, managers and research personnel and faculty from colleges and universities.[11]

Project-based teachers' digital competency development: Digital competency development projects are aimed at two groups of teachers: pre-service teachers and in-service teachers. For example, the " Preparing Future Faculty Program", is intended for pre-service teachers and aims to provide education for doctoral and graduate students who are interested in teaching in higher education, so that they acquire the competencies for their teaching careers in colleges and universities. This method connects the training of pre-service university teachers with their doctoral/postgraduate training system, and effectively supports the improvement of their digital competencies. The project provided a great model and has led to a wave of training graduate students to become future teachers in American colleges and universities. On the other hand, an example of in-service teachers' digital competency development is the National Teaching Innovation Contests for College Teachers in China. Sponsored by the China Association of Higher Education, the competition aims to inspire college and university teachers to devote themselves to teaching, so as to instill in them a passion for the pursuit of teaching excellence. In 2021, around 300 teachers from 31 regions in China participated in the competition, showcasing a total of 199 courses and demonstrating advanced teaching concepts, and achievements in teaching reforms and innovation.

Training and development led by higher education institutions (HEIs)

Higher education institutions provide institutional and policy support for improving teachers' digital competencies.

Organizations dedicated to developing teachers' digital competencies: Many higher education institutions have established Centers for Faculty Development or Centers for Teaching and Learning, with the goal of improving teaching competencies and fostering the awareness of lifelong learning in the digital age. These faculty development centers play a significant role in promoting online training, blended training, and the practice of combining virtual learning and real-life teaching practice. Faculty development centers are conducive to integrating the resources of the entire institution, promoting resource sharing among different regions and institutions, and forming an open and borderless community for professional development and interaction. For example, Harvard University has established the Derek Bok Center for Teaching and Learning, which offers teachers with workshops and seminars on the application of technological innovation and how the internet transforms teaching; it also provides individual coaching based on classroom observation, shares success cases and effective methods, organizes Freshmen Seminar Round Tables on Teaching, and provides curriculum design support for foundational courses with the help of the Instructional Services Support Team (ISST).[12]

Policies and systems for developing teachers' digital competencies: Many colleges and universities provide support for the improvement of teachers' digital competencies on policy and system levels, such as establishing a professional development system or a workshop consultation system, etc. Institution-level policies and systems are generally detailed and specific plans based on national or regional policies on developing teachers' digital competencies, as well as the specific contexts of the college or university. Their systems include formulating a framework for digital competencies, issuing rules on how to manage and use certificates of digital competencies, and introducing incentive policies, etc.[13]

Teachers' self-directed learning and self-empowerment

In the digital age, teachers learn independently with Open Educational Resources (OER), share ideas and reflect on teaching practices in online communities and learning communities, and develop personalized competencies based on adaptive learning systems. Teachers may utilize all of these tools to independently improve their digital competencies.

Self-directed learning based on open educational resources: refers to teachers setting and planning learning tasks independently, formulating learning goals, selecting and using appropriate learning resources, and monitoring and reflecting on their learning process. Teachers monitor, review and regulate their own learning progress and learning methods in-session, and examine, summarize, evaluate and remedy their learning outcomes post-session.

Sharing ideas and reflecting on teaching practice in online communities and learning communities: involves using digital technology to remove the barrier of time and space, enhancing teachers' sense of belonging and improving professional growth model, one that should be based on real practice and solving practical problems through coaching; and advocating collaborative communication and interaction to achieve shared progress among teachers. The ultimate goal is to improve or build new skills and enhance teaching performance. In this process, teachers, as adult learners, together with their peers, observe and analyze other participants' digital teaching experience and compare that against their own to identify problems and deficiencies, which allow them to spot new learning opportunities. Through sharing experience and collaborating with one another, teachers refine old skills, learn new skills, and solve problems in teaching.

Personalized teaching competency development based on adaptive learning systems: artificial intelligence and data mining technology provide technical support for personalized development of teachers' digital competencies. Adaptive learning systems not only provide digital learning resources for competency development; their learning analysis functions also analyze teachers' prior knowledge, cognitive preferences, learning styles and self-regulation ability according to their learning trajectories. Based on these data, systems model effective strategies for teachers to better conduct personalized learning.

5.4 Summary and Future Developments

Digital technology requires teachers to be competent in new areas, which can be broken down into four categories: awareness, literacy, capacity and research of integrating digital technology into teaching. In addition, teachers develop their digital competencies dynamically in three stages: acquisition, deepening and creation. The development of digital competencies of teachers in higher education presents characteristics of objective differentiation, multi-party collaboration, standardized content, diversity in formats and comprehensive evaluation. Strategies for developing teachers' digital competencies include policies at the government level, multi-party collaboration at the civil society level, training and development at the higher education institution level, and self-directed learning at the teachers' level.

The ways forward of digital competencies of teachers in higher education and their improvement will focus on the in-depth application of artificial intelligence, research on digital competencies in the context of human-computer collaboration and competency development models based on artificial intelligence.

Teachers' digital competencies in the context of human-computer collaboration: The rapid development of artificial intelligence poses challenges to teachers' career prospects. The repetitive, monotonous and routine teaching work represented by knowledge transfer may be replaced by smart teaching systems. Teachers will focus on inspiring, creative and emotional teaching work, and human-computer collaborative teaching will become at trend. The construction and development of teachers' digital competency standards in the context of human-computer collaboration will become a subject of research and exploration.

Teachers' digital competencies based on artificial intelligence: In the future, AI teachers and human teachers will augment and shape each other and evolve together. AI teachers enhance human teaching, and human teachers provide enriching education wisdom to AI teachers. The two evolve and develop while empowering each other. The teacher development model based on artificial intelligence will also become a new research topic.

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Chapter 6
Digital Transformation:
Learners and Their Learning

The ultimate goal of the digital transformation of higher education teaching is to help students master learning and development in the digital age. Professional talents trained at scale in the industrial age have been unable to meet the needs of the digital age, and the goal of higher education has gradually shifted to cultivating multi-disciplinary talents. Multi-disciplinary talents should be equipped with comprehensive qualities including cross-disciplinary values, essential attributes and key competencies.[1] Digital literacy is not only an important part of comprehensive qualities, but also an important pathway for learners to acquire professional knowledge and professional competence in the digital age. At the same time, students' learning and cognitive styles are undergoing fundamental changes. Ubiquitous learning has gradually become the new normal of learning, and human-computer collaboration has gradually become the main cognitive style of learners. The changes in learners' development goals, learning styles and cognitive styles have brought great challenges to traditional learning based on fixed spaces and static resources. This chapter first clarifies the content and key elements of learners' digital literacy, then explains the changes in their learning and cognitive styles in the digital age, and finally, conditions needed to support the development of digital literacy and the transformation of learning and cognitive styles.

6.1 Developing Digital Competence of Learners

Driven by the advent of globalization and new technologies, socio-economic development is undergoing profound changes. Living in the complex and ever-changing digital age, learners are faced with new challenges in all aspects, whether they are citizens of the digital age, or students in higher education institutions and future employees of the job market. As citizens of the digital age, learners face challenges of information overload and information leakage; as college and university students, learners face challenges brought about by the new paradigm of "digital transformation of higher education teaching and learning"; as future employees of the job market, learners face the challenges of lifelong learning brought about by the ever-changing job market. All three challenges require learners to develop comprehensive qualities in the digital age, including cross-disciplinary values, essential attributes, and key competencies to meet the needs of future development, among which digital literacy is becoming increasingly important as the basis for achieving Goal 4 of the United Nations Sustainable Development Goals (SDG 4).[2]

Digital literacy is the ability to safely and appropriately acquire, manage, understand, integrate, communicate, evaluate and create information through digital technologies to promote employment, decent work and entrepreneurship, including the ability to apply digital technologies, information and data literacy, the ability to communicate and collaborate with digital technologies, the ability to create digital content, awareness of digital safety and digital ethics, continuous learning, problem solving, reflection and self-improvement through digital technologies, and digital expertise and competence.[3] Among them, digital technology application ability, information and data literacy, digital expertise and competence are the essential components of digital literacy, serving as an important foundation for forming digital security awareness and digital ethics.

Digital technology application ability

Digital technology application ability refers to operating general digital equipment and software proficiently, understanding the foundation of digital technology[4], learning to operate general hardware and software[5], understanding emerging technologies such as AI[6], as well as having design and programming capabilities. The ability to apply digital technology is the basis for learners to use digital technology for communication and collaboration, continuous learning, problem solving, reflection and self-improvement.

Information and data literacy

Information and data literacy focuses on identification, retrieval, storage of digital information, as well as acquisition, analysis, interpretation, evaluation, and application of data.7 In an era where digital content is deeply integrated into lives, work and studies, learners should be able to use data-based information to make rational decisions. This requires students to have the ability to browse, search and filter data information, master the methods of evaluating and managing data, explore emerging data products and their applications, and solve problems innovatively based on data. [8]

Digital expertise and competence

With the continuous expansion of the digital industry and the digital transformation of traditional industries, skills required for various occupations are no longer limited to professional knowledge and competencies, but also knowledge and competence of using digital technology to work efficiently. As a result, learners need to develop occupation-based expertise and competence with digital literacy, that is, digital expertise and competence. This requires learners to understand the core digital technology required for a specific occupation, use digital technology to complete tasks of a specific role, interpret and evaluate digital information and data in their specific field, and use digital technology to communicate, collaborate, solve problems and complete work-related tasks.[9]

6.2 Towards a New Normal of Ubiquitous Learning

With the support of technologies such as the Internet, AI and 5G, learning approaches are exhibiting increasingly ubiquitous characteristics: "at all times, in all things, for all people, in all places". Ubiquitous learning has been embedded in everyday learning, life and work, breaking the boundaries between formal and informal learning, school-based learning and lifelong learning.[10]

Ubiquitous learning can be understood and defined from a broad perspective and a narrow perspective respectively. In the broad sense, ubiquitous learning takes place anywhere, anytime, which means as long as learners are willing, they have timely access to information and resources by choosing the right tools and environments.[11] In the narrow sense, ubiquitous learning implies that with the support of ubiquitous technology and ubiquitous computing, learners actively use readily available resources to carry out various learning activities according to their learning and cognitive goals.[12]

Ubiquitous learning has five main characteristics: ubiquity, accessibility, interactivity, situational learning environment and personalization.13 See Table 6-2-1 for details.

Table 6-2-1 Characteristics of Ubiquitous Learning

Characteristics	Definition
Ubiquity	Learning takes place everywhere, the need for learning and learning services are everywhere. Learners can access a variety of embedded and non-embedded ubiquitous learning support based on their needs anytime, anywhere, continuously and seamlessly.
Accessibility	Openness, compatibility, diversity, and efficient communication of the learning environment makes learning tools and methods easily accessible to learners.
Interactivity	Learners can collaborate and share ideas synchronously or asynchronously with experts, teachers or learning partners at any time through various terminal devices, and directly obtain information from the ubiquitous environment anytime, anywhere.
Situational learning environment	Rather than placing people in the world of computers, computers are integrated into everyday life. The learning process is seamless, meaning learners are not even aware of the existence of the learning environment.
Personalization	Learning resources are sorted and classified according to the needs of learners, while relevant learning resources are recommended according to the learners' personal learning preferences, cognitive levels, etc.

6.3 Human-Computer Collaboration as a New Cognitive Approach for Students

With the full-scale popularization of AI technology, humans are increasingly using smart machines to understand and transform the world. Born in the new century, the new generation of college students are the natives of the digital age. They grew up with mobile devices at their fingertips and the convenience and speed of the Internet, and naturally have adapted to technology and its rules in the process of adapting to the digital environment. In the process of adaptation, they have formed a "human-computer augmentation" cognition mode based on technology, which is mainly reflected in the transformation from individual cognition to primary and secondary cognition, distributed cognition and embodied cognition.

From individual cognition to primary and secondary cognition

Primary and secondary cognition is a new dual cognition mode, mainly based on human brain cognition and supplemented by the "external brain"consisted of modern digital technology. As a method, the primary and secondary cognition affects the way people understand things, and it expands the independent individual cognition to the " human + technology "cognition. As a cognitive perspective, the primary and secondary cognition is based on the human perspective and supplemented by the perspective of technological cognition, which is conducive to broadening people's understanding of the world.[14]

The primary and secondary cognition not only fully mobilizes human initiative, but also takes full advantage of support from modern digital technology that helps humans to understand and transform the world, thereby greatly improving limited human cognition. Rooted in the digital age, primary and secondary cognition emphasizes the supporting role modern digital technology plays for human cognition, and focuses on the coordination among humans, technology and technological products, that is, how humans use technology to assist their own cognition and how to adjust accordingly.

From individual cognition to distributed cognition

Distributed cognition is a new fundamental paradigm for rethinking the phenomenon of cognition in all domains, based on the argument that the nature of cognition is distributed. Distributed cognition goes beyond the traditional perspective that cognition is an information processing process at the individual level; rather, cognition is not limited to the cognitive activities happening in an individual's mind, but includes the process of conducting activities through interaction between human and technological tools. Cognition is distributed among medium, environments, individuals, and is situated in a more complex system composed of multiple individuals, tools and environments.[15]

Distributed cognition is an important cognitive approach for humans to adapt to the complexity of the digital age. The collaborative thinking of people and smart devices enable people nowadays to deal with increasingly complex problems and ever-multiplying knowledge.[16] To understand how learners learn with a cognitive process distributed in a complex system, George Siemens and Stephen Downes developed the Connectivism Learning Theory. According to the theory, learning itself is a complex system; and "existence" is both an entirety and distributed, and knowledge exists in various connections. Therefore, learning is establishing connections and forming networks, including neural networks, conceptual networks and social networks.[17] The goal of learning is to grow knowledge based on creation, that is, to circulate knowledge.[18]

From individual cognition to embodied cognition

According to the definition of **embodied cognition,** when an individual moves in the environment, their actions affect perceptions, while perceptions affect future actions, which then determine new perceptions, so on and so forth, forming a " perception-action cycle"[19]. In a learning space, learners seek solutions to problems by integrating multiple methods including sensory experience, action experience, cooperation and communication, recap and reflection, so that learning becomes a process of continuous interaction among body, mind and environment,[20] namely, integrated participation of "cognition-body-space".

Technology is ubiquitous in our life, especially technology related to instructional media and tools as they play an increasingly important role in everyday teaching and learning. Embodied cognition theory values the body and its experience, and the "expansion" of the body and its experience through technology allows us to gain more perceptual experience, and refine, generalize and consolidate experience.[21] Embodied online learning spaces provide learners with rich learning resources, offer open-ended problem situations, create a positive and interactive communication atmosphere, and use accessible tools to support and guide learners to reflect on problems from different perspectives, which promote learner participation on a behavioral, cognitive and emotional level that improves learning engagement and quality.[22]

6.4 Supporting the Digital Transformation of Student Learning

In order to support the development of students' digital literacy and the transformation of learning methods, the following conditions need to be provided: digital and adaptive learning scenarios, diverse and smart Open Educational Resources (OER), open and social learning communities and personalized and precise learning support services, etc.

Creating digital and adaptive learning scenarios

A digital learning environment that combines online and offline learning. With the development of technologies such as computers, mobile networks, and sensors, various learning terminals including smartphones, tablets, and laptops became available. In the digital learning environment, learning terminals are responsible for communicating with the cloud computing center, retrieving various learning services required by its user, connecting with the cloud to transmit information, receive response data, and adaptively present learning resources. Learning terminals are tools for learning and interaction. Currently, mobile terminals are able to sense the learner's environmental information, biometrics, basic information of real-life objects, etc., so as to meet the learner's learning needs and provide the learner with seamless learning opportunities.

In the meantime, the widespread popularization of technologies such as artificial intelligence and the Internet of Things has promoted the emergence of online + offline integrated learning spaces. The online + offline environment is an innovative learning space that uses sensors to detect and capture objective information related to learning activities in the offline environment, and integrates in-classroom and on-the-job learning environment with the virtual learning space based on the internet and multimedia.[23] In the case of Cadi Ayyad University in Morocco, during Covid-19 lockdowns, the university utilized smart digital platforms to support students, allowing them to conduct practical work remotely anytime and anywhere, please see **Case 10** *(Morocco: The Role of Smart Digital Platforms in Supporting Remote Practical Works in the Light of the Spread of the COVID-19 Crisis)* in the appendix for details.

Personalized learning service recommendation based on context awareness. As emerging technologies, such as artificial intelligence, big data and cloud computing, are being employed by the education sector, traditional learning scenarios are constantly being reconstructed, people and equipment are getting highly integrated, and the hidden features of diverse, dynamic and fragmented scenarios are being detected and understood by Internet devices.[24] By exploring new personalized learning service models based on scenarios, personalized and precise learning service needs will be met in the digital learning environment.[25] Scenario-based learning analysis integrates learners' social relationships, emotional status, and learning scenario information (such as time, device, space, events, etc.) to gain a full picture of how they learn, which is conducive to uncovering their potential learning needs. Generally speaking, the elements of learning scenarios are categorized as follows: subjects (learners), time, space, device (technology) and event (behavior). Notably, the personality characteristics of learners are not limited to intellectual factors, but also non-intellectual dimensions, such as learning style, interest and preference, social network, emotional status, etc.[26] Analyzing the evolution framework of online learning service recommendation illuminates real learning needs, which contributes to effective and quality recommendations of learning services , and helps learners take control over their learning and become more efficient in their learning.

Providing Diversified and Smart Open Educational Resources

Open educational resources are “teaching, learning and research materials in any medium that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions”.[27] In addition to a wealth of educational resources, OER also include resources such as context, tools, and frameworks, which not only provide content for learners' digital learning, but also environmental support for learners to conduct autonomous and lifelong learning.[28] OER have played an important role in promoting educational equity, co-constructing and sharing of resources, and reforming higher education. For example, eight universities in Zhejiang Province, China have jointly formed a digital teaching community for liberal arts education in colleges and universities. Colleges and universities in the community contributed and integrated quality educational resources to improve the quality of education for innovation-oriented talents.

Currently, with the development of emerging digital technologies represented by 5G and artificial intelligence, the functions of OER are becoming increasingly diversified, innovative and smart. Diversity and innovation are mainly manifested in the continuous expansion of learning and service space, and improvement in the depth and breadth of openness; education development is also empowered to produce, disseminate and apply knowledge and information. The smart attribute of digital OER is reflected in the ever-growing of its content, including the technology, knowledge, experience, learning ability and creativity of teachers and scientific researchers, etc., as well as the values, sensing and perceiving skills, interpersonal coordination, emotional control, responsibility, and loyalty that are part of individual emotional intelligence.

Building an Open and Social Learning Community

The digital age is also an age of network, where learning involves more than learners themselves, but also the connection between people. A learning community is consisted of learners, facilitators and other people who have a sense of belonging to a team and share common aspirations and extensive communication opportunities. It is a learning team where people share goals and ideas, have discussions, enjoy activities and inspire one another to learn.[29] New technologies and media provide new foundations and conditions for building learning communities, allowing them to become more open and social.

The construction of an open learning community includes the following aspects: the openness of learners, resources and learning methods. First of all, not all learners of the learning community are students; they can be people from different age groups, regions and occupations because they can use readily available mobile devices to learn anytime, anywhere. Secondly, when fostering openness of a learning community, various learning resources are integrated to allow learning based on fragmented time, further promoting openness and sharing of high-quality learning resources. Strengthening the openness, personalization and interaction, as a part of community building, provides learners with a more open and freer learning space, where they can customize personalized learning plans according to their own needs. Finally, the learning model has changed from the traditionally “teaching-based” model to open blended learning, as building a learning community changed the closed-off structure of an individual school. In such a learning community, learners are provided with an open learning method, granting them easy access to various resources that they need on various platforms.

The social aspects of a ubiquitous learning community are manifested in two main aspects, the formation of social cognitive network, and the popularity of various social media apps. Ubiquitous learning community, with its openness towards audience and resources, helps learners to form their individual cognitive network and social cognitive network. In the process of human-human interaction and human-computer interaction, a network is formed, where knowledge and learners impact each other and are intertwined. The essence of social media apps is participation and sharing, whose purpose is to make every member's voice heard within a group. Therefore, social media apps play a positive role in expanding interpersonal communication in the physical world. As social media apps become more and more popular, their role in ubiquitous learning communities is also expanding.

Providing Personalized and Precise Learning Support Services

Learning support services are the key to the success of digital learning[30]. Based on advanced educational concepts and technological advantages, they provide learners with diversified, personalized and precise learning support services. More and more colleges and universities are using digital means to guide learning and monitor its progress and outcome. Learning support services and their alarm and assistance systems for learners are becoming more complete and even smarter. These services provide learners with timely answers to their questions and precise profiling, which help them to complete their studies and achieve personal growth. Smart technology will expand the application scenarios of learning support services, and " virtual teaching assistants" facilitate online real-time tutoring and speeds up communication. Virtual teaching assistants could substitute teachers to offer simple Q&A, including explaining course basics, online supervision and other consultations. To a certain extent, they alleviate issues caused by a low teacher-learner ratio, as teachers are not able to reply to every question in real-time. In addition, they supervise learning and improve learners' discipline.[31]

The personalization characteristics of learner-oriented learning support services are becoming more pronounced, which helps to better clarify personalized learning pathways and identify learning difficulties. Personalized learning support services can provide learners with personalized guidance and precise solutions to their learning difficulties, and improve learning quality based on individual progress and needs. For example, FutureLearn, a UK-based platform, in its decade-long operation, (http://www.futurelearn.com/courses) has taught more than 1 million learners all around the world, during which they collected millions of data points in terms of content relevance and practicality, and used these data points to identify what learners want to learn.

6.5 Summary and Future Developments

Industrial digital transformation highlights the importance of digital literacy in learners' development goals, while the evolution of various emerging technologies has reconstructed their learning and cognitive styles. In order to cope with the challenges brought about by the changes in learners' development goals, learning methods and cognitive styles in the digital age, learning support conditions such as scenarios, resources, communities and support services also need to be transformed accordingly. It is necessary to create digital and adaptive learning scenarios, provide diversified and smart open educational resources, build an open and social learning community, and provide personalized and precise learning support services to meet the learning needs of the digital age.

People are exploring complex learning practices in the digital age, and are increasingly aware of the limitations of current learning patterns and theories in supporting complex learning practices in the digital age. A lot of topics require further research and exploration, including patterns and characteristics of learning in the digital age, how to design more effective learning support conditions, and the effects of various learning support conditions on learning.

Explore complex patterns of learning in the digital age. The emergence of various emerging technologies in the digital age has reshaped the coverage, characteristics, medium, and production and dissemination methods of knowledge,[32] increasing categories and expanse of knowledge. New knowledge covers massive network information, dynamic subjective knowledge, domain operation knowledge and comprehensive fragmented knowledge.[33] Previous learning theories are increasingly limited in supporting the development of complex learning practices in the digital age, and learning patterns still require further exploration, mainly including:

The relationship between individual learning and knowledge evolution: What are the roles in knowledge evolution? What roles do learners play in the evolution of knowledge? How does knowledge evolution affect individual learning?

Cognitive characteristics and growth patterns of various types of learners: What types of learners are there in the digital age? What are their respective cognitive characteristics? How has their growth been affected by technological developments?

Focus on the interaction of individual learning and group learning. With the rapid development of AI-related technologies, humans will enter a digital age in which people and people, people and things, and things and things are deeply integrated, and the constituent units of learning organizations will no longer be individual learners, but group learners.[34] The Internet has expanded the ability and scope of individual connection, and learners can connect with individuals around the globe anytime, anywhere. In this context, the Connectivism Learning Theory came into being, which equates learning with establishing connections with valuable people and information, and believes education is building a learning community that is conducive to extensive and effective communication among individuals.[35] More research is required in the following areas:

The relationship between individual learning and group learning: What is the position of the individual in a network structure formed by a group? What is the role of individual learning and group learning, respectively?

The interaction mechanism between individual learning and group learning: How do individual learning and group learning interact and evolve together?

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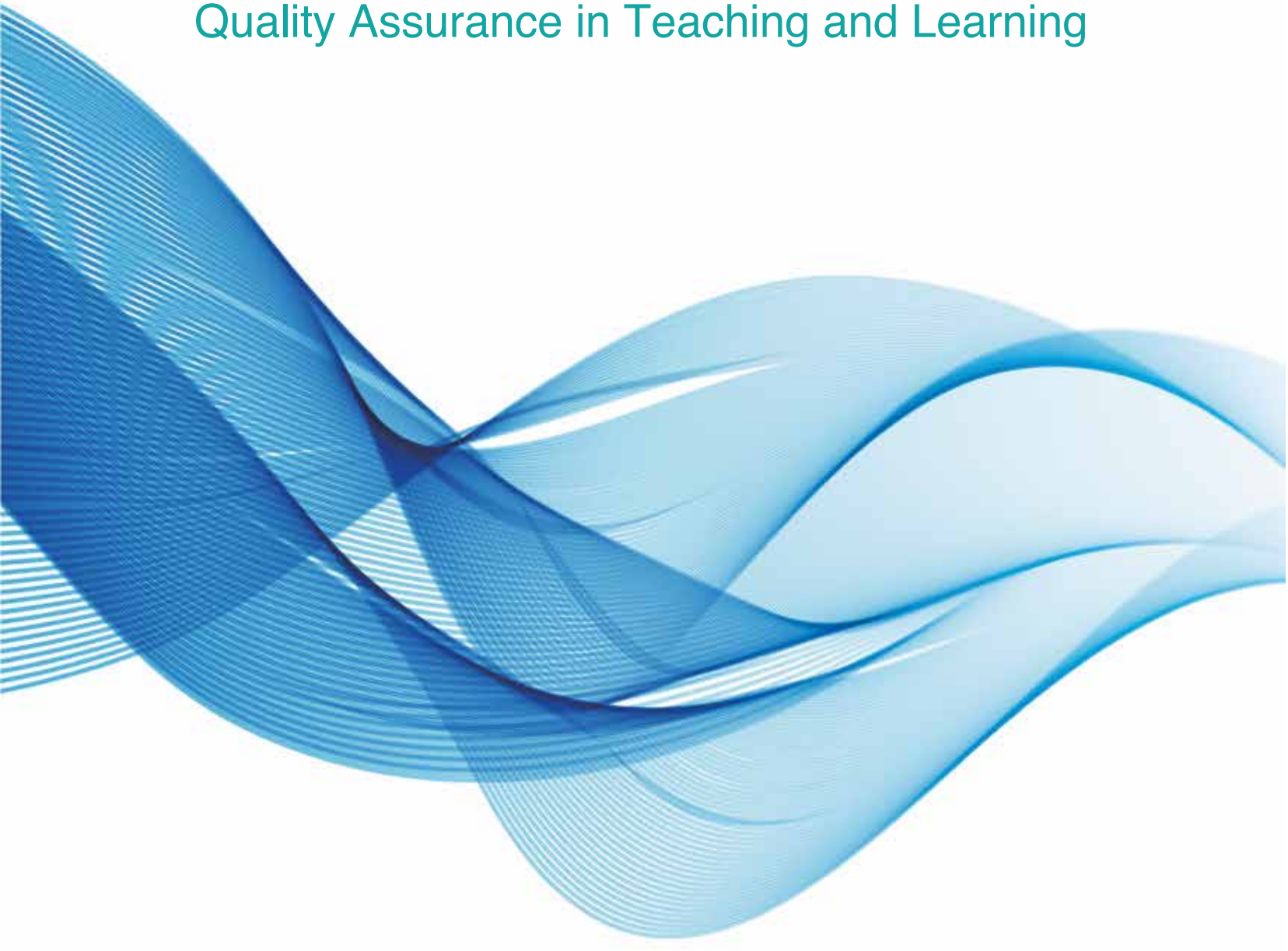
Chapter 7

Digital Transformation:

Quality Assurance in Teaching and Learning



The quality of teaching and learning is essential to the very survival and development of higher education. Quality assurance (QA) in teaching and learning is the sum of a set of measures—from monitoring, diagnosis, feedback to improvement—designed to supervise and improve the teaching and learning quality.1,2 QA in higher education evaluates student learning, teaching implementation, teaching resources, instructional environment and support services against the established QA standards. It also dynamically adjusts the various QA goals, standards and implementation actions in light of the societal needs. The intention is to guarantee higher education quality in a systematic, all-rounded and multi-dimensional manner and to accomplish the talent training objectives. Given the digital era comes with new requirements for talent training, students' learning methods, teachers' professional competencies, courses and delivery are all bound to undergo changes. Thus, the teaching and learning QA system must also adapt to the ongoing trend, rolling out digital transformation of key links and core businesses. In this chapter, we will elaborate on the characteristics of the digital transformation of QA in teaching and learning and present a major implementation measure, the digital transformation of teaching assessment.

7.1 The Characteristics of the Digital Transformation of Quality Assurance in Teaching and Learning

The digital era has brought about changes in QA goals and standards for education and the teaching quality assessment. Thus, the digital transformation of QA in teaching and learning takes on new characteristics.

Goals—from a single set to more variety: The digital era needs talents with a more diversified set of capabilities. This induces the move away from the previous uniform QA goals in education to multi-level and diversified goals, as well as a focus shift from students' knowledge acquisition to well-rounded development, especially capacity building and values nurturing.

Functions—from rating to early warning: The traditional approach to QA in education is evaluating the teaching delivery and learning performance, and then adjusting and optimizing the follow-up QA actions. Empowered by big data and AI predicting technologies, QA in education is now able to collect and analyze student learning, teaching delivery, course implementation and other live data. Those, in turn, make it possible to present in time how the teaching and learning are going and predict where the whole process is trending. Hence, an early-warning function.

Objects—from scattered to integrated: Following the digital transformation, the QA objects in teaching and learning change from structured data analytics of single information systems to unstructured data comprehensive analytics across information systems and businesses. Within the original QA system, information is scattered, links have no substantial connection, and different departments focus on their own fields. By contrast, a digitally transformed QA system is free of such challenges, as it integrates all QA objects in a systematic manner.

Coverage of standards—from phased and singled-faceted to full-process and all-sided: As quality goals take on more dimensions and measuring & statistics are digitalized, the standards for QA in teaching and learning have moved away from targeting only some instructional stages and certain aspects of instructional objectives, to covering the whole process of education and all dimensions of instructional objectives.

Teaching quality assessment—from periodic to normalized, and from sampling to total-size: By the traditional approach to QA in education, only students, teachers, courses, and academic programs sampled from the total are subject to assessment, usually on a semester basis. This leads to poor assessment feedback time efficiency and assessment result accuracy, hence an inadequate impact on teaching. By contrast, the data-driven intelligent teaching assessment improves the time efficiencies of measuring, assessment and feedback, which makes normalized and full-size quality assessment possible.

Teaching quality assessment flow—from closed to open: In the old assessment process, data moved among different assessors, at a high cost yet low efficiency and with poor transparency. In the digital era, the data sharing concept and the support of digital technologies have made it possible to bring in more objects and stakeholders. Different stakeholders can assess using the same database. This also helps smooth out the cooperation and interaction flow both within the university and between university departments and external agencies, as well as makes the assessment process more transparent, more wide-engaging and opener.

7.2 Transformation of Teaching Quality Assurance Implementation

Teaching quality assessment is an important measure for teaching QA implementation and an essential part of the education QA system.[3,4] In the digital age, transforming QA of teaching and learning in higher education is largely about transforming teaching quality assessment; specifically, teaching quality assessment is supposed to highlight the development aspect of functions, underscore diversity and inclusiveness in object and content selection, engage more stakeholders, adopt a data-driven and intelligent computing based methodology, and let the assessment results and findings feedback to teaching.

Functions of teaching quality assessment shift from screening-focused to development-centered

Teaching quality assessment, done in the traditional way, is separate from teaching activities and has a time lag; gaining teaching process data (as it happens) is impossible. Such assessment can hardly provide timely, valuable information for teaching activity improvements.[5] The old approach is functionally oriented towards appraisal and screening, aims at inspecting the learning outcomes of students by stages and conducting quality of teaching and learning inspection in the form of summative assessment. The result is unlikely to truly reflect the classroom teaching quality, nor is it conducive to giving play to the role of assessment feedback in improving students' learning. Such methodology can hardly produce the developmental benefits for teachers' and students' growth that assessment results should have.[6]

The development of digital technologies like big data, AI, mobile communication, and cloud computation has fueled the explosive growth of educational data. A large amount of high-dimensional and unstructured data is constantly generated and stored at relatively low costs. These developments make it possible to collect the behavioral information of teachers and students throughout the teaching process and to capture and mine the huge amount of live data from the teaching activities. This further enables a precise reflection of learning statuses of individual students and groups as well as the exploration of heterogeneity and common features of different groups.[7] The digitally-enabled teaching quality assessment turns into an intelligent dynamic information feedback system, which can monitor teaching activities in action, continuously collect and process information related to teaching, and timely feed the assessment results back to stakeholders:

Students can have a clearer grasp of their learning progress to recognize their current position, challenges they face and focus areas for future study based on the visualized feedback information.

Informed by the teaching information analytic results, teachers can more efficiently understand students' learning conditions (both individually and as a group); make timely adjustments to teaching activities, teaching strategies and the rhythm of teaching implementation; and provide targeted guidance for students. They can also find the basis on which they can improve their courses by consulting the live information on the course implementation plus the participation experience and knowledge contributions from students.

Proceeding from the teaching assessment data, education administrators are enabled to weigh the rationality of curriculum design and identify problems within the teaching reform. Data-driven intelligent analysis, for example, makes it possible to integrate multiple teaching units or courses for quality assessment and drives a dynamic equilibrium of the whole teaching system in HEIs and continuous improvement of educational quality.

The above analyses show that in the digital age, teaching quality assessment forms an iterative loop with teaching activities. This way, the entire teaching and learning process is akin to a "self-correcting system", where assessment helps bring better learning, improved teaching and timely adjustment.

Teaching quality assessment objects and contents become diverse and inclusive instead of scattered

Traditionally, teaching quality assessment often treats related objects separately, resulting in procedural repetitions and low integration of the assessment results. Under big data-driven assessment, data can be shared among teaching-related objects. Centered around the learning and development of students, this methodology integrates multiple assessment objects, including student learning, teaching delivery, teaching resources, instructional environment and support services.

Assessment of student learning. The assessment of student learning covers all aspects of the entire student learning process, including cognition, skills, emotion, social capacity and digital literacy. From a time-dimension, it includes not only the evaluation of the learning outcomes of a course and each of the course's unit components but also the overall evaluation of students across different courses and training links. The monitoring and evaluation at each stage extracts data from the teaching information flow, analyzes and processes it, and produces feedback. Thus, the feedforward control, real-time control, and feedback control of the whole teaching process are completed, covering diagnostic assessment, formative assessment and summative assessment. In terms of assessment scope, both group evaluation and individual evaluation are included. Big data technology can help realize "all-sided" quality monitoring, "all-stakeholder" involvement, "all-rounded" data collection, and "full-process" supervision and tracking for the entirety of learning activities. It can also achieve "personalized" and "adaptable" evaluation of individual students. This not only promotes the holistic improvement and development of teaching, but also considers individuals' special needs in development. From the dimension of activity types, the big data-driven assessment includes the learning activities completed by students independently, such as tests and homework, as well as the multi-dimensional evaluation of collaborative activities, such as in-activity interactions and activity sequences.

The integration of learning data helps shatter cross-course boundaries in the assessment of student learning, as all courses and links under the training program are evaluated as a whole. From that, opinions can be formed on students' mastery of the knowledge system of an academic program, their progress in developing advanced thinking abilities, and their cooperative and communication capabilities. This way, the student learning assessment results are integrated across courses and training objectives.

Teaching assessment for teachers. The assessment of teaching mainly focuses on teachers' teaching behaviors. Such include their grasp of student learning status and intervention in student learning, and their teaching approach, teaching means, teaching strategies, pronunciation and intonation, emotions and moods, etc. After assessment modeling, teachers are subjected to standardized measurement of the required professional competencies to check whether some of them are more sensitive to ICT competence and are skill-wise prepared for differentiated teaching.[8] On the basis of the teaching assessment results, it is possible to present, with a larger scope and more details, which stage a teacher is at along their professional competency development path and what the teacher should focus on subsequently.

Assessment of teaching resources. The teaching resources in the digital age exist in more diverse types. When evaluating teaching resources, it is necessary to consider the following: whether the presentation of resources in different media forms is clear, complete and targeted, and whether the presentation caters to students' perceptual characteristics and meets their learning needs; how about the consistency between teaching resources and course content; whether it respects security and privacy and follows appropriate open licenses for various data types; and whether the different types of resources are linked properly, and demonstrate the logical soundness the curriculum and knowledge system, the learning progressiveness, and the timeliness of updating digital teaching resources, etc.

Assessment of instructional environment. The evaluation of instructional environments includes the functional practicability, interactive friendliness and data security of the instructional and learning environment. Functional practicality relates to the diversity of learning activities supported by the instructional environment and the appropriateness of learning feedback and intervention. Interactive friendliness aims for the instructional environment in use to suit the cognitive style of students and the teaching staff, reducing the cognitive load. Data security focuses on the security of learning data and personal privacy.

Support service assessment. This refers to the evaluation of the learning support and service system. As this system should feature integration, personalization and digitalization, its evaluation is approached from the following aspects: whether it provides support for students throughout their academic program, provides systematic services and data and arranges the steps in the learning flow for students; whether it gives students access to the information and services they need anywhere.

Teaching quality assessors: from mainly regulators and administrators to all stakeholders

In the digital era, a decision-making mode based on shared data is possible through constructing a rights distribution system centered around teaching data that meets the development needs of stakeholders. This data-centered teaching assessment methodology enables participation by all stakeholders, who can negotiate and talk, jointly build up the assessment system, share responsibilities, and engage in checked and balanced supervision. To some extent, the data-centered methodology overcomes the cognitive limitations and ambiguities of traditional teaching assessment, makes teaching assessment more comprehensive and targeted, and provides a solution for reconstructing the assessment rights distribution system. Stakeholders in teaching can express their development needs and value propositions in time. The digital means help generate assessment relationships in time, make available comprehensive assessment data, and enable rapid analysis and feedback of assessment results. Also, the methodology enables exchanges and consultations among different stakeholders and enhances the communication among assessors as well as between assessors and assessment objects.

Teaching quality assessment mode: toward a data-driven and scaled one

Digital transformation has driven the shift in teaching quality assessment approach in higher education to data-driven, formal modeling and intelligent calculation and analysis. Conventional assessment methods—e.g., questionnaire survey, classroom behavior observation, and examination—have some demerits, including the high time consumption, data inaccuracy, missing or non-collectable process data, etc. Moreover, data continuity, integrity and integration are all either insufficient or non-existent, information links inherent in data are severed, and the analysis results based on such data are not as comprehensive as they should be. The intelligent assessment powered by human-computer collaboration fully leverages multi-source data; processes structured, semi-structured and unstructured data; consolidates quantitative and qualitative evaluation; continuously monitors, measures and improves the teaching quality based on data; and makes the assessment conclusions more immediate, continuous and scientific.

The digital transformation of teaching and learning quality assessment mode is mainly reflected in the collection and analysis of assessment data. With digital transformation, data collection now covers all time frames and space; the data collected have enhanced authenticity, objectivity and accuracy; and the scope of data identification and analysis has expanded, covering more diverse data types. The data collection and analysis have now become more efficient by leveraging intelligent technologies. Examples include: a) Make full use of the cameras and eye-tracking systems installed in classrooms to collect the images and sound signals of in-class teaching in real-time, then carry out in-class emotion recognition using data on teacher' and students' voices, facial expressions and body postures; the aim is to obtain the dynamic emotional change information of teachers and students; b) With the help of AI technology, learn about the classroom performance of students from the dimensions of classroom participation,

interaction, thinking state and classroom emotion; c) With the help of new technologies like online teaching platform and wearable devices, capture, store and analyze the data on teachers and students throughout teaching. Compared with traditional methods where it takes time to get feedback results on tests, questionnaires or interviews, the AI-supported classroom teaching assessment speeds up the evaluation process and sharpens feedback efficiency. Helped by the text visualization analytic tools, the AI-supported approach can evaluate students' learning and their grasp of knowledge system through big data, which enables assessors to swiftly realize how the students are doing and how their knowledge system is evolving. The time flow and map of educational data are integrated, thereby showing the characteristics of educational events in a specific time and space in a three-dimensional way. This helps to predict the future development of education and to provide strong support for educational decision-making.

Teaching quality assessment results: from evaluating the attainment of goals to serving decision-making

Traditional teaching quality assessment is more about evaluating the attainment of educational and teaching objectives. By contrast, the big data-driven teaching quality assessment is designed to provide a basis for comprehensive and accurate decision-making through better monitoring of the teaching process. For students, the learning evaluation feedback can help them know the learning outcomes and adjust their learning strategies in time. In teachers' case, starting from the assessment results, they are able to adjust course resources in time, improve teaching strategies, and customize counseling for students. Administrators, for their part, can adjust the training program and optimize the teaching service system at the macro level according to the detailed teaching data from different dimensions, with the aim of better serving the education management and decision-making.

7.3 Summary and Future Developments

In the digital age, the QA goal for teaching and learning in higher education have diversified; the QA functions have changed from rating to early warning; the objects from scattered to integrated; the coverage of assessment standards from phased and single-faceted to full-process and all-sided; the methodology from periodic to normalized and from sampling to total-size; and the process from closed to open. The teaching QA implementation will also change accordingly. However, the following existing problems are worth further exploring:

Data quality problem: Big data has a mixed quality profile, which is prone to data noise, false correlation and accidental homogeneity. Given massive samples are usually aggregated from multiple sources at different time points using different technologies, they are thus susceptible to heterogeneity, experimental differences and statistical bias.[9]

The demand for multi-dimensional data comprehensive modeling: With the teaching and learning environment extending from physical space to online learning space, the live teaching process data stays in multi-dimensional spaces. Supported by evolving technologies like data mining and learning analytics, it is now possible to collect various teaching data in such spaces. Researchers may further probe into how to build a comprehensive scientific model so as to cover multiple data patterns such as students' academic progress, emotions & attitude, physical & mental health, and to improve the education QA system and make it more systematic and refined.

Expectations of human-computer collaboration in teaching assessment: By leveraging diversified and process-generated data, intelligent systems can accurately analyze students' profiles, provide timely decision-making and feedback, and effectively optimize the effect of teaching quality assessment. Yet, teachers oversee classroom teaching, so a pain point in multi-dimensional evaluation application is how to give full play to the advantages of machine intelligence while also considering the features associated with teacher presence.

Data privacy and ethical issues: Applying intelligent equipment subjects both teachers and students to all-directional, full-process behavioral data capturing. The privacy in the teaching process is easily collected and prone to dissemination and diffusion, from which one can infer personal preferences and thinking habits of students.[10] We believe future studies should look into rule-setting and assessment boundaries in the data collection and analysis stage, and explore how to effectively prevent the risk of privacy leakage in teaching.

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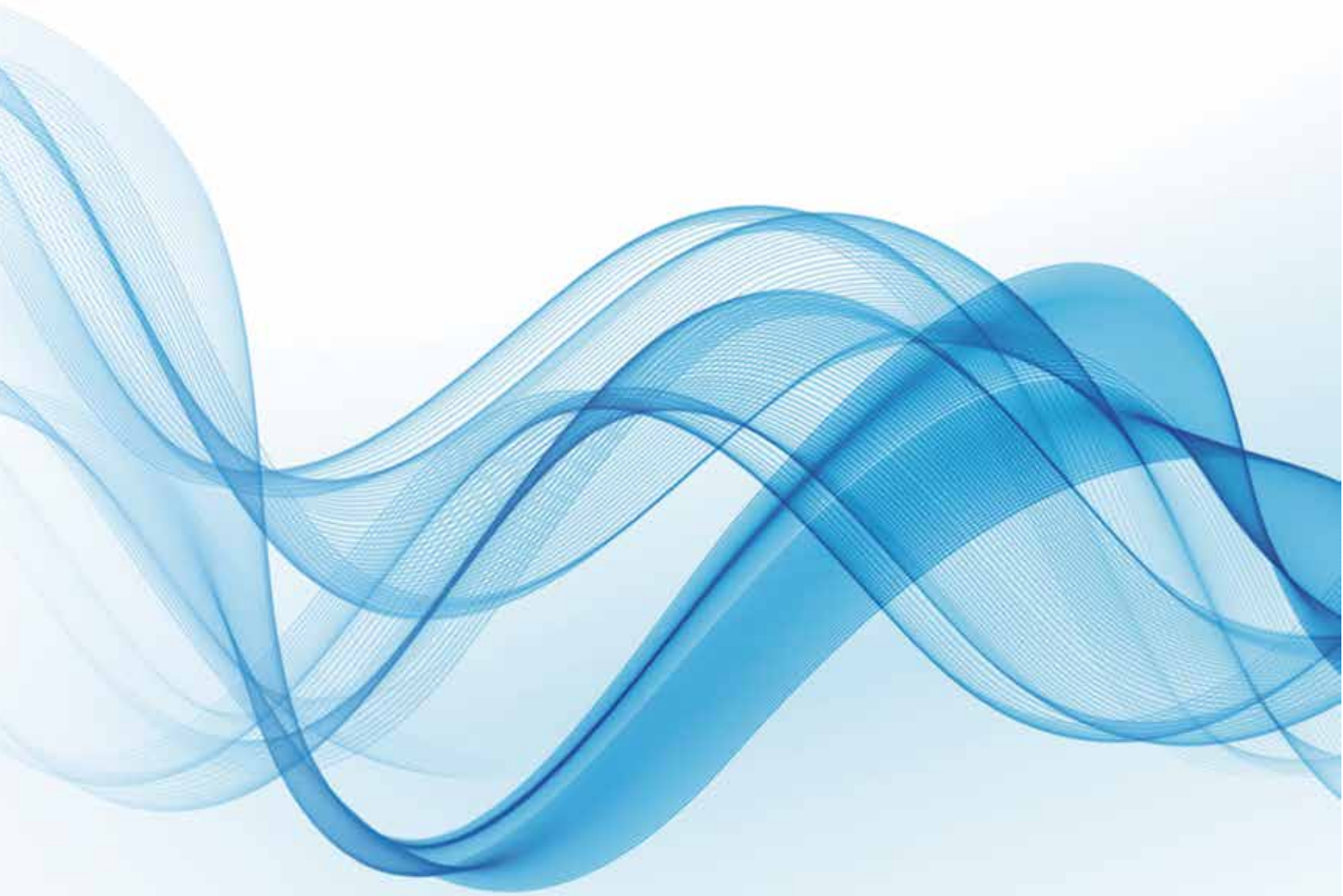
Chapter8
Challenges and Responses



Teaching and learning in higher education is a complex dynamic system. Amid the external social, economic, political and technological impacts, HEIs, academic programs, curriculum and delivery, teachers, students and the teaching QA (all internal core elements) interact with and influence one another. The digital transformation of teaching and learning in higher education is pushed forward through reconstructing the operational modes, strategic directions and value propositions. Chapters 2-7 of this report expound on the contents and characteristics of the digital transformation of the above core elements, some of which are ongoing, while more are the focus areas for future. Driving the digital transformation of teaching and learning in higher education is a system-level project, involving multiple stakeholders and factors inside and outside HEIs. Also, the transformation will be a long-term, progressive process. This means that challenges are inevitable and addressing them takes the coordinated and systematic efforts of all stakeholders.

Challenge 1: A digital divide engendered by technological changes

While creating huge opportunities for education, digital technological changes have also engendered constantly widening inequalities for countries, regions and groups; the ubiquitous digital divide is a prominent example.[1] In the report Reimagining our future together: a new social contract for education released on November 10, 2021, UNESCO noted that "gaps in educational opportunity and outcomes between and within nations augmented....with worrisome increases in inequality and exclusion". Currently, education digitalization and IT infrastructure are unevenly developed worldwide, and the COVID-19 crisis has only highlighted the educational development imbalance induced by the digital divide.[2] Learners in many far-flung areas have no access to remote online learning, or can only rely on certain types of technological resources, which shed light on the political, economic, technological, gender and educational inequalities that are common worldwide.[3]

The digital divide in education is not just a technological divide, but also a digital literacy divide.[4] Facing a large amount of fake information, rumors and irresponsible propagation, the public could get lost in the flood of information without adequate digital literacy, and even risk easy incitement, potentially leading to prejudice, hate speech and aggression. In the meantime, the ubiquitous technology presence and the ever-expanding learning spaces pose a digital adaptability challenge to learners and teachers in the future. Unrestricted and unreflecting technological development could result in potential attacks on human beings themselves. People's excessive use of technological means may damage brain health, depress attention, and even endanger learners' rights to connectivity, data, information and privacy. In which, issues like moral crisis and ethical risk management, educational equity and sustainable development become especially urgent.

The technology-induced digital divide asks that higher education actively adapt to technological changes, while staying clear of technological limitations and ethical risks. International organizations, governments and HEIs need to make joint efforts to continuously build the infrastructure for digital transformation of teaching and learning. The goal is to ensure that higher education can provide equitable technical resources, right to information and educational opportunities for every learner, while also adapting to the differences in educational technology popularization, usage habits and social culture in different regions. It is also imperative to take digital literacy as an essential literacy of the 21st century; special efforts should be directed to cultivate students' rationalism, empathy, creativity and critical thinking in digital space to ward off the risks associated with digital society. In short, in the reality predicament of the technological age, a new social contract for education should strive to ensure that the digital technologies, tools and platforms applied to the education field stick to the following direction: supporting human rights, improving human capacities, and promoting human dignity and humanistic spirit, thereby maintaining the peace, justice and sustainable development of the digital society.[5]

Challenge 2: Inertia constraint of the existing teaching system in higher education

The digital transformation of higher education teaching and learning not only is about the teaching and learning per se, but also challenges the existing physical forms and operating modes of universities. On physical forms, the transformation will shatter the boundaries among HEIs in future, rendering the traditional walls obsolete. On operating mode, it will bring about connectivity both within the higher education community and between HEIs and total factors of society. That way, teaching staff, curriculum, facilities and services, as resources, can be shared, and maximizing the resource allocation from outside HEIs is possible. This student-centric, institution-connected teaching approach should bring disruptive changes to universities' traditional teaching management. However, the education and teaching system born in the industrial society—from universities to academic programs and curricula—still sticks to the old ways (an inertia effect). The system still approaches technological empowerment of education from an industrial society perspective. On the one hand, while information technologies have been driving educational and teaching reforms, this process has left the existing educational system intact, as it has been just improvements on the existing school, major and even curriculum frameworks. On the other hand, the "Technology-Centric Theory" has dominated the ongoing IT application in education for a long time. Yet, the premature deployment of new technologies and the resulting poor effects led to doubts about return on investment, hampering the further application of technology in education. How to go digital within the existing teaching system of higher education has no doubt become a big challenge.

A prominent feature of the information society is the rise of cyberspace. Cyberspace helps break down the spatiotemporal boundaries of local education, and connect it with global educational resources—even with the social, economic and cultural environments, so as to jointly shape a higher education teaching system for future. As the information society is here, building theories and designing systems for education of the future should duly reflect and respond to the facts of the digital transformation in this society.[6] Hence, higher education policy makers, HEI administrators, researchers and practitioners must shake off the mindset trap that "the digital transformation of education relates only to the education field". The above-mentioned stakeholders should have a keen appreciation of the essence of digital transformation of higher education teaching and learning and its relationship with other systems; jointly formulate the vision and path for the digital transformation endeavor that are reflective of all stakeholders' concerns; integrate resources and services in other fields of society based on cyberspace, and promote the systematic transformation of higher education.

Challenge 3: Teaching management and decision-making based on intuitive experience

Many HEIs rarely apply empirical evidence to their teaching management and decision-making process, and instead rely more on the experience of decision-makers. Such experience is usually fragmented, illogical or even contradictory. This could weaken HEIs' teaching management capacities, posing big challenges to the digital transformation of higher education teaching and learning.

The scientific management and decision-making of teaching is rooted in a correct understanding and rational call of the objective facts of teaching development. In their teaching reforms, HEIs should start from evidence and combine with professional expertise and practical wisdom, before making decisions on how to improve education and teaching.[7] Furthermore, HEIs should carry out educational research, educational decision-making, and education & teaching reforms based on evidence, and deliver all-win outcomes amid the trio's interactions.[8] When pushing ahead with the digital transformation, HEIs should seek out evidence from multiple sources and be ably prepared to collect and analyze evidence. By serious use of teaching-related big data, HEIs can not only obtain teaching information in time, but, more importantly, monitor and make dynamic changes to the teaching process more efficiently. The digital transformation of teaching management is not just the technical upgrade of management tools and means. A key feature lies in integrating digital technology into the teaching management system, so as to construct a continuous action system—from information collection, analysis and judgment, consultation and argumentation, planning and decision-making, to implementation and monitoring and feedback and adjustment.9 Only a high level of teaching management can underpin and support a smooth digital transformation process of teaching and learning.

Challenge 4: Lack of cross-field academic programs and a flexible credit and degree certification system

At present, HEIs still target "special-purpose" talents training when designing their academic programs, which lags behind what the digital economy needs—a "versatile" talent cultivation. Single discipline-focused academic programs lack an interdisciplinary width and are unfit to cultivate students' comprehensive problem-solving capabilities. The specialty-centered talent training program requires that students complete a fixed combination of courses within a specified time, and they can only get credits and degrees after passing exams and evaluations. The digital transformation of higher education teaching and learning is to rise above the limitations of academic programs, and also shatter the barriers among programs, colleges, society, and even countries. In this scenario, with control of learning in their own hands, learners can freely select courses from other programs and universities to personalize a course combination and match their own development needs.

The key to realizing the above-mentioned digital transformation is to build a flexible credit and degree certification system. The intention is to free students from the shackles of affiliation labels, break the geographical boundaries, and realize students' freedom of course selection, learning and mobility. The *Horizon Report | 2019 Higher Education Edition* published by EDUCAUSE considers "degree modularization and decomposition" as a long-term trend in higher education, pointing out that learners get digital badges and micro-credential by taking online courses, which upends the traditional way of earnings degree certificates.[10] In 2021, EDUCAUSE noted again that micro-certification is one of the key technologies and practices that will influence the future teaching and learning in higher education.[11] The growth of micro-certification has prompted many HEIs to rethink the curriculum development process and the relationship between for-credit and non-credit courses. Government agencies and HEIs should work jointly to formulate policies and standards that could promote the reform of credit and degree certification system. They could use blockchain and other technologies to promote the adoption of micro-certification and micro-credential across HEIs and academic programs, so as to establish a flexible credit and degree certification system. Learners can go beyond the limitations of the traditional degree system, where they are no longer confined to a certain HEI or program and can make choices and even personalize a program. To that end, we look forward to international organizations strongly advocating and teaming up with national governments to establish an internationally accepted credit and degree certification system.

Challenge 5: The development of differentiated teaching constrained by the traditional class and course system

Students are bound to vary in their development pathways, as they differ from one another in starting points, personality traits and development goals. Differentiated teaching and precise teaching thus become necessary to meet students' personalized learning needs. However, as HEIs now mandate face-to-face in-class, course-based teaching, teachers are hamstrung and find it impossible to cater to each student's learning needs during teaching. Stratified and precise teaching is hard to materialize. There is still a big gap between students' longing for self-paced learning and the reality of insufficient learning independence.

But by integrating AI, big data and other technologies into courses, differentiated teaching now becomes possible. We thus suggest that university administrators build a digital teaching and learning environment for teachers and students, provide relevant technical support, and encourage teachers on intelligent teaching explorations. We recommend that teachers and instructional designers improve their data literacy, cultivate technological capabilities for the intelligent instructional environment, fully integrate big data, AI assistant and other technologies into curriculum and the course delivery process, and expand the spatiotemporal possibilities for teaching. The aim is to accurately analyze learners throughout teaching, predict teaching outcomes, and regulate the teaching process, to meet learners' personalized learning needs.

Challenge 6: Teachers' insufficient practical capacity in digital teaching innovations

Teachers direct the teaching process. Yet, HEI teachers' inadequate digital competencies have become a roadblock to the digital transformation of teaching and learning. Teachers' digital competencies comprise: the awareness and literacy to integrate digital technology into teaching; the ability in digital-driven teaching innovations; and the ability in human-AI collaboration for teaching of the future. Governments should design the criteria of teachers' digital competencies and policies to promote the development of teachers' competencies. HEIs should build a complete system for the professional competency development of teachers. Social organizations should support teachers in digital competency development with all kinds of resources, implement development projects in this aspect, and roll out teachers' digital competency certification. International organizations should advocate international and regional cooperation and develop online training programs to increase teachers' digital competencies, especially micro-credential and micro-degree programs. All these suggestions above are driving continuous improvements in digital competencies of teachers. Meanwhile, facing the impact of digital technology, teachers also need to keep updating their teaching ideas and improving their professional competency, thereby turning the challenge into an opportunity to overhaul traditional teaching and bring forth new ideas for teaching of the future.

Challenge 7: Self-management ability for digital learning lacking among students

The digital transformation of higher education teaching and learning is also a process of letting learners take control of their own learning. Further, a talent training model based on "student experience" can be constructed, through reinventing the current operating model of the education and teaching systems. Under this new model, learners can make their own development plans, choose relevant courses or programs, and formulate learning pathways and plans, etc. after considering their own interest areas and study plans. With that, they can gradually move towards self-improvement while continuously "awakening, designing, motivating and regulating" by themselves—a dynamic process. Learners would then be able to decide what to learn, how to learn, and how about the learning outcomes. Hence, a brand-new model of "self-learning, self-organizing, self-cultivating, self-planning, self-regulation and self-adaptation" would form.[12] This requirement not only poses a great challenge to learners' self-management ability, but also reveals the limitations of the existing textbook-and teacher-driven teaching mode.

To respond to the talent training mode change and give full play to students' right to control of learning, HEI administrators should support the self-controlled development of students using digital technology. An example is to use AI technology to establish a prediction model, by which to identify employment and skills development trends and help students figure out their future learning and development pathways.[13] Meanwhile, the role of teachers should transform from persons who impart knowledge to student development consultants and professional instructors, among other social educational functions. Additionally, students should give full play to their own initiative and avoid drifting from "teacher dependence" to "technology dependence".

Challenge 8: Blindness and choice dilemma brought by fragmented learning

The Internet accommodates a sea of digital learning resources. While it provides students with opportunities to learn anytime and anywhere, the concomitant resource fragmentation could also subject students to directionless learning and choice dilemma. With the development of AI, big data and other technologies, the adaptive learning support service based on knowledge map can integrate fragmented knowledge, reconstruct the association inside knowledge, and realize a meaningful rebuilding from fragmented resources to a knowledge system. This way, it helps solve the problem of knowledge isolation on the Internet and support learners' personalized learning in an organized manner. University administrators, instructional designers and researchers should work together to sort out the varied subject knowledge in higher education, and build an adaptive visualization learning engine complete with subject knowledge verification, subject knowledge integration and subject knowledge map navigation.

Challenge 9: Complicated teaching practice and development of teaching theories

With its emergence, the Internet has reshaped the content, characteristics, carriers, and modes of production and dissemination of knowledge. Knowledge is not merely refined symbolic knowledge, but also includes information, understanding, skills, values and attitudes.[14] Different from the traditional knowledge types, the new knowledge will encompass massive networked information, dynamic subjective knowledge, domain operation knowledge, and comprehensive fragmented knowledge. The complex teaching practice in the digital age has increasingly exposed the limitations of the original educational theories. A large number of teaching and learning laws for the digital age still need further exploration; examples include laws on the production and dissemination of new knowledge, the generation and evolution of knowledge, the relationship between individual knowledge production and group knowledge production, the complexity features of teaching and learning, the cognitive characteristics and growth laws of various categories of learners, and the support of teaching design or learning design for complex knowledge.

Teachers and researchers in HEIs should break away from the "single-discipline, closed" organizational paradigm of academic research. Instead, they should accumulate efforts across disciplines and regions, explore an actionable and effective online collaboration mechanism for research, and jointly confront and tackle the new problems brought about by the digital transformation of teaching and learning. Meanwhile, they should pay attention to the data-driven evidence-based research paradigm, and produce new ideas, new theories and new methods leading the practice of digital teaching.

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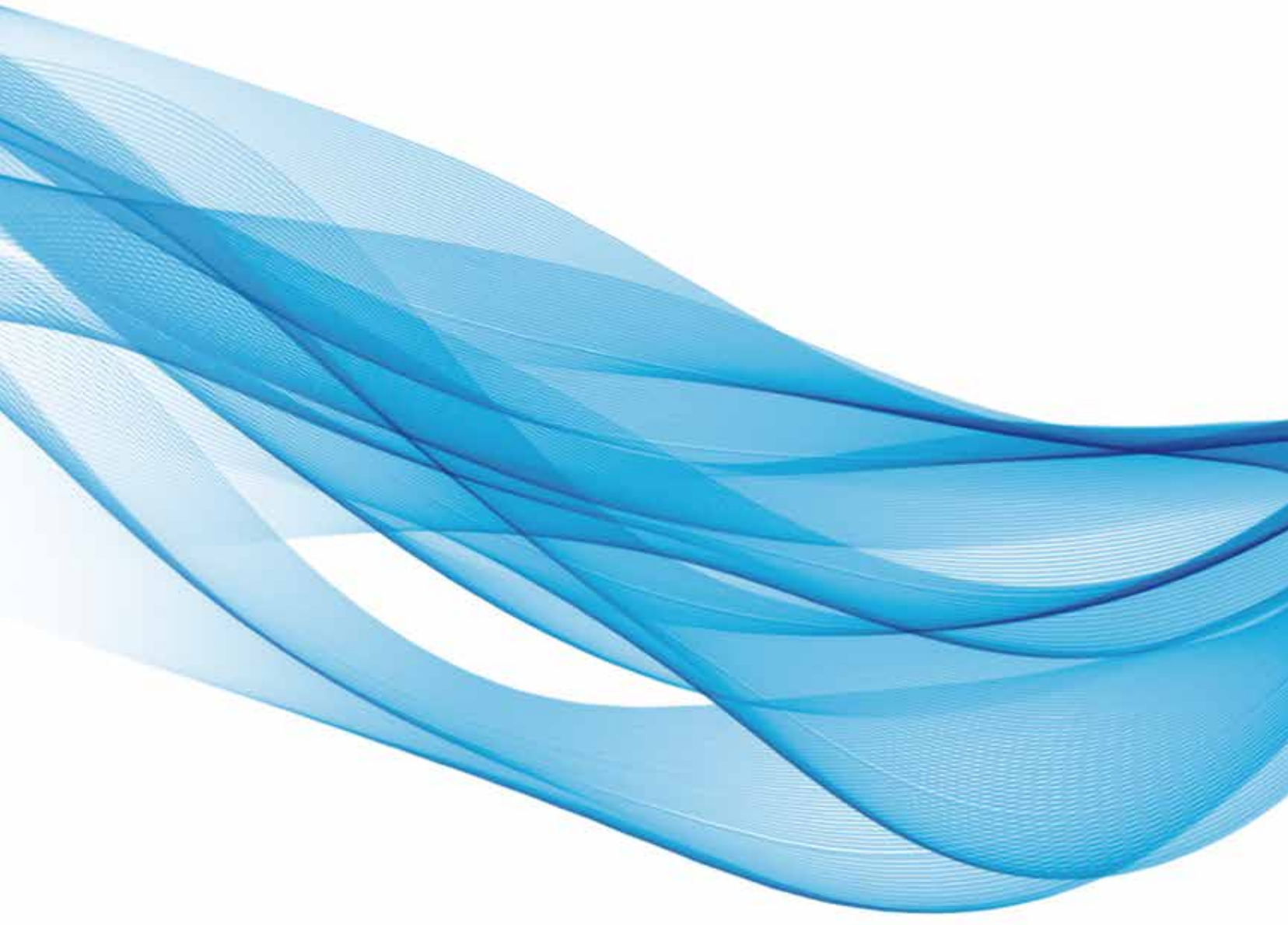
Appendix
Cases of Best Practices



While government's digitalization policy orientation affects the digital transformation of higher education teaching and learning, decision-makers, administrators, teachers, and students in HEIs all play crucial roles. For this study, the research team solicit cases of best practices on the digital transformation of higher education teaching and learning from HEIs worldwide. We hereby select eleven cases from nine countries, namely, Egypt, Indonesia, Kazakhstan, Malaysia, Morocco, Peru, the Philippines, Serbia, and China.

The case from Ain Shams University of Egypt (one of the most influential universities in Africa and the Mideast) lays out the series of digital transformation efforts at the institutional level including improving the technological environment amid the COVID-19 pandemic. The Indonesian case presents how the Indonesia Cyber Education Institute has integrated the quality online courses nationwide, and gave an overview of the credit and certification recognition. The Kazakh case introduces the implementation of the UNESCO's program on improving teachers' digital competencies in Central Asia. The Universiti Putra Malaysia case demonstrates traditional research university's thinking on building a digital smart campus. Morocco's case demonstrates the value of an online lab and training platform and areas to watch out for in building such platform. The Peruvian case shows how Pontificia Universidad Católica del Perú has managed to integrate the professional competencies training of teachers in practice. The Filipino case sets forth the serial measures required in promoting the digital transformation of higher education teaching and learning at the national level. In the Serbian case, HEIs and internship sponsors jointly explore how to improve the employability of students by leveraging online learning management platform. Among the three Chinese cases, the case of Central China Normal University presents the university's systematic efforts to promote the digital transformation of teaching and learning in academic programs as well as its practices to reinvent the talent training system. Yangzhou University showcases the outcomes of a special training designed to improve blended teaching competency of teachers. In the third case, several universities in Zhejiang Province have come together to build the digital teaching consortium on general education courses, which inspires further knowledge sharing and co-building of open educational resources.

Case 1 Malaysia: The use of guiding metrix to align institutional digitalization and management strategies for enhanced ICT capacity of HEIs

The rapid development of digital technologies has continued to challenge the role of higher education. In Malaysia, although efforts to promote and enhance ICT use in its higher education institutions (HEIs) have been on the rise in recent years, there is still a need to appropriately align its digitalization and management strategies to achieve the efficiency of institutional governance and ensure equitable access to quality higher education and lifelong learning opportunities for all. Meanwhile, the unexpected COVID-19 caused educational crisis and shift of learning approach has also made this alignment a more pressing need for HEIs across Malaysia.

As a leading university in the country, Universiti Putra Malaysia (UPM), has been a prominent pioneer in this process. Its recently launched 'UPM Strategic Plan 2021-2025' has demonstrated its commitment and determination to drive the research university striving to become a smart campus. Not only will this plan allow UPM to pay special attention to strengthening the crucial aspects of smart campus digitization that involve teaching and learning, services, infrastructure, and sustainability, but also facilitate the evaluation of its whole system to make sure the feasibility of corresponding actions.

UPM' s plan has incorporated multiple theories, including the Model of Performance improvement (Rummler & Brache, 1995), UNESCO' s Stages of ICT Adoption and Use (2010), UNESCO' s comprehensive approach to ICT in education policy implementation (2004), as well as five core areas of the higher education ecosystem, to design its research methodology. The team designed a guiding matrix to facilitate policy discussion around what ICT-driven innovations, curricula delivery, and learning ecosystems are necessary and relevant. This matrix helped stakeholders determine whether current policies are systematic and meet the diverse needs of stakeholders and contingencies. Then, it assessed the current alignment of digitalization and management strategies through investigation of technology use from the aspects of policy, enablers, continuous development (training), learners' inclusion and partnerships. The result of the holistic evaluation was the key reference to the policy-making and capacity building plan of UPM.

Comments: This case shows that when promoting the reform of HEIs teaching through digital technologies, overall planning and top-level design are necessary. Research is required and considerations should be taken in terms of teaching, supportive services, infrastructure, and the sustainable development of digital campuses. At the same time, the needs and suggestions of stakeholders should also be taken into consideration while also implementing multi-party evaluations. All above will ensure a systematic, inclusive, and feasible digital transformation.

Source: Dr. Habibah Ab Jalil, Associate Professor, Deputy Dean (Graduate Studies and International) of Faculty of Educational Studies, Universiti Putra Malaysia (UPM)

Case 2 Kazakhstan: Professional development of HEI workforce

Since 2020, the UNESCO Cluster Office in Almaty has organized the online training for teachers in Central Asia on the topic "Implementing education for sustainable development through the use of distance learning technologies." The training was developed to improve the qualifications of higher education personnel. In addition to tools and services that help in quick adaptation to the online learning environment, the training study the topics of the Sustainable Development Goals, teaching methods, competence-based approach, criterion assessment and other topics of interest to teachers.

The online training revealed a great interest on the part of teachers in studying the available possibilities of distance learning technologies, including ready-made online services and tools. The main objectives of the training were the effective implementation of education for sustainable development and education in the spirit of global citizenship, as well as increasing the potential of teachers in the field of using distance learning technologies.

During developing the online training program, the developers focused on the data from the opinion poll of teachers and tried to take into account the following methods, technologies and tools in their training: critical thinking, design thinking, teamwork, competence-based approach, brainstorming, project learning, problem-solving training, storytelling, criteria-based assessment. During the training, the following Internet services and tools were used: ZOOM, Miro board, Google Form, Kahoot, Wooclap.

It was also important to find out the needs and preferences in the choice of topics for online learning, so that in the learning process, trainers can place greater emphasis on discussing relevant and interesting issues.

Teachers have a need to improve their soft-skills and competencies, and such training provides them an opportunity to do it. They can practically pump up skills, test various tools, including online services and tools. The developers of the training program hope that the knowledge transferred during the training will help teachers to conduct their online classes even more interesting and effective.

Comments: This case shows that the digital transformation of teachers' professional competencies is not just about improving their technology application capabilities, but instead requires teachers to acquire the mindset, literacy and competency to integrate digital technology into teaching. In the meantime, a variety of targeted training activities can be adopted to improve teachers' professional competencies. For instance, the teachers' training program in this case exemplifies such purpose-built program provided by the UNESCO. We must understand that quick success is unrealistic on this front, instead, it needs sustained efforts to push and continued enhancements via teaching practice.

Source: Report prepared by Zeinolla Saule, Omarova Assel, Aben Assel – PhD (UNESCO Almaty)

Case 3 Egypt: Online learning during COVID-19 pandemic

Ain Shams University (ASU), as one of the oldest and most prestigious universities in Africa and the Middle East, is an Egyptian university founded in 1950 with more than 200 thousand students, 14 thousand academic staff and more than 900 academic programs.

ASU has accumulated expertise for digital transformation that leads to a mandate that needs a series of deep and coordinated work force as well as culture and technology changes. Students had to be motivated, trained and well equipped to have their courses and programs in the reconfigured online and blended way of learning. All academic staff had to adopt all tools of virtual teaching and remote working.

ASU Sector adopted strategies to transform these challenges to opportunities by giving much efforts that ends up with improving our educational technological infrastructure, developing, deploying and maintaining an advanced e-Learning environment (LMS), raising ASU staff e-Learning competency to select and use a range of e-Learning facilities, techniques and tools, and last but not least, building our students' capacity to allow them to operate effectively within an online learning environment and providing them with 24/7 technical support.

During COVID-19 pandemic, instruction was partly through Interactive Live sessions and partly through recorded video lectures with open communication channels with students. Our Online Learning Statistics during COVID-19 pandemic revealed that more than 6,000 online courses from different academic programs were developed including more than 26,000 video lectures and about 6,000 interactive online sessions with 74% of students regularly interacting with their instructors.

ASU developed a new e-Learning portal "ASU2Learn"; a well-developed e-Learning system that provides variable educational tools in response to the growing demands of blended learning through the effective implementation of modern technologies in e-Learning and distance education. It includes also innovative teaching and learning tools: virtual classroom, e-portfolio integration for competency-based education systems, virtual microscopy, virtual laboratories and virtual patient platforms.

For teachers, it helps them to create, update and manage interactive e-content, easily integrate online and offline learning experience, use online collaboration tools to create virtual classrooms, track students' performance and get their feedback allowing curriculum modifications and delivering individualized feedback, and manage administrative tasks as track attendance, student grading, distributing materials etc. For students, it allows them access their course lessons anytime and anywhere, learn collaboratively by creating online study groups, interact with their peers and teachers, and submit their homework, track their grades and provide course feedback. ASU Virtual Microscopy Platform, integrated within "ASU2Learn", included 1072 scanned microscopic slides, in addition to 4500 slides that are shared with a number of eminent universities in Europe and United States.

E-Assessment was included as one of the modalities for assessing students. It includes creating standardized Item Bank based on program ILOs to develop a balanced exam, delivering it to examinees through multiple platforms (PCs, smart phones or printed papers), and using easier and more advanced software for electronic exams correction producing meaningful exam analysis.

From this crisis management experience, we learned that blended learning, when properly designed, will offer a perfect learning experience to students. Blended Learning should not be viewed by instructors as an 'add-on' to an existing teaching approach. It is about "re-designing the teaching and learning dynamic."

Comments: A push for digital transformation requires great efforts from HEIs, including improving the educational technological environment—which comprises the digital transformation of the physical instructional environment and the construction of a digital instructional environment like learning management systems (LMS). On that basis, HEIs then need to design and optimize the course content, teaching methods, course evaluation and feedback to produce a good learning experience for students. This requires the concerted efforts among teachers, students, and administrators to enhance their knowledge and competency of digital transformation.

Source: Abdel-Fattah Saoud (Vice President of Education and Students' affairs, Ain Shams University); Mona Abdel-Aal Elzahry (Executive Director of Education Strategy Administration, Ain Shams University); Dalia Ahmed (Director of the eLearning Central Unit, Ain Shams University)

Case 4 China: Universities in Zhejiang province form digital teaching community of general education courses

Non-comprehensive universities in Zhejiang Province share the challenges of "underdeveloped general education systems, general education disjointed from academic program education, and an insufficient supply of general education teachers". To address the challenges, the Zhejiang Provincial Department of Education and Center for Educational Technology have established a digital teaching community of general education in HEIs in Zhejiang, with eight member entities—including Zhejiang Gongshang University and Hangzhou Dianzi University. The objectives include: to promote collaborative innovation among HEIs and experts in different HEIs, to build a "networked, digital, personalized and lifelong" general education system in Zhejiang's HEIs, to realize the co-building and sharing of general education resources in HEIs, and to explore an effective mechanism and mode of implementing blended teaching. The ultimate goal is to advance the reform of teaching and learning methods of general education at Zhejiang's HEIs, and shore up the quality of innovative talent training work in HEIs.

In the preparatory stage, this digital transformation initiative has taken measures such as setting up an online learning space, providing digital learning resources, and integrating high-quality online courses from HEIs within the community. It has aggregated 100 online courses, 100 online books for reading, 100 online films, and more than 30 sessions of online lecture videos.

The concrete implementation stage involves: setting up a co-building and sharing mechanism for general-education elective courses, establishing a credit mutual recognition system among community members and a settlement methodology for teachers' workload. The teaching and learning methods adopted include online course self-directed learning (MOOC, Massive Open Online Course) and online course blended teaching (SPOC, Small Private Online Course). In the light of their respective conditions, the members have carried out school-based MOOCs and flipped classroom guided reforms as well as offline social practical works in practice bases, etc. These initiatives also helped community members to build several educational practice bases with discipline characteristics.

To monitor the implementation progress and effectiveness, the community employs the evaluation approach of "general literacy evaluation + learning process monitoring". The dimensions of general literacy evaluation include Chinese studies fundamentals, science and technology, society and management, human intellectual development, literature and art, and history and civilization. The changes of students' general literacy and the effect of general education can then be observed, through analyzing the data collected by the general literacy assessment system.

Comments: A digital community for resource building and teaching practice sharing in university alliance could find a actionable focal point and operational mechanism out of their shared challenges, thereby achieve successful long-term collaboration. For example, addressing the common problems of general education courses in this case, the community integrates highly qualified teachers and quality online courses to provide open educational resources, enforces community-wide recognition of both teachers' workload and students' credits, and introduces a unified evaluation of learning effects, etc. Other universities can draw on such measures.

Source: http://gtt.eduyun.cn/gtt/pcjyxxh20191/20211021/40687.html

Case 5 China: Central china normal university integrates information technology to promote the reinvention of talent training system

Central China Normal University (CCNU) lists "educational informatization" as a development strategy and has initiated a systematic, eight-focus-overhaul of its entire talent training system.

1. Revise its student training program to mirror a desired student-centered talent training model. In 2013, CCNU released a new edition of its student training program. The new program sticks to a student-centered philosophy throughout, as CCNU adjusts the curriculum structure, condense offline-class course hours and credits, provides various classroom modalities, and strengthens the process-based evaluation, among others.

2. Reconstruct the instructional environment to realize integration across three spaces—"physical learning space, resources and social". For learning space, CCNU has developed cloud-integrated classrooms, through which the following functions are realized, namely, rich media content presentation, teacher-student interaction, learning scenario awareness, and adaptive teaching services. On resources, CCNU has pulled together high-quality digital courses, developed in-house or through commissioning, and offered open access university-wide. As to social learning space, CCNU has developed a cloud-based platform by its own, with day-to-day teaching and learning activities available in the cyberspace. It has formed a teaching and learning environment where teachers and students can roam seamlessly, online or offline, in-class or out-of-class, and virtually or in physical space.

3. Implementing progressive multi-stage training to improve teachers' IT-enabled teaching competence. CCNU roll out targeted progressive training programs by stage for new teachers, backbone teachers and seed teachers. The objectives include improving teachers' IT-enabled teaching competencies and innovation awareness, and helping them ride on the tide of the informatization era where "academic, technology and arts" are deeply integrated.

4. Enrich teaching resources and provide a more opened education. In terms of resource organization, CCNU has formulated three categories of digital curriculum resource specifications (A, B, and C). It has offered an online course option to all mandatory courses, and further expanded its resource supply by both self-developing and bringing in quality digital courses.

5. Innovation in teaching methods and promote blended teaching. Backed by an advanced instructional environment and high-quality educational resources, CCNU has vigorously advanced the online-offline-blended teaching mode that combines teaching with discussion. From which, a number of excellent teaching innovation cases have emerged.

6. Reform evaluation methodology by carrying out data-based comprehensive evaluation. CCNU has built its own teaching and learning base state database, with the students' learning process data collected through multiple online and offline channels. This database provides support for learning situation diagnosis, comprehensive evaluation, and academic planning, helps to shape a data-driven, process-based and developmental approach to evaluation.

7. Optimize management services and build a new ecosystem for student nurturing. Backed by extensive IT application, CCNU has been improving its management service quality, and manages to provide student services throughout their stay in CCNU. This embodies the "3S" education concepts of self-management, self-study, and self-service. CCNU has developed an IT-supported "five-in-one" education ecosystem covering ideological and political education, general education, academic program education, practical works education and management services.

8. Set up a teaching festival to curate a teaching culture. CCNU has introduced a set of measures, including pioneering the "Teaching Festival" branded activity, designing the teaching innovation award, and promoting the technology integrated education. It aims to foster a university-wide cultural atmosphere where teaching is valued. advocated, and teachers enjoy teaching and sharpen skills.

Comments: As shown by this case, when pushing for the digital transformation of academic programs, HEIs need to reflect first on what a digital society expects from its graduates and then relook at their talent training mode. As such, should HEIs target the full adoption of digital-informed talent training programs with satisfactory results, they ought to plan with the full picture in mind, organize resources and actions holistically and establish comprehensive supports. In this case, based on its five years of work, CCNU summarizes the institutional-level experience in driving the reinvention of talent training system, with several specific measures listed that can be worthy references to other HEIs.

Source: Qingtang Liu, Faculty of Artificial Intelligence in Education, Central China Normal University

Case 6 Indonesia: Online learning development in higher education

The Indonesia Cyber Education Institute (ICE-I), launched in 2021, was designed to be a marketplace of online courses in Indonesia. It collects and provides quality collection of online courses both from top national universities as well as international higher education institutes to the higher education community in Indonesia. The establishment of ICE-I became increasingly strategic in higher education practice in Indonesia. There are 275 courses available from the ICE-I Consortium members and 1420 EdX courses. Some other partner institutions are also coming in to provide services through ICE-I. For the first three years of its establishment, ICE-I service offers free unbundled courses that can be recognized toward independent study, student exchange, or micro-credential under the Policy of Merdeka Belajar Kampus Merdeka.

Thus far, 3800 students are enrolling through ICE-I. Each student can take up to 20 credit hours or more than one course. As such, 8857 students enrolled in various courses from ICE-I Consortium and EdX. This number is expected to increase in the following academic semester. The provision of online courses for the higher education community by ICE-I is perceived to be efficient. Students may enroll in the online courses available in ICE-I for free, including the opportunity to take the exams and obtain a certificate once they pass the exams.

Comments: In this case, after students complete state-recognized online open courses, they get recognition for their achievements, including course credits or certificates. “Degree modularization and decomposition” is a long-term trend in the teaching reform of higher education. Under this trend, by using the online open courses, students are now able to customize their course combination and earn digital badges and micro-credential. This modality upends how degree certificates are traditionally obtained, and we consider it as one of the critical experiments to affect higher education of the future.

Source: Paulina Pannen (Chairman, Indonesia Cyber Education Institute, Universitas Terbuka, Indonesia)

Case 7 Serbia: Internship program supported by LMS

The new reality we are all facing since the outbreak of the COVID-19 pandemic requires a new approach, methodologies, and new ideas. When it comes to higher education, distance learning, e-learning, and blended learning methods were widely used long before the pandemic. However, the adjustment for the specific needs of each HEI was necessary. Since the outbreak of the pandemic, to keep the processes of teaching and learning going, most HEIs combined online collaboration tools with learning management systems (LMS). These solutions gave satisfactory results and represent a new type of blended learning, flexible enough to switch to full online mode at any time. Students’ internships required different methodology. Our goal was to set up a system and methodology that will enable students’ internships to take place during the pandemic (fully online at the time of lockdown), and for students to be integrated into specific business environments, in accordance with their study programs.

Our intention is to create a system that takes everything important into account and provides fully reliable insight into which activities are forthcoming and how they should be carried out. Using the appropriate algorithms of learning analytics, the system will learn and be more and more adapted to the needs of all three stakeholders, with an emphasis on the students’ needs. To achieve these goals, we had to provide the resources and experts to deal with the matter and to use advanced features of Moodle LMS and learning analytics with the goal to optimize type of activities conduction, but also to increase the usage of available resources targeting the maximum growth of success rate and internship learning outcomes.

The internship e-course is designed to support traditional teaching and learning and provides access to all resources from a remote location. Since students of the Faculty of Technical Sciences – University of Novi Sad are experienced and familiar with working within Moodle distance learning environment (they use it from the first year of studies), Moodle was also chosen for the internship e-course.

Moodle provides numerous advantages in addition to facilitating internships without interacting directly with students in the classroom. It allows teachers to enhance the content, engage students, and increase interest in self-directed involvement in assigned tasks and activities. It allows learners to set their own pace, boosts their willingness to learn and advances their digital learning knowledge and skills. The teaching and learning digital transformation is significantly accelerated and HEIs must have pre-prepared mechanisms to respond to these challenges. In times of vast endangerment, future respond may imply the possibility for establishing E-internships that will be conducted fully online.

Comments: This case shows that preparing students via proper internship arrangements could help them better adapt to the society, although the quality of internship learning depends on whether the intern employers engage proactively and the cooperation among university, students and intern employers. In the tripartite cooperation could use a digital learning and management platform to increase chances for accurate student-employer pairing, promote courses development focused on internship requirements, and stimulate students’ capacity in self-directed learning, among others.

Source: Branislav Bogojević, Bojan Lalić,Tanja Todorović,Nikola Zivlak (Faculty of Technical Science, Department of Industrial Engineering and Management, University of Novi Sad)

Case 8 China: Yangzhou university teachers' blended teaching ability training

Yangzhou University's (YZU) experiment with blended teaching started in 2007. In 2016, YZU tracked records and evaluated the results from this experiment, and uncovered a set of problems, such as uneven blended teaching competency profiles among teachers, insufficient integration of online/offline teaching, and reluctance to use the online teaching platform. Further research by YZU identified the main causes, i.e., unclear core elements for such competence and training plans lacking focus. On this basis, YZU began teacher training to sharpen their blended teaching competence; the university designed systematic training contents, developed new training methods, and tried to boost teacher participation and produced meaningful results.

First of all, taking into account the features of its subjects and the actual needs of teachers, YZU identified the core elements of teachers' blended teaching competence in dire need of improvement. Moreover, it proposed a university-centered, classroom-based, problem-driven and pragmatic scheme for improving teaching competence. In its training offerings around a series of themes, YZU covered the whole process, i.e., the design, development, implementation and evaluation of blended curricula. Under such framework, YZU aims to improve teachers' capabilities in the blended learning environment design, the learning assessment and quality control in the blended environment, the learning analytics-driven student-personalized teaching, and the flexibility and self-adaption to the blended teaching. Secondly, YZU adopted a blended training mode of online self-directed learning and offline focus discussions, so that teachers can experience and think about the design of blended curriculum and the delivery of blended teaching in students' shoes. Step 1: Offering offline guidance, YZU clarified the objective, significance, tasks and methods of the blended curricula development. Step 2: Teachers took the course "Blended Curricula Design and Construction" online and completed related learning activities. Step 3: After the online course is completed, course instructors answered the questions and addressed doubts from the participating teachers offline, and critiqued on trainees' curriculum design cases. Finally, YZU gave play to teachers' subjectivity in training participation, to activate teachers' participation willingness and motivate them to put what they learned into continuous practice.

So far, YZU has rolled out 119 appointment-based training sessions around 14 themes, drawing altogether 2,625 participants from its teaching staff. The sessions delivered 100% teacher satisfaction, with 95% expressing intention for follow-up training. The flexible and targeted training by YZU has laid a solid foundation for teachers to involve in the blended teaching reform.

Comments: As illustrated by this case, to drive up teachers' blended teaching competence, HEIs need to shore up the overarching plans for such training, strengthen the thematic design and respond properly to teachers' needs. Meanwhile, HEIs can come up with a more flexible training mechanism, so that teachers can be proactive in the process—from "'I'm asked to take training" to "I want training". Admittedly, teachers' reluctance is a common challenge for such training.

Source: Jiali Wang, Office of Academic Affairs, Yangzhou University

Case 9 Peru: Design and implementation process of online teaching and learning to ensure continuity and university education quality

Since March 2020, Pontificia Universidad Católica del Perú (PUCP) has taken a series of measures to ensure the quality of online teaching and learning in response to the COVID-19 pandemic. Training professors played a central role in the adaptation process to the online modality in the knowledge and use of the online learning environment PAIDEIA Pucp (Moodle). In this regard, a self-instructional online course was offered, having the following objectives: to sensitize teachers to the distance learning modality; to know and use Paideia platform and its activities; and to prepare the design and implementation of learning activities for the distance learning modality in four progressive and complementary levels.

The training covered the following aspects, i.e. acquisition of information: preparation of materials and resources to present the content of each course; communication/Interaction: design of activities that will enable synchronous and asynchronous communication among professors and students. With the training program, professors had to design and adapt the processing activities to the online modality to promote students' learning and the development of competences, by using self-study activities or a different type of collaborative work. As for the assessment of learning, guidelines were provided for professors to design assessment activities, using synchronous and asynchronous online tools, in which students could develop and show their learning outcomes.

Consequently, professors have significantly improved their competences for distance teaching on the institutional platform and the use of video-conferences Zoom, thanks to the variety of training actions and pedagogical and technological support. These competences have contributed to improving the quality of OBTL.

Comments: This case shows that multiple methods can be used to promote a digital turn in teaching, such as creating teachers' professional competency development courses (allowing them to self-educate any time), and providing them with diversified training, etc. What matters the most is, of course, that teachers could integrate what they learn into their teaching. Also, teachers need to form a community for teaching practice and experience sharing, allowing them to jointly cope with the challenges brought about by the digital transformation reality.

Source: Cristina Del Mastro Vecchione (Academic Vice-president, Pontificia Universidad Católica del Perú)

Case 10 Morocco: The role of smart digital platforms in supporting remote practical works in the light of the spread of the COVID-19 crisis

Regular education often suffers from finding appropriate solutions to many of the problems it receives during the educational process, most recently the spread of the corona pandemic (COVID-19), which has led to the closure of universities and educational institutions throughout the world in general and the Kingdom of Morocco in particular. E-learning and distance learning through digital educational platforms are imperative. Therefore, educators in general and university education in particular, must accelerate the adoption of this type of education, activate its role and enhance the competence of its students and teachers to prevent the disruption of the course of education and its activities in emergencies, such as those we now live in. This platform is available at the expense of the Faculty of Sciences Semlalia, Cadi Ayyad University, with a role to support distance learning under current global health conditions and how it is designed and managed to support and sustain education.

The E-labs platform has been established to adapt quickly and flexibly to students to do remote practical works in an atmosphere of desire and enthusiasm. The smart platform was first designed in 2017 with software styles such as PHP, HTML, CSS, Python, JavaScript, LabVIEW, and MYSQL. Its main role was to perform remote practical works at any time and place.

To achieve the desired effect of this smart digital platform, the following problems need to be addressed, i.e. the lack of technology requirements and capabilities to respond to quality operation; a mechanism for the continuous training of professors on how to design real practical works; mechanism for the continuous training of students to engage both in remote and face-to-face learning modes; provision of digital programs relevant to students' needs and facilitate the roles of professors so that they are more connected and motivated to use platform tools.

Comments: As shown by the case, a smart online platform for practical works is of great value to teaching and learning amid the COVID-19 crisis, especially for some academic programs with requirements on practical works. But such platforms and related courses development must closely reflect student needs, and must ensure continuous investments and improvements. For the effective use of remote practical works platforms, it is necessary to further train teachers and students to enhance their implementation abilities and to motivate them to use the platforms.

Source: Abdelali El Gourari , Mustapha Raoufi & Mohammed Skouri (Faculty of Sciences Semlalia, Cadi Ayyad University)

Case 11 Philippines: Post-COVID educational innovations from practices and challenges of teacher education institutions during the pandemic

The Philippine government imposed a total lockdown in mid-March 2020 as a primary measure to prevent the widespread of COVID-19 disease. The education sector likewise has been greatly affected by the prolonged lockdowns in the country. UNESCO (2020) identified over 28 million Filipino learners at the basic and higher education institutions who have been affected by the strict quarantine measures imposed by the government.

Facing inevitable drastic transitions with limited preparation time, all HEIs are challenged to immediately transform the entire education system by adopting flexible learning and making whatever necessary adjustments and innovations to achieve learning continuity for all students amidst the pandemic. In particular, the important role of teacher education institutions (TEIs) in this time of crisis is very crucial not only to the higher education sector where it operates but also to the basic education system for which it serves.

This case study presents the contextual implementation of the Commission on Higher Education Memorandum Order No. 4, among the select TEIs in the Philippines. Using the various components of flexible learning modalities as a theoretical lens, the study revealed the fundamental significance of institutional policy on flexible learning that must be based on the contexts, resources, and capabilities of the institution. Since effective communication is one of the key elements to policy success, there should be an established and strong line of communication between teachers and learners through available and appropriate means to promote healthy student-teacher engagement, relevant mentoring, and feedback mechanisms. The integration of technology in flexible learning during the pandemic has brought major progress in the Philippine higher education system. Through this, content and learning materials development and evaluation and assessment have been digitized, though can also be print-based to cater the needs of students that do not have technological resources. Finally, flexible learning during education emergencies requires strong support services specifically on logistics, training, and well-being.

The flexible learning experiences of the TEI participants presented challenges and opportunities that can be a reference for practice and scholarship. Particularly, the challenges of flexible learning in this study focuses on the lack of resources in order to deliver equitable higher education. This suggests that the government must allocate funds to further improve the necessary technological infrastructures so that education can propel to the direction that it should take. HEIs at their level can establish partnerships with industries such as telecommunication companies, professional or civil society organizations, international or local agencies in order to address the challenges on internet connectivity and other concerns. HEIs must also

prioritize ICT training and upskilling of faculty to align with the agile education environment which the pandemic has highlighted. Sharing of resources through consortia, coalition, or networking can be put together to optimize capacity-building programs across different organizations.

Comments: This case shows that a strategic plan on the national level is needed, along with the supporting systems for plan advancement, during the adoption of more flexible digital learning amid the COVID-19 pandemic. That said, the landing and implementation of these systems requires concerted efforts by multiple parties as well as comprehensive supports and safeguards. The aim is to make the learning opportunities equitable and accessible to all students. An extremely important aspect in this process is the interaction, feedback and synergies between teachers and students.

Source: Jerome T. Buenviaje (Dean, College of Education, University of the Philippines Diliman)

Summary

From the above cases, we can see that the digital transformation of higher education teaching and learning is mainly affected by the international trends in educational informationization; it consists largely of online teaching practices adopted by various countries in response to the COVID-19 pandemic. These cases show that the digital transformation efforts in HEIs across countries currently focus mainly on 1. Universities, academic programs, teachers and students. Given the digital transformation of teaching and learning at the HEI level has a global impact, HEIs must plan at the top level and design schemes that could systematically promote digital transformation, which involves a clear digital transformation vision and safeguards for academic programs, courses, teachers and students. Among which, as an essential basis, HEIs must develop high-quality physical and cyberspace environments; some of the above-mentioned cases prove the necessity and importance of building smart online learning platforms. For the digital transformation at the academic program level, digital-informed programs should be rooted in what a digital society asks from an HEI graduate, focus on fostering students' all-rounded qualities, and try to reinvent the talent training model.

On the digital transformation of courses and delivery, various initiatives and experiments were conducted on areas including curriculum development, the co-building and sharing of quality course resources and how to perceive and reform teaching methods. For example, some HEIs have developed curricula with the needs of employers in mind; integrated the high-quality teacher and course resources through building a HEI community; launched course mutual-recognition, micro-credential and micro-certification programs; and adopted a blended teaching methodology. Regarding the digital transformation of teachers' professional competencies, several cases have shone light on the importance of training and adopted multiple training strategies to drive teacher application, including rolling out appointment-based training sessions based on teachers' needs, letting first-mover-teachers train and guide peers, and combining training with actual teaching work.

Moreover, the cases on teachers' training also demonstrate the role of external support, such as the professional training program provided by UNESCO. The digital transformation of student learning, for its part, decides whether digital learning can be adopted by and benefit students. This requires establishing a digital, adaptive, ubiquitous learning environment for students, setting up a student learning community, and providing timely, accurate and personalized learning assessment and support services, especially the enhanced interaction between teachers and students. The aim is to increase the digital literacy of students and facilitate learning outcomes.

Admittedly, the digital transformation of higher education teaching and learning is still at the exploratory stage, with considerable room for innovations. This also calls for a more systematic planning and reinvention of the QA system for teaching and learning, and requires stakeholders to take part in the evaluation. The above challenges are problems confronting the current digital transformation endeavor. Yet, challenges indicate opportunities for improvement; international organizations, governments and HEIs could jointly explore effective strategies and useful experience for the digital transformation of teaching and learning.