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China's Approach to Digital Transformation of Higher Education

Digital Infrastructure and (Open) Educational Resources

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1. Introduction

China is a huge country both in terms of geography and population with a territory of 9.6 million km2 and a population of over 1.4 billion. It is divided into 23 provinces, 5 autonomous regions, 4 municipalities directly under the Central Government, and 2 special administrative regions. Ever since the founding of the People's Republic of China in 1949, education has always been top on the priorities of governments at all levels with no efforts spared to enhance the educational level of the whole population. Currently, China implements the policy of nine-year compulsory education (six years of primary school education and three years of junior middle school education) free of cost. Public education is the norm although private education, from K-12 to higher education, is encouraged and has made significant progress in the past few decades.

Due to historical and geographic reasons, social and economic development varies from one province to another, and even within a province, which results in disparities in educational development including educational opportunities, resources and quality. In light of this reality, addressing educational inequalities and providing equitable access to quality education for all have become a primary concern of the Central Government. Numerous measures and incentives have been taken and adopted in the continuing attempt to deliver this goal and the latest initiative which started in the turn of the century is the use of modern technology for the purpose. Digital transformation is now regarded as a national strategy for education in the 21stcentury by the Chinese Government. The emphasis that the Central Government has laid on the role of digitalization in achieving balanced development of education countrywide is echoed by the formulation and implementation of corresponding national policies, initiatives, action plans, and schemes in the past two decades. With tremendous inputs in terms of public funds and human resources as well as effective orchestration, the digitalization drive has borne fruits, especially in infrastructure and digital educational resources, and the concept of digital transformation is now ingrained in the discourse of education in general and gradually accepted by educators and other educational stakeholders.

Overall, the higher education sector is in the vanguard of this digitalization drive which has been integrated into the institutional (both long- and short-term) strategy of all colleges and universities, in particular public higher education institutions (HEIs). The most recent embodiments of the digitalization drive are the application of artificial intelligence and the emergence of 5G university campuses. As far as HEIs are concerned, digital transformation is to serve the dual purpose of responding to the national strategy and their own institutional strategy. For the former purpose, contributing

to the national strategy of digital transformation of education is their social responsibility, especially for those publicly-funded HEIs. For the latter purpose, HEIs are intrinsically motivated to embark on the digitalization drive in order to improve learning, teaching, and research which can give them an advantage over other HEIs in the fierce competition both at home and abroad. A recent pertinent example is that digitally-prepared universities have managed to cope with the COVID-19 pandemic far more efficiently and effectively and to the greater satisfaction of their students than their less-digitally-prepared counterparts. In a sense, the pandemic has reinforced the embedding of digital technologies in (higher) education, an impact which will probably shape the landscape of (higher) education in the years to come.

Digitalization has positive connotations in the discourse of Chinese (higher) education, in particular the discourse in and around its education policies, although it should be admitted that there may be a gap between rhetoric (policy) and reality (practice), just as is the case in other parts of the world. It is also worth pointing out that China implements a highly centralized higher education system. Therefore, the Chinese model of digitalization may be different from those in other socio-political contexts. For example, the macro-level factors tend to play a bigger role in the digitalization drive in China, which may be very conducive to pooling limited resources and mobilizing all stakeholders for the pursuit of a common goal. This is particularly significant when China was less developed and could not provide an adequate budget for education and when it remains divided across the country in terms of educational access, quality and resources. On the other hand, the centralized mechanism may have its downsides. It is hoped that these contextual factors need to be borne in mind when reading, interpreting and even learning from this chapter.

In line with the specific research questions of EduArc, and also given the nature of chapter, the most dominant method used in this chapter is the secondary research method with the methods of case study and interview adopted mainly for the micro-level part. Data for the secondary research are government documents and institutional documents as well as materials found on official websites, including government, government department or agency, university and college, and association/partnership websites. Content analysis is made of these materials, expert opinions are sought, and discussion occurs among the project team. The researchers are insiders, hence probably with advantages and disadvantages. To avoid possible research bias, findings are often triangulated to ensure their accuracy.

This chapter aims to give an overview of digital transformation in China's higher education sector at macro-, meso- and micro levels. The macro-level part will review national policies, standards, infrastructure construction as well as the main driving forces behind the digitalization drive. The meso-level part will cover regional and/or alliance partnerships, institutional digitalization strategies, development of (digital) (open) educational resources, and institutional infrastructure construction. The micro-level part will focus on staff and student perspectives regarding application of digital technologies in teaching, learning and administration. It is hoped that lessons learnt from China are of relevance to other parts of the world. Furthermore, comparison of different country reports may also carry rich implications for policy-makers, administrators, managers, academic staff and students, yielding fascinating new insights into digitalization of higher education.

2. Digital Transformation in the Chinese Context

Throughout the world, higher education has been undergoing digital transformation and China is no exception. The importance that the Chinese government attaches to digital transformation of (higher) education has always been consistent, as can be seen in the rest of this chapter. For example, it is stipulated in the Education Law of the People's Republic of China (hereafter simply, The Education Law) that

> *The people's government at the county level or above shall develop education via satellite television and other modern means for teaching and learning, and the administrative departments concerned shall give such development priority and support.*
>
> *The State encourages the wide use of modern means in teaching and learning by schools and other institutions of education' (Chapter VII, Article 66) (The National People's Congress of the People's Republic of China, 1995).*

In 2015, the Education Law was amended and new content is now added to Article 66 to the effect that the State shall promote the use of information technology (IT) in education, speed up construction of digital infrastructure and take advantage of IT to facilitate access to and sharing of high quality teaching resources and improve teaching and administration (The National People's Congress of the People's Republic of China, 2015). The Higher Education Law of the People's Republic of China (hereafter simply, The Higher Education Law), which was passed in 1998 and amended in 2015, also makes it clear in Chapter II Article 15 that 'The State supports higher education conducted through radio, television, correspondence and other long-distance means' (The National People's Congress of the People's Republic of China, 1998).

Sharing of educational resources is also encouraged in the Higher Education Law:

> *The State encourages collaboration between higher education institutions and their collaboration with research institutes, enterprises and institutions in order that they all can draw on each other's strengths and increase the efficiency of educational resources (Chapter 1, Article 12) (The National People's Congress of the People's Republic of China, 1998).*

Before we move on to other sections, it would be desirable to clarify terminology used in this chapter. First, in the Chinese context, informatization is the 'standard' term for the use of IT while digitalization is more often used to refer to the use of a specific technology, i.e. digital technology, rather than as an umbrella term. But given the background of the audience of this report, we will use digitalization rather than informatization as an umbrella term. Second, there is no official definition of Open Educational Resources (OER) in China. Judging from our knowledge of this field, it seems that Chinese policy makers, researchers, and practitioners follow 'by default' the definition of United Nations Educational, Scientific, and Cultural Organization (UNESCO), according to which OERs are

> *teaching, learning and research materials in any medium, digital or otherwise, 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 (UNESCO, 2012).*

3. Digital Transformation of the Chinese Higher Education System

3.1 Facts and figures

According to the Higher Education Law,

> *The State Council shall provide unified guidance and administration for higher education throughout the country.*
>
> *The people's governments of provinces, autonomous regions and municipalities directly under the Central Government shall undertake overall coordination of higher education in their own administrative regions and administer the higher education institutions that mainly train local people and the higher education institutions that they are authorized by the State Council to administer (Chapter 1, Article 13) (The National People's Congress of the People's Republic of China, 1998).*

The establishment of undergraduate or post-graduate HEIs is subject to review and approval by the Ministry of Education (MOE) under the State Council and the establishment of junior colleges whose graduates are not degree holders is subject to review and approval by the people's governments of provinces, autonomous regions and municipalities directly under the Central Government but needs to be reported to the State Council.

The Higher Education Law also ensures funding for public HEIs and encourages non-State sectors to be involved in the provision of higher education (see Chapter VII 'Input to Higher Education and Guarantee of Conditions' for details):

> *The State institutes a system wherein government appropriations constitute the bulk of the funds for higher education, to be supplemented by funds raised through various avenues, so as to ensure that the development of higher education is suited to the level of economic and social development.*
>
> *The State Council and the people's governments of provinces, autonomous regions and municipalities directly under the Central Government shall, in accordance with the provisions in Article 55 of the Education Law, ensure that funds for State-run higher education institutions gradually increase.*
>
> *The State encourages enterprises, institutions, public organizations or groups and individuals to invest in higher education (Article 60) (The National People's Congress of the People's Republic of China, 1998).*

Implied in Article 60 of the Higher Education Law are two messages. One is that there are both public and private colleges and universities in China and the other is that public HEIs are the most dominant force in China's higher education sector. With the rapid growth of economy in the past four decades, the Chinese Government's investment in education has been on the rise all the time, including higher education. Therefore, unlike their foreign counterparts, Chinese HEIs, especially public colleges and universities are financially more secure and stable, even in recent years of global economic austerity which has had a significant impact on colleges and universities around the world (Qayyum & Zawacki-Richter, 2018; Zawacki-Richter & Qayyum, 2019).

Up to May 31st, 2017, there were 2914 HEIs in China [1], including 2631 conventional campus-based HEIs and 283 adult HEIs (see the list of Chinese colleges and universities for details) (MOE, 2017a). Of all these HEIs, 75 are affiliated to the Chinese Ministry of Education, about 30 to other ministries and the rest of them to the provincial governments or their education authorities where they are located, hence often referred to as 'local colleges and universities'. It should also be noted that there are 747 private HEIs with an enrolment of 6,284,600, representing about 17% of the total higher education student population in China. The latest statistics show that China has a higher education student population of 37,790,000, reaching a gross enrolment ratio of 45.7% in higher education (MOE, 2018a).

3.2 Current state of overall digital transformation

In 1998, MOE announced its Action Plan for Invigorating Education towards the 21st Century (hereafter simply, the Action Plan), which called for the implementation of Modern Distance Education Initiative to build an open education network and establish a lifelong learning system in China (MOE, 1999a). It was argued that Modern Distance Education Initiative should make good use of a variety of educational resources and contribute effectively to equal access to educational resources, which was of significant relevance to China where there was still a shortage and uneven distribution of educational resources (MOE, 1999a). Measures to build or improve technology infrastructure for the implementation of this initiative were outlined in this official document (MOE, 1999a). In 1999, the State Council published its Decision to Deepen Educational Reform and Fully Promote Quality-oriented Education (hereafter simply, the Decision), Article 15 of which clearly voices the Chinese government's strong support to the enhancement of the use of educational technology and digitalization of education in addition to the establishment of a modern distance education network (State Council, 1999). As pointed out above, digital transformation can trace its root to the Education Law. Nevertheless, we may be justified in arguing that what started digital transformation materializing were MOE's Action Plan and the State Council's Decision.

In 2003, as one of the measures to implement strategies and decisions from the Central Government and its education authorities to modernize education in China, MOE launched an initiative to develop 'Top-quality Courses', encouraging HEIs around the country to be actively engaged in this project by developing and submitting their courses for review with the aims to effectively promote innovation in education, deepen teaching reform, facilitate the use of modern IT in teaching, and share high quality teaching resources. MOE pledged to subsidize the project and organize reviews of these courses. Courses which received high ratings by a panel would be awarded the title of 'State-benchmarking Course' and be curated on a website exclusively for the purpose of sharing these courses (http://www.jingpinke.com) (MOE, 2003) [2]. From 2003-2010, nearly 4,000 courses were recognized as 'State-benchmarking Course' (Hu, Yang, Wei & Yang, 2014; Wang & Håklev, 2012).

In the same year, China Open Resources for Education (CORE) was established following the MIT OpenCourseWare conference in Beijing. CORE was a non-profit organization,

> *a consortium of universities that began with 26 IET Educational Foundation member universities and 44 China Radio and TV Universities, with a total enrollment of 5 million students. It aimed to provide Chinese universities with free and easy access to global open educational resources and provides the framework for Chinese-speaking universities to participate in the shared, global network of advanced courseware with MIT and other leading universities (China Open Resources for Education, n. d.).*

Ever since these early initiatives, digitalization has been gaining increasing momentum with more and more national policies made and introduced with the aim to encourage and speed up digital transformation in China's (higher) education sector, as is evident in the following sections of this report. Governments at all levels have invested heavily in digitalization infrastructure and capacity building for this purpose. In 2016, Chinese Premier Li Keqiang advocated the integration of the idea of Internet Plus into every sector of the society, including education, in his report to the National People's Congress of the People's Republic of China on behalf of the Central Government, which can be regarded as the culmination of the Government's emphasis on digitalization in the past decades and has ever since sparked greater enthusiasm for digital transformation in the whole society.

To provide a snapshot of the current state of digital transformation within higher education in China, a preliminary analysis was conducted of the 13th Five-Year (2016-2020) Development Plans of 75 universities which are directly under MOE[3] (MOE, n. d.). Of the 75 universities, 56 mention their achievements in terms of digitalization in the 12th Five-Year period (2011-2015); 48 outline their digitalization strategies for the 13th Five-Year period; and all of them delineate specific digitalization transformation measures in terms of instruction, learner support, administration and management as well as the university's for-profit businesses (see Section 5.2 for details). It may be unrealistic to predict how well the goals and objectives set in these five-year development plans will be delivered at the end of the 13th Five-Year period. Nevertheless, what these development plans display is really a promising vision for digital transformation in the Chinese higher education sector in the foreseeable future.

4. Digital Transformation at the Macro Level

4.1 OER Policy-making

As mentioned earlier, MOE's Action Plan (MOE, 1999a) and the State Council's Decision (State Council, 1999) initiated the digital transformation movement in the (higher) education sector. But it was not until in the last decade that policies were formulated and introduced one after another in an attempt to boost the digital transformation process and maximize the benefits that it has brought forth.

In 2010, Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010-2020) (hereafter simply, the Outline) was published (Central Committee of the Communist Party of China & State Council, 2010), Chapter 19 of which is dedicated to acceleration of digital transformation, including speeding up infrastructure construction, developing and using high quality educational resources on a greater scale, and building a national education information management system.

In order to implement the Outline, MOE formulated its Ten-Year Development Plan for Educational Digitalization (2011-2020) (hereafter simply, the Ten-Year Development Plan) (MOE, 2012a), which delineates the overall strategy (including current state and challenges, principles and guidelines, and development goals), development targets (including narrowing digital divide, sharing high quality educational resources, accelerating digitalization in vocational education, promoting integration of IT and higher education, improving the lifelong learning system, enhancing education management efficiency, upgrading public service capacity, strengthening professional development, and ensuring sustainability), action plans, and guarantee measures.

In 2015, the State Council issued its guidelines on promoting the idea of Internet Plus in all walks of like (State Council, 2015), which advocates the establishment of an innovative mode of education provision. Internet enterprises and educational institutions are encouraged to collaborate in developing digital educational resources and providing online education to meet market demands; schools are urged to make full use of digital educational resources and online education platforms, experimenting with new models of online education, widening access to high quality educational resources and contributing to educational justice. The guidelines also recommend sharing of online course materials in the provision of degree/diploma programs, offering more Massive Open Online Courses (MOOCs), exploring mechanisms for recognition and transfer of online learning credits, and accelerating transformation of higher education business models (State Council, 2015). In the same year, MOE called for HEIs to develop and use MOOCs more extensively and effectively (MOE, 2015a) and issued its guidelines on comprehensively promoting digital transformation in education in the 13th Five-Year period, for example, adopting and localizing MOOCs and Clipped Classroom practice as well as innovating instructional management in HEIs (MOE, 2015b).

In 2016, MOE issued its 13th Five-Year Plan for Educational Digitalization (hereafter simply, MOE's 13th Five-Year Plan) (MOE, 2016), the main goal of which was to better implement the Outline published by the Central Committee of the Communist Party of China and the State Council (2010) and the Ten-Year Development Plan (MOE, 2012a), with the overarching aim to advocate such development ideas as innovation, coordination, green, open and sharing in order to establish an online, digital, personalized and lifelong education system and build a learning society where anyone can learn anywhere and anytime. When it comes to HEIs, it urges colleges and universities to continue to develop and open up their online courses to the general public and encourages HEIs affiliated to MOE and other ministries to help HEIs in West China to carry out blended instruction reforms by taking advantage of open online courses. The Central Government promises to support and push forward HEIs' ongoing efforts to share digital educational resources, encouraging them to establish online education alliances and university-enterprise alliances for continuing education in order that HEIs' high quality educational resources can be put to better use (MOE, 2016).

In January, 2017, the State Council published The 13th Five-Year Plan for National Educational Development (hereafter simply, the National 13th Five-Year Plan) (State Council, 2017), which outlines China's major objectives and targets for the education sector at the national level over the period 2016-2020. There are 38 mentions of the term 'educational resources' in this document which has a length of about 42,000 Chinese characters. There is a subsection on developing 'Internet Plus' education which covers four areas: accelerating the development of a sound system of rules and regulations, further improving infrastructure conditions, committedly pushing forward in-depth integration of IT and education, and continuing to promote co-construction and sharing of high quality educational resources. In terms of rule-and-regulation setting, it highlights the need to formulate standards for the quality of online education and digital educational resources, develop approval and monitoring mechanisms for digital educational resources, protect authors' intellectual property rights and encourage the business sector and other non-government sectors to develop digital educational resources, contributing to the emergence of a market conducive to the growth of digital educational resources. In terms of infrastructure, it aims to achieve full coverage of broadband networks and popularization of online instruction environments. Another focal point of infrastructure construction is to continue the construction of a national public platform for educational resources as well as a platform for educational administration and management. In terms of integration of IT and education, teachers are encouraged to make use of IT to enhance their instruction, innovate new instructional methods, and benefit from high quality educational resources by practicing new methods such as Flipped Classroom and blended instruction. Finally, this official document also calls for HEIs to develop open online courses that are in line with their respective expertise, set down instructional quality evaluation criteria and credit recognition rules for open online courses, as well as incorporate online courses into the curriculum and syllabus. Co-construction of educational resources and platforms for OER is also encouraged.

In 2018, MOE issued its Action Plan for Educational Digitalization 2.0 (hereafter simply, Educational Digitalization 2.0) (MOE, 2018b). Educational Digitalization 2.0 sits under the Outline (Central Committee of the Communist Party of China & State Council, 2010), MOE's Ten-Year Development Plan (MOE, 2012a), its 13th Five-Year Plan (MOE, 2016) and the National 13th Five-Year Plan (State Council, 2017). The 19th National Congress of the Communist Party of China (CPC), which was held between 18 and 24 October, 2017, set new goals for all sectors of China, including (higher) education.

Educational Digitalization 2.0 can be regarded as an updated version of previous digitalization plans in order to better respond to the spirit of the 19th CPC National Congress.

The fundamental intention of Educational Digitalization 2.0 is that by 2022 all teachers will teach via digital means; all students will learn via digital means; all schools will have digital campuses; digitalization application and digital literacy of teachers and students will reach a higher level; and an 'Internet Plus' education platform will be built (MOE, 2018b). Of particular relevance to HEIs are the improvement of MOOC provision and the collaboration of HEIs and other social sectors in providing top quality MOOCs. 3,000 State-benchmarking Open Online Courses, 7,000 national-level and 10,000 provincial-level higher education top quality courses, both online and offline, will be developed as 'model courses' setting examples of how IT can be integrated into education. Guidelines on digital campus construction for schools at all levels, including HEIs, will be formulated and put into use. Capacity building for teachers, including HEI teachers, is also placed on the agenda. Compared with earlier digitalization plans, Educational Digitalization 2.0 is characterized by application of cutting-edge technologies such as AI, big data, blockchain technology, and smart devices. Digital transformation is one of the 10 strategic priorities of China's Education Modernization 2035 Initiative and one of the 10 key development tasks of the corresponding Five-year Implementation Plan for Speeding up Education Modernization (2018-2022), both recently issued by the Central Committee of the Communist Party of China and the State Council (2019 a, 2019 b).

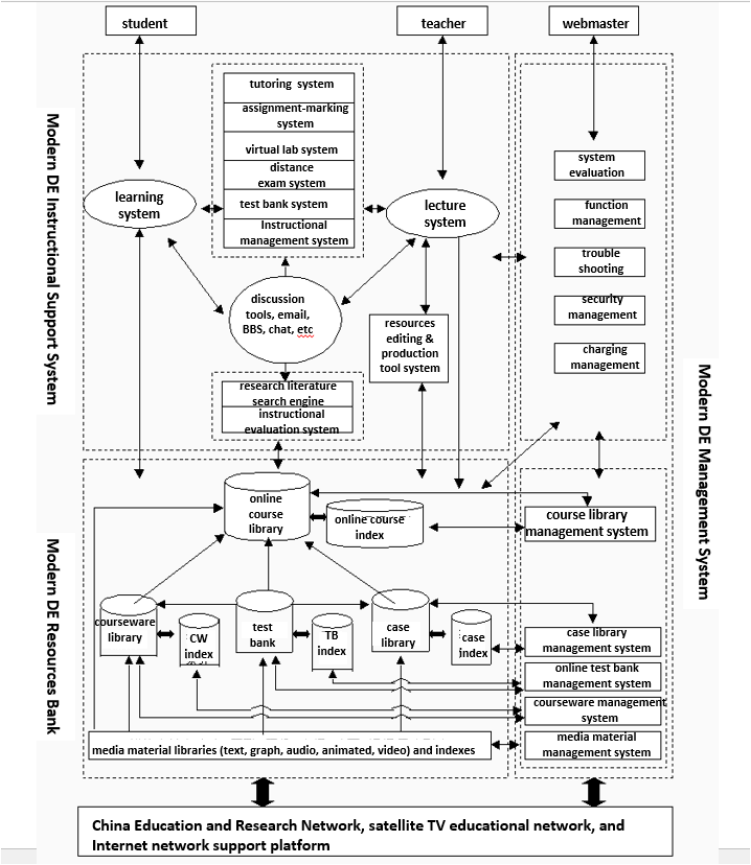
Higher education in China is a highly centralized system although according to the Education Law (The National People's Congress of the People's Republic of China, 2015) and the Higher Education Law (The National People's Congress of the People's Republic of China, 1998) the Central Government delegates some administration and management responsibilities of HEIs to provincial governments. Given the Chinese social system and this centralized feature of (higher) education, the broader policy environment plays a key role in influencing the digital transformation of the country's higher education. An in-depth analysis of the above favorable government policies show that digital transformation in the (higher) education sector has always been considered as some kind of national strategy. Hence, funding and human resources can be guaranteed and relevant barriers can be cleared away more effectively. For example, the last section of MOE's Educational Digitalization 2.0 describes five measures to ensure the successful implementation of this plan (MOE, 2018). The first measure is to strengthen leadership and coordination. China is a geographically vast country with radical differences in different regions, hence the urgent need for strong leadership and coordination. Educational digitalization is listed as an evaluation index of local educational development. The second measure is to innovate new ways of investment in educational digitalization, diversifying sources of financial input. The third measure is to pilot educational digitalization on a small scale and use lessons learnt from these pilot projects to train teachers, managers and administrators. MOE also urges local authorities to create a favorable atmosphere for this transformation and change educators' traditional mindset using both traditional and new media. The fourth measure is to continue cooperation with international organizations and institutions such as UNESCO and to be actively involved in international initiatives of educational digitalization, exchanging experience with international counterparts and learning from each other. The last measure is to assume accountability for the security of cyber space. Chief administrators of educational institutions are held accountable for cyber security and appropriate mechanisms are to be put in place. It is of paramount importance that the Central Government pledges its support to digital transformation. Otherwise, educational institutions would have to struggle to move on with a less promising vision ahead.

4.2 Association and national standards

In 1999, MOE decided to establish the Modern Distance Education Resources Committee (MDERC) and its Expert Panel with the aim to drive the construction of modern distance education resources and assure their quality (MOE, 1999b). The tasks set for this committee included formulating principles and policies for developing modern distance education resources, making resource development plans, coordinating the construction of all kinds of educational resources at all levels, and formulating technological standards.

Figure 1

Modern Distance Education Resources Construction Architecture (MDERC, 2000).



In May, 2000, MDERC issued Technical Specifications for Modern Distance Education Resources Construction (TSMDERC) (trial version) (MDERC, 2000). As is clearly stated in the Preface, this standard focuses on the guidelines for resource developers, production requirements, and functions of the management system, rather than on the data structure of the software system. Parts of the specifications draw on Learning Object Metadata (LOM) model by IEEE LTSC (Learning Technology Standards Committee). Educational resources as referred to in this document include media material library, test bank, case library, courseware library and online courses. Its educational resources development architecture covers an instructional support system and a management system (see Figure 1).

But TSMDERC is not mandatory. Nor is it a national standard in the proper sense of the term. Rather, it is an association standard. MOE's Educational Digitalization Technology Standard Committee (EDTSC) came up with a draft version of Technical Specifications for Educational Resource Construction Information Model CELTS-41.1 CD1.0 in December, 2002, which drew on TSMDERC as well as LOM by IEEE LTSC but never went official (EDTSC, 2002; Q. Li, personal communication, January 3, 2019).

Similar to TSMDERC is Technical Specifications for State-benchmarking Shared Courses Construction (TSSSCC) issued by MOE (2012b). Educational resources as referred to in TSSSCC include basic resources (course profile, syllabus, calendar, lesson plan or presentation slide, key content, assignment, reading list and video lecture) and extended resources (for example, case library, assorted lecture library, multiple-media resources library, discipline-specific knowledge retrieval system, demonstration/virtual/simulation training system, test bank system, assignment system, online self-testing or online examination system, tools for learning, teaching and discussion, as well as online courses based on multiple media). In terms of basic resources, TSSSCC covers the structure, format and technical specifications, and metadata specifications of a basic resource. For example, the metadata of a resource should include Title, Author, AuthorOrg, Copyright, Level, Readers, Subject01, Subject02, ResourceType, MediaType, Keywords, Abstract, CourseTitle, Language and Note (MOE, 2012b). As for extended resources, TSSSCC also creates some

technical requirements. The relationship between these association standards and international e-learning standards and specifications is demonstrated in Figure 2 (Lu & Wei, 2005).

Figure 2

Cross-references of educational resource standards between China and other countries

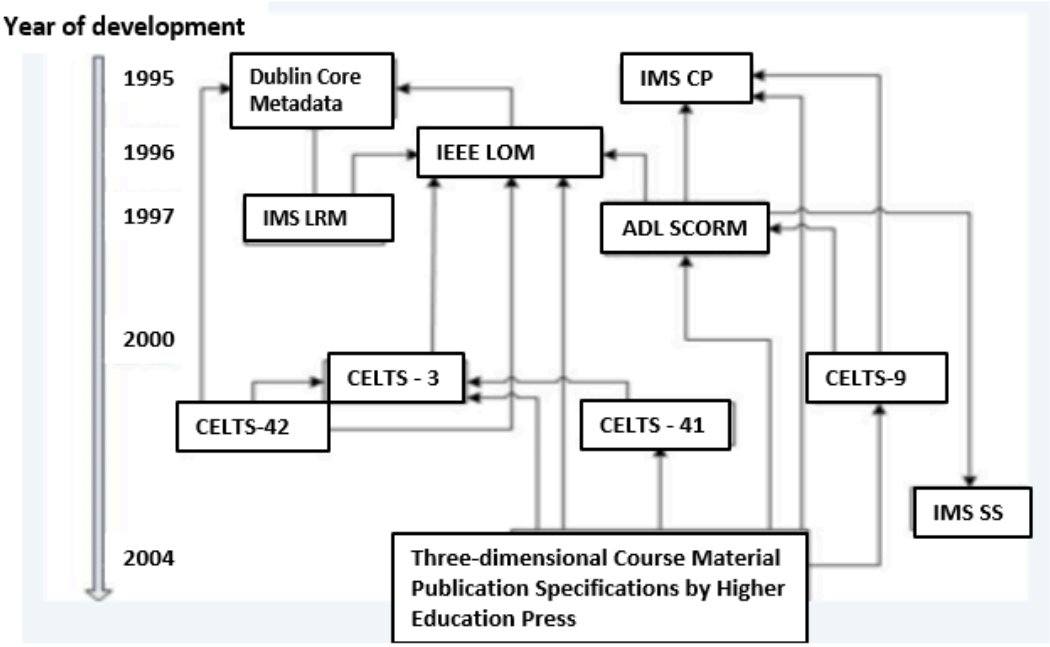


Figure 2: Cross-references of educational resource standards between China and other countries

(Note: CELTS-3 Learning Object Metadata (LOM) Specifications; CELTS-9 Content Packing Specifications; CELTS-41 Technical Specifications for Educational Resource Construction; CELTS-41 Metadata Application Specifications for K-12 Educational Resource)

In addition to these association standards, there are also national standards in relation to educational digitalization in China. Chinese E-Learning Technology Standardization Committee (CELTSC) has developed dozens of national standards ranging from general guidelines to learning resource, learner, learning environment, education management information, multimedia instruction environment, virtual experiment, learning tool as well as e-textbook and e-schoolbag. [4] Standards concerning learning resources include

- GB/T 36347-2018 Information technology - Learning, education and training - Common cartridge profile for learning resources
- GB/T 36350-2018 Information technology - Learning, education and training - Semantic description of digital learning resources
- GB/T 28825-2012 Information technology - Learning, education and training - Classification and codes of learning resource
- GB/T 29807-2013 Information technology - Learning, education and training -XML binding specification for learning object metadata
- GB/T 29809-2013 Information technology - Learning, education and training -Content packaging XML binding
- GB/T 29802-2013 Information technology - Learning, education and training - An information model for test and question
- GB/T 30265-2013 Information technology - Learning, education and training -Learning design information model
- GB/T 29810-2013 Information technology - Learning, education and training - Test and question information model XML binding specification
- GB/T 26222-2010 Information technology - Learning, education and training -Content packaging
- GB/T 36437-2018 Information technology - Learning, education and training - Simple sequencing of courses
- GB/T 21365-2008 Information technology - Learning, education and training - Learning object metadata
- GB/T 36642-2018 Information technology - Learning, education and training -Online courses [5]

These national standards were developed by researchers from universities, research institutes and/or the corporate sector under the leadership and coordination of CELTSC. For example, GB/T 36642-2018 Information technology - Learning, education and training - Online courses was the result of joint efforts by 39 researchers from six universities (Tsinghua University, East Chia Normal University, Shanghai Jiao Tong University, Beijing Normal University, Capital Normal University and Shenzhen University), China Electronics Standardization Institute, and four enterprises. The leading researcher, Professor Li Zheng from Tsinghua University, explained the purpose of this standard in an interview which we believe is applicable to all the above standards (Xin, 2018). According to Professor Zheng, on the one hand, the implementation of GB/T 36642-2018 can break down technical barriers between different platforms and different educational institutions in terms of educational resource sharing; on the other hand, technical standardization is conducive to equal access to education. Moreover, this standard can also facilitate cross-platform comparison and evaluation of online courses and define the basic support functions of an online course platform. In other words, these standards are designed to facilitate development and sharing of digital educational resources so as to optimize their use, reducing repetitive investments and increasing cost-effectiveness.

Like the above mentioned association standards, these national standards are not mandatory either. Therefore, the development of standards can benefit from the involvement of the corporate sector which is a major driving force behind the application of standards in practice, according to Zheng (Xin, 2018). For example, Beijing Muhua Information Technology Co., LTD., which develops and operates the Tsinghua University-funded Xuetangx.com, 'the world's first Chinese MOOC platform, authorized to operate edX courses in the Chinese mainland' [6], is a partner institution of GB/T 36642-2018 Information technology - Learning, education and training - Online courses. The other corporate co-developers of this standard are MOE's Higher Education Press, IFLYTEK Co., LTD (iFLYTEK) (a software enterprise) and UOOC.ONLINE. Beijing Muhua Information Technology Co., LTD has committed to taking the lead in applying this standard to online courses offered at Xuetangx.com.

Up to December, 2018, CELTSC has developed 46 national standards and 12 association standards on educational digitalization (Xin, 2018).

4.3 Driving forces behind digital transformation

Digital transformation at the macro level is driven by the determination of the Central Government to modernize Chinese education, enhance (higher) educational quality, and achieve educational equality by investing in digital infrastructure construction, capacity building, technology-enhanced learning and teaching, and developing and sharing of high quality educational resources. It is a national strategic mission. The determination of the State to pursue educational

digitalization has remained steadfast in the past decades, as is evidenced by the Education Law (The National People's Congress of the People's Republic of China, 1995) and the Higher Education Law (The National People's Congress of the People's Republic of China, 1998) as well as numerous national strategic plans, including several which were dedicated to educational digitalization (see Current state of overall digital transformation under the Digital Transformation of the Chinese Higher Education System section and Policy-making under the Digital Transformation at the Macro Level section).

To deliver the goals of educational digitalization, measures were taken by the Central Government and MOE to ensure the successful implementation of relevant policies, including providing funding, incentive or subsidy, strengthening leadership and coordination, creating a favorable innovative atmosphere, and promoting international cooperation (see MOE, 1999a; MOE, 2012a; MOE, 2018). For example, in 2011, MOE issued a series of suggestions on the development of State-benchmarking Open Courses, which included awarding of honorable titles and provision of funding in the form of subsidy to courses which were well received after being made available online (MOE, 2011). A similar measure was taken by MOE in 2012 to encourage the construction of State-benchmarking Shared Courses (MOE, 2012c).

From 2012 to 2016, eight reviews were conducted of video open courses and altogether 922 resources were awarded the titled of Top-quality Video Open Course with financial support given to the providing universities.[7] From 2013 to 2016, MOE approved 2911 projects on development of State-benchmarking Shared Courses, each of which was granted a subsidy of RMB 100,000 yuan as development fee.[8] Of these courses, 2866 were awarded the title of State-benchmarking Shared Course in 2016[9] and 2017[10] respectively. In 2017 and 2018, MOE awarded 1291 online courses the title of State-benchmarking Open Online Course.[11]

MOE is pushing forward the recognition of MOOC credits, according to the head of the Higher Education Section of MOE (Wu, 2018). So far, over 6 million higher education students have obtained credits by learning MOOCs. MOOCs are believed to be able to break the boundary of traditional education and tear down the walls of brick-and-mortar educational institutions, hence disrupting campus-based classroom teaching and transforming education in a radical manner. Intensive integration of IT and education can afford Chinese HEIs great opportunities to overtake their counterparts in advanced countries (Wu, 2018). This is a very strong motivating force behind the State's strategy of educational digitalization. China has reiterated, again and again, the determination to carry out digital transformation in its (higher) education sector.

4.4 OER Infrastructure: National platforms

In 1994, funded by the Central Government and directly under the supervision of MOE, six elite universities in China 'set up the first education network using transmission control protocol/Internet protocol "China Education and Research Network" (CERNET)' (Zhao & Jiang, 2010, p. 574). CERNET is now accessible all over China with universities and colleges, primary and secondary schools and research institutes as its users, ensuring 'safe and high-speed information exchange among educational institutions both at home and abroad' and ushering in the era of e-campus to Chinese HEIs (Zhao & Jiang, 2010, p. 575). Given its role, CERNET may well be regarded as the meta-infrastructure of digital transformation for Chinese HEIs.

Openness and sharing have been advocated and practiced ever since the initial stage of educational digitalization in China. For example, when MOE initiated a project to develop high quality course resources in 2003 (MOE, 2003), courses which had been awarded the title of 'State-benchmarking Course' were curated on a website exclusively for the purpose (http://www.jingpinke.com), freely available to the general public for five years (Wang & Håklev, 2012). This platform, operated by Higher Education Electronic Audio-Video Press affiliated to MOE, has been restructured and becomes a repository of educational resources both at the undergraduate and junior college/vocational higher education levels, storing a total of 1,299,268 resources in a variety of subjects, including history, management, education, science, engineering, medical science, bio-chemistry, pharmacy, civil engineering, electronic information, textile, food, health care, tourism, arts, design and media.[12] It also puts a comprehensive incentive scheme in place to encourage users to share resources.[13]

In 2011, MOE launched another initiative to develop top quality open courses, with more emphasis on the use of information and communication technology (ICT). Open courses are comprised of two types: top quality video open courses and top quality shared courses. Up to January 3rd, 2019, 992 video open courses and 2884 shared courses are curated on iCourse platform, operated by Higher Education Press affiliated to MOE, which is also home to MOOCs provided by Chinese universities and establishes a space called 'School Cloud' to offer customized service to partner HEIs in relation to the development, management and application of open online courses.

In 2012, the National E-learning Resources Center (NERC) was established and is operated by the Open University of China (OUC) (formerly known as China Central Radio and Television University [RTVU], China's only dedicated distance education institution at the national level governing a national network of RTVUs). Like its developer and operator OUC, NERC has established a national network. So far, NERC has set up 255 branches nationwide with 51,000 courses available. NERC was a deliverable of the HEI undergraduate teaching quality and teaching reform project (MOE & MOF, 2007). One of its sub-projects was the Construction of Online Education Digital Learning Resources Center, undertaken by OUC in 2008. It took OUC five years to construct NERC.

In 2014, NetEase, an Internet technology company and MOE's Higher Education Press started an online education platform - Chinese University MOOC (CUM), curating State-benchmarking Open Courses and providing MOOCs developed by Chinese universities. This is a very popular MOOC platform in China with relatively more information available online. Therefore, the rest of this section will focus on describing CUM.

Like other large MOOC platforms in China, CUM is a centralized platform. Its course development guidelines cover course development specifications and requirements as well as instructions on operating the platform (iCourse Center, 2014). Part I Specifications and Requirements is subdivided into teaching content and course structure. Specifications are laid down on teaching content in terms of video lecture production (length, resolution, format and size, audio quality, image layout, subtitle, and interaction design), teaching materials (types and format), quiz (self-assessment and auto marking), discussion, unit test and assignment, and examination as well as on course structure in terms of duration, two levels of heading and corresponding content, and modes of content delivery. According to the latest statistics (National HEI Teaching Research Center & iCourse Center, 2018), up to December 31st, 2017, CUM provided nearly 2,000 MOOCs, including MOOCs labeled as Chinese University MOOCs (that is, using its own brand name), Chinese Advanced Placement (CAP) MOOCs, vocational education MOOCs, and general open online courses, with engineering, science, life science, economics and management, and computing topping the list of the most popular subjects. Over 10 million learners registered with CUM, with an average enrollment of four MOOCs per person (40,370,000 course enrolments by December 31st, 2017). MOE awarded 490 MOOCs as State-benchmarking Open Online Course for the first time in 2017 (MOE, 2017b) with 65.7% of them (322 MOOCs) from CUM. It is worth mentioning that CUM also offers space for Small Private Online Courses (SPOCs) for partner HEI students. Unfortunately, many OER platforms do not have in place specific evaluation mechanisms for educational resources uploaded, hence failing to assure their quality and compromising users' experience (Dong, Du, Xu, Zheng, & Hu, 2017).

Although CUM is a joint venture by NetEase from the corporate sector and MOE's Higher Education Press, it is non-profit in nature. As a centralized platform, providers of MOOCs need to design and develop their course resources in accordance with CUM's guidelines (iCourse Center, 2014) and upload all the resources to the platform. All the learning activities, assessments and learner support go on through the platform. Learners who have managed to complete and pass a course will be issued an electronic certificate of accomplishment free of charge but can pay to obtain a paper certificate if they so wish (Y. Han, personal communication, January 3, 2019; Hu, Yu & Chen, 2015).

5. Digital Transformation at the Meso Level

5.1 Alliance and subject-based partnerships

Legal and policy foundations

As mentioned above, China is a geographically vast country with blaring disparities in different parts in terms of economic and social developments, including distribution of educational resources. In the light of this reality, cooperation between HEIs and cooperation between HEIs and research institutes, the business sectors and/or other institutions are encouraged in the Higher Education Law so that parties concerned can give full play to their respective advantages and put educational resources to more effective use (The National People's Congress of the People's Republic of China, 1998). Chinese HEIs' awareness of the necessity and benefits of joint development and sharing of educational resources can be traced back to 2003 when they formed CORE to coordinate cooperation in developing open educational resources between HEIs, both at home and abroad.

Given that an effective mechanism to boost co-development and sharing of high quality digital educational resources has yet be to established, as pointed out in the Ten-Year Development Plan (MOE, 2012a), one of the principles and guidelines proposed by MOE in this document is application-driven joint development and sharing of high quality digital educational resources. To achieve this objective, MOE stresses the need to establish an open cooperation mechanism to facilitate government-led, multi-party-involved joint development and sharing (MOE, 2012a). Cooperation in developing sharable digital educational resources is a recurrent theme in this plan. For example, it highlights the importance of joint development and sharing of high quality digital educational resources, comprehensive in-depth integration of IT and education, and promotion of innovations in instruction and administration to ensure educational justice, enhance educational quality and build a learning society. To this end, MOE aims to push forward the formulation of technical specifications and application guidelines for digital educational resources and to develop corresponding review and evaluation index systems (MOE, 2012a). Of particular relevance to the higher education sector are (1) to establish a mechanism for co-developing and sharing higher education resources in order that HEIs can benefit from each other's high quality courses and library resources as well as digital laboratory platforms in instructional practice; (2) to encourage the co-development and sharing of high quality instructional and research resources between East China and West China HEIs; and (3) to support students' inter-institutional selection of online courses and the joint development of these courses (MOE, 2012a).

Cooperation in developing and sharing digital educational resources is also emphasized in MOE's 13th Five-Year Plan (MOE, 2016a), which calls for the establishment of online education alliances and university-enterprise alliances for this purpose. In the same year (2016), MOE announced its Action Scheme for Joint Development of Education in the One Belt and One Road Countries (MOE, 2016b). Cooperation in educational resource development and sharing is one of the recurrent themes in this scheme.

Co-construction of educational resources and platforms for OER is also encouraged in the National 13th Five-Year Plan (State Council, 2017), which points out that co-development and sharing of high quality educational resources can accelerate transformation in educational provision models and learning styles.

In 2018, MOE announced its Educational Digitalization 2.0 (MOE, 2018b), with the establishment of an integrated 'Internet Plus Education' mega-platform as one of its key goals. This mega-platform is intended to integrate public educational resource platforms and support systems of various sorts and at various levels with the aim of building a public system of national digital educational resources. One of the proposed actions is cooperation between HEIs and other social sectors in developing top quality MOOCs (MOE, 2018b).

A preliminary analysis of the 13th Five-Year (2016-2020) Development Plans of 75 universities which are directly under MOE (MOE, n. d.) also shows that some HEIs realize the value-added benefits of cooperation with their counterparts in developing and sharing (digital) educational resources, especially MOOCs and other online course materials.

Given such steadfast policy support in the broader social and political context, it is no surprise that the number of partnerships in this field has mushroomed, in particular in the most recent years. Nevertheless, despite consistent support from the Central Government, cooperation in this field needs strengthening. HEIs, professional associations, and the business sector should be more actively involved in joint development of educational resources and corresponding resource-sharing platforms (Dong, et al., 2017). In other words, a more effective mechanism is needed to ensure the sustainability of these joint efforts, according to Dong et al. (2017). Cooperation in educational resource development and sharing is also influenced by relevant factors. For example, in terms of policy support, recognition and transfer of credits acquired from learning open or sharable educational resources, appraisal of the quality of these educational resources, accreditation of the operation of their platforms, and protection of copyrights, among other things, should be institutionalized (Hu, et al., 2015).

Examples of regional and/or alliance partnerships

CNMOOC [14]

CNMOOC is the official website of Top Chinese University MOOCs Alliance , launched by Shanghai Jiao Tong University in April, 2014, originally aiming to promote mutual recognition of MOOC credits among the 19 HEIs in southwest district of Shanghai and to enable students to study a second degree in the partner universities (Wu, 2015). CNMOOC is an open, non-profit, cooperative educational platform, serving not only the partner institutions but also the general public. [15] It now has 101 partner institutions, including 92 universities and nine other institutions (CNMOOC, n. d.). Up to January 13, 2019, in addition to a micro specialization, it has 957 courses offered on the platform, taught in Chinese (842 courses) and English (115 courses), in the subject areas of philosophy, economics, law, education, literature, history, natural science, engineering, agriculture, medicine, military science, management science, and arts. [16]

University Open Online Courses (UOOC)

UOOC, launched by Shenzhen University in South China, is the website of the UOOC Alliance of Local Universities. As mentioned earlier, of the nearly 3,000 colleges and universities in China, except the 75 universities affiliated to MOE and about 30 others affiliated to other ministries of the Central Government, the rest of these HEIs are often referred to as 'local universities'. UOOC is the first alliance of local universities in China, guided by the principles of joint creation, joint construction, and joint use. It started with 56 member institutions and now this number has doubled, reaching 125 with a student population of three million. About half of the member institutions have provided 309 MOOCs to the platform with an enrollment of half a million students. UOOC has also established relevant rules and regulations to ensure its successful and effective operation, including Charter of UOOC Alliance, Regulations on UOOC Alliance Construction and Operation, and Regulations on Quality Assurance and Mutual Recognition of Credits from UOOC MOOCs. [17] Training sessions both for academics and platform administrators are also held regularly (UOOC, n. d.). But it should be noted that only students from partner universities can register for course study (Wu, 2015). In this sense, it may not be as open as 'open' is commonly interpreted.

Course Sharing Alliance of West and East China HEIs (WEMOOC)

WEMOOC was started by Chongqing University in West China in April, 2013 with 28 top Chinese universities as its first members. [18] Later that year, Peking University was elected as the chair of WEMOOC [19]. WEMOOC now has 132 member institutions [20], aiming to cooperate in developing high quality video online courses, constructing a connected platform for these courses, sharing these resources, and recognizing video online course credits (WEMOOC, 2013a). It also has its Regulations on Course Quality Assurance, which covers course development (types of course content, recommendation procedure, and review of technical specifications and instructional design), management of instructional quality, quality evaluation, and relevant research (WEMOOC, 2013).

In addition to CNMOOC, UOOC and WEMOOC, there are several regional/alliance platforms which are hosted by the CNMOOC provider:

- East China Five-University Courses Sharing Consortium (https://edtechbooks.org/-NiGE) – comprised of five top universities in East China, namely Shanghai Jiao Tong University, Fudan University, Zhejiang University, Nanjing University and University of Science and Technology of China.
- Fujian Open Online Courses Education Alliance (http://www.fooc.org.cn/) – with support from the Department of Education (DOE) of Fujian Province, 42 colleges and universities in the province created this alliance in 2016. Currently, there are 69 courses available online. It now also has 20 member institutions from the corporate sector. [21]
- Jiangsu Alliance of CNMOOC – comprised of 11 top universities in Jiangsu Province with only seven courses provided by Nanjing University. [22]
- Open Quality Courses Shared Learning Center of Heilongjiang Colleges & Universities (CNMOOC)– including 39 colleges and universities in Heilongjiang Province and 16 HEIs outside the province. This is a deliverable of a project led by the provincial government to promote joint development and sharing of open online courses. [23]

Some are hosted on the website of MOE's Higher Education Press:

- Jiangsu HEI Online Course Center – an online instruction platform jointly operated by DOE of Jiangsu Province and iCourse to serve HEIs in the province. Currently, there are 346 undergraduate courses and 133 vocational higher education courses available online. 101 colleges and universities in the province are its members. [24]
- Hebei HEI Courses Online – with 23 member institutions and 112 online courses offered, including MOOCs, open onine courses and SPOCs. [25]
- Shanghai Online Course Center – currently including six top universities located in Shanghai, namely Fudan University, Tongji University, East China Normal University, East China University of Science and Technology, Donghua University, and Shanghai University of Finance & Economics, with 22 MOOCs and six SPOCs available from its member institutions. [26]
- Hubei Online Course Center – offering 156 online courses from 12 HEIs in Hubei Province, including both MOOCs and SPOCs. [27]
- Henan Online Course Center – with 803 online courses, MOOCs, SPOCs, and video open courses available from 26 HEIs in Henan Province. [28]
- Sichuan Online Course Center – having ten HEIs in Sichuan Province as its members, with 189 MOOCs and SPOCs available. [29]
- Guangxi Online Course Center – currently only involving four universities in Guangxi Province which provide nine courses. [30]
- University Open Online Course Alliance of Guangdong-Hong Kong-Macau Bay Area – started by eleven universities from Guangdong Province and established on November 24, 2018. Its members include 52 HEIs, 13 of which are from Hong Kong and Macau. There are now 398 online courses offered. DOE of Guangdong Province promises to provide special funds every year to support the development of online courses (Department of Education of Guangdong Province, 2018). Unfortunately, an Internet search for its website returns zero result.

And some others are hosted by a digital technology company on its course platform – Zhihuishu (Wisdom Tree):

- Open Quality Courses Shared Learning Center of Heilongjiang Colleges & Universities (Zhihuishu – in addition to 93 courses provided by its members - 38 HEIs in Heilongjiang Province, it also introduces 389 courses from HEIs outside the province to the students of its member institutions. [31]
- Shanghai Course Center – started by the Commission of Education of Shanghai, it comprises 30 HEIs from this municipality directly under the Central Government, currently providing 28 courses. [32]
- Open Online Course Alliance of Guangdong Undergraduate Universities – with 66 HEIs from Guangdong Province joining the alliance. 357 courses are available but only 10 are provided by its alliance members. [33]
- The Platform of Higher Learning Online Open Courses in Shandong – led by DOE of Shandong Province, 61 HEIs from Shandong Province form an online course alliance to share high quality educational resources. So far, 39 HEIs have shared 91 open online courses and 379 courses from HEIs outside the alliance are introduced to the platform. [34]
- Hainan HEI Course Sharing Alliance – led by DOE of Hainan Province, 18 colleges and universities in Hainan Province formed this alliance in 2016. [35] Currently, there are 35 online courses shared online. [36]
- Jilin HEI Course Sharing Alliance – comprised of 53 HEIs from Jilin Province, the alliance has 84 courses on offer. [37]

Examples of subject-based partnerships

CNMOOC, iCourse and Zhihuishu (Wisdom Tree) also host some subject-based platforms.

China HEI Computer Education MOOC Alliance (http://www.cmooc.cn/#jgsz)

In December, 2014, the Alliance was created with coordination and organization from MOE Instruction Steering Committee of HEI Computer Science Programs, MOE Instruction Steering Committee of HEI Software Engineering Programs, and MOE HEI Computer Curriculum Steering Committee. [38] It is a MOOC-based computer education community with 214 colleges and universities from 31 provincial-level administrative divisions (including three member institutions from the Army). [39] Currently, it offers 37 MOOCs and 23 SPOCs. [40]

The Pilot Software Engineering Schools Association

The Association was established in November, 2014 with approval from MOE's Department of Higher Education, joined by software engineering schools from 37 colleges and universities around the country. [41] 38 courses are on offer. [42]

Library and Library Science Online Course Alliance

Created by MOE Steering Committee of HEI Library and Information Science, MOE Instruction Steering Committee of HEI Library Science, and iCourse in January, 2017 [43], the Alliance has 32 university libraries and 33 schools of management, of information management, and of computer science and IT as well as departments of library information and archive sciences from HEIs around the country. [44]

China HEI Mathematical Modeling Course Center

Jointly constructed by the organizing committee of Contemporary Undergraduate Mathematical Contest in Modeling (CUMCM) and Higher Education Press, the Center provides video open courses, resource sharing courses, MOOCs and SPOCs on mathematical modeling.

Huaxia Yuefu Music Online Course Union

Formed by the National Research Center of HEI Instruction, Music Education Society under the Chinese Musicians Association, and iCourse, the Union aims to engage Chinese HEIs and other institutions in developing open online music courses. 10 music courses are available online now. [45]

Foreign Trade Vocational Education MOOC Alliance

Established in May, 2016 by a dozen of vocational secondary and higher education institutions in this sector, [46] it now has 15 member institutions but only two courses are available which are developed by its members. [47]

Traditional Chinese Medicine HEI Course Sharing Alliance

Started by Shanghai University of Traditional Chinese Medicine together with 16 other HEIs in the sector in May 2015, [48] it is dedicated to developing and sharing high quality online courses on traditional Chinese medicine. It now has 19 traditional Chinese medicine universities as its members. [49]

People's Medical Publishing House MOOCs

This is the platform of Chinese Medical Education MOOC Alliance started by People's Medical Publishing House together with 53 medical universities as well as Chinese Medical Association and Chinese Medical Doctor Association in 2014. Nearly all medical colleges and universities in China (about 200 HEIs) have now joined the Alliance. [50] Currently, the platform offers 50 MOOCs with another 68 in production and 1866 open courses. It is worth mentioning that some MOOCs and open courses target secondary medical education and medical professional development. [51] 30 universities use their cloud service for SPOC delivery.

China MOOCs for Foreign Studies (CMFS)

As stated on its website,

> *Initiated by Beijing Foreign Studies University, China MOOCs for Foreign Studies (hereafter referred to as CMFS) was founded on December 23, 2017 in Beijing, China. It is a nationwide nonprofit organization formed by foreign studies universities and colleges endeavoring to promote MOOCs of foreign languages and cultures in China. At present, CMFS has 136 member universities and colleges.*

UMOOCs is the official website of the CMFS' open courses. As an online course platform for universities and colleges, it offers high-quality foreign studies courses online from universities both at home and abroad, and provides course certificates from these universities. The platform enables CMFS members to share their courses and promote the innovative language teaching methodologies and models in China. On UMOOCs, universities can build their own courses, share courses with other universities, and achieve credit recognition. [52]

Quality assurance of regional/alliance and subject-based partnerships

As is obvious from the above examples, whether regional, alliance-affiliated or subject-based, partnerships in constructing and sharing digital educational resources develop at different rates. Some are well developed while others are almost in name only without substantial input and significant engagement from its member institutions.

All alliances/platforms have their quality assurance mechanisms. For example, UOOC members have to follow UOOC Rules for MOOC Production, which covers identification of courses to be developed as MOOCs, course production, course uploading, organization of instruction, and quality assurance mechanism with an attachment detailing technical specifications for creating a video lecture (UOOC Alliance of Local Universities, n. d.). As mentioned earlier, it also puts in place Regulations on UOOC Alliance Construction and Operation, and Regulations on Quality Assurance and Mutual Recognition of Credits from UOOC MOOCs. WEMOOC also puts Regulations on Course Quality Assurance in place to guide course development, management of instructional quality, quality evaluation, and research (WEMOOC, 2013).

The platform of the Shandong alliance - Platform of Higher Learning Online Open Courses in Shandong has to follow rules set down by DOE of Shandong Province (2017) which stipulate in detail measures to ensure the quality of open online course development and sharing. China HEI Computer Education MOOC Alliance (2015) issued its Guidelines on Course Development, including the approval procedure of a course, basic requirements of course production, and support from the alliance. It has three committees in relation to quality assurance, namely Training Committee, Quality Specification Committee and Course Development Committee, each of which has to obey their respective rules and regulations. [53] Shanghai Course Center formulated a series of standards to be followed by its course providers. For example, its Standards for Live-broadcast, Interactive, and Recording Lecture Halls includes very specific processes and technical specifications for the construction of such a lecture hall and its use. [54] It is the same case with its Standards for Sharable Course Video Lecture [55] and How to Watch Live-broadcast Lectures in the Lecture Hall. [56] Moreover, its Instructor Manual provides detailed information about how to prepare instructional materials, how to carry out

instructional activities, and how to acquire IT support, among other things. [57] Jilin HEI Course Sharing Alliance has a dedicated section on quality assurance in terms of course development, course delivery and platform operation in its Charter, [58] although relevant rules, regulations, and specifications are not openly available. This is also exactly the case with the Charter of Traditional Chinese Medicine HEI Course Sharing Alliance. [59]

Hainan HEI Course Sharing Alliance (2018) issued its Quality Standards for and Regulations on Sharable Course Development. In addition to requirements for course components, its quality standards section also lays down rules for the design both of online course (instruction) and face-to-face activities (if a course is designed to be delivered in a blended mode) as well as the design for course assessment and course evaluation. Procedures of application for sharable course development and selection of courses to be shared among alliance members are formulated in this document which also specifies types of teacher professional development opportunities to be offered.

5.2 HEI digitalization strategies

As mentioned earlier, there are nearly 3,000 colleges and universities in China where Higher education is a highly centralized sector. Given that educational digitalization is a national strategy, we may as well assume that all HEIs have their own digitalization plans or measures accordingly to be in line with the national digitalization strategy. Nevertheless, it would be impossible to look at the digitalization strategies of all these HEIs. Therefore, we will focus on the 75 universities which are directly under MOE. To be specific, we will examine their 13th Five-Year (2016-2020) Development Plans, all of which are available on the MOE website (MOE, n. d.), to see what role digitalization is intended to play in the overall development of these universities.

As pointed out earlier, of the 75 universities, 57 mention their achievements in terms of digitalization in the 12th Five-Year period (2011-2015); 48 outline their digitalization strategies for the 13th Five-Year period in an explicit manner, whether in a section or in a subsection, or even in an independent paragraph with a corresponding title; and the remaining 27 HEIs delineate their specific digitalization transformation targets in statements about instruction, learner support, administration and management as well as the university's for-profit businesses. In this subsection, we will review and discuss the institutional digitalization strategies in more detail.

Institutional digitalization strategies

All the 48 universities whose 13th Five-Year (2016-2020) Development Plans include institutional digitalization strategies focus on the enhancement of efficiency and effectiveness in administration, management and support as the goal of digitalization transformation. For example, all of them mention strengthening the construction of digital infrastructure, including online platforms, cyber security, resource-sharing environment, data-sharing facilities, mobility, and so on. 35 of them plan to make the most of digital technology to improve decision-making, routine management and student services. 20 of them mention the goal of constructing or upgrading their digital libraries to better support research as well as learning and teaching. Staff capacity building, inter-university collaboration in resource sharing and instruction, as well as credit recognition and transfer are also specifically mentioned in the digitalization strategies of some universities.

In sharp contrast to the overwhelming importance attached to administration, management and support services, innovation in instructional models and in modes of learning are specifically mentioned in the institutional digitalization strategies of 18 universities although as many as 74 universities specify their targets for instructional innovation elsewhere in their development plans.

Specific intended digitalization targets

Take Renmin University of China (RUC) for example. RUC's digitalization strategy is comprised of three parts (RUC, 2016, pp.70-72). The first aspect is IT-driven transformation of and innovation in instructional and research models. When it comes to instructional models, the targets include: (1) transforming the existing digital environment into a smart one; (2) enriching and improving high quality digital educational resources and software tools; (3) adopting a variety of instructional methods, for example, heuristic, inquiry-based, discussion, and participatory, and encouraging development assessment to establish a new instructional model embodying learner-centeredness; (4) encouraging

students to carry out active learning, autonomous learning and cooperative learning using IT such as Cloud Classroom; (5) enabling students to cultivate the habits of taking advantage of IT in their learning so that they can develop personal interests and enhance learning quality; and (6) strengthening student's abilities to raise, analyze and solve problems in an online environment. As for innovation in the way research is conducted, the targets include: (1) establishing a scholarship resources center; (2) constructing an IT-based platform for research collaboration and communication; and (3) developing a high performance computing platform to support cutting-edge research.

The second aspect is the construction of three integrated platforms for students, faculty and administrators/managers respectively on the foundation of the university's OA system. The student platform is to support students from enrollment, registration, orientation, course study, graduation, employment guidance to alumni membership. The faculty platform is to have multi-functions, namely, as an online course platform for teachers to prepare their lectures, carry out instructional activities, mark assignments, and organize examinations and enter their scores; as a research platform to provide research resources and support; as a management platform for faculty recruitment, appointment and promotion, remuneration and reimbursement, among other things; and as an administrative platform to improve administrative efficiency by optimizing digitalized management in such areas as finance, university assets and logistics with the aim of shifting from a traditional, hierarchical approach to a flatter management structure.

The third aspect is the establishment of an agile, smart, open, and sharable digital environment, including user center, data center, application center, developer center, high-speed campus network and multi-media facilities. It is of significant relevance to this chapter that this environment is also intended to (1) explore IT-based approaches to inter-university cooperation; (2) develop an inter-university, joint accreditation system with the aim of integrated management of inter-university users; and (3) increasingly share library resources, courseware, and online courses among universities, innovate inter-university online instruction models, and explore mechanisms for credit accreditation, recognition and transfer among universities.

Elsewhere in RUC's 13th Five-Year (2016-2020) Development Plan, in its Goals and Actions section, RUC commits to significantly speeding up the development of digital courses by allocating more money for the purpose and innovating their development and business mechanisms, which is considered as one of the actions to achieve the goal of optimizing undergraduate curriculums (RUC, 2016, p. 23).

In reporting their achievements during the 12th Five-Year period (2011-2015), 33 of the 75 MOE-affiliated universities mention the development of digital educational resources, including MOOCs, SPOCs, video open lectures, state-benchmarking online courses and so on. The number has increased to 55 when it comes to digital educational resource development as intended digitalization targets during the 13th Five-Year period. Many universities even specify the number of digital educational resources to be developed over this period. For example, Table 1 is the development targets of Beijing Normal University (BNU) for digitalization set in its 13th Five-Year (2016-2020) Development Plan (BNU, 2016a, p.13).

Table 1

BNU's intended targets for digitalization over the 13th Five-Year period

Item	Intended number/percentage
Smart classroom (%)	15
Undergraduate MOOCs	75
Postgraduate MOOCs	25
High quality online undergraduate course resources (%)	10
High quality online postgraduate course resources (%)	10
Undergraduate student studying for-credit MOOCs	1 MOOC per person

Both 'joint development' and 'sharing' are high-frequency words in these 13th Five-Year (2016-2020) Development Plans, which are set in accordance with a path of innovative, coordinated, green, open and shared development which was proposed at the Fifth Plenary Session of the 18th CPC Central Committee in October, 2015. Therefore, it is nothing unusual that the ideas of joint development and sharing are reflected in the 13th Five-Year (2016-2020) Development Plans of Chinese public universities. Of the 75 MOE-affiliated universities, 66 describe their 'joint development' measures and targets, and 73 set forth their 'sharing' measures and targets. Nevertheless, a content analysis show that only seven universities' joint development efforts are concerning inter-institutional development of digital educational resources and that 26 universities mention inter-institutional sharing of digital educational resources in their 13th Five-Year (2016-2020) Development Plans. The idea of joint development in these documents is more often referred to as cooperation in other aspects such as joint development of Confucius Institutes with universities in other countries, co-construction of laboratories and research centers with foreign or domestic universities or the business sector, joint implementation of practicum and/or internship programs with other social sectors, and so on. As for sharing, as mentioned above, slightly over one-third of the universities have plans to promote inter-institutional sharing of digital educational resources. In the remaining two-thirds of the cases (47 universities) where sharing is not concerning digital educational resources, sharing is more often intra-institutional, rather than inter-institutional.

Institutional governance and support structures

All universities have an office of digitalization management, aka Office of Informatization if translated literally from Chinese, and/or computing/IT/network/educational technology center, by whatever name it is called, in charge of digital transformation affairs. In some universities, these two departments are assigned different responsibilities while in others they are actually two in one. Take Peking University (PKU) for example. PKU has an Office of Informatization to manage institution-wide digitalization processes, including (1) implementing national laws, rules, regulations and policies and formulating the university's policies, regulations and standards in relation to digitalization, (2) making and carrying out institutional plans for digitalization processes, (3) coordinating and managing institutional funds for digital construction, (4) overseeing the construction of digital projects; (5) coordinating related departments and dealing with major issues in relation to the construction, operation and management of digital infrastructure, (6) managing and monitoring the university's website as well as coordinating and ensuring cyber security, (7) monitoring and evaluating the development and situation of the university's digitalization, and collecting relevant statistics, and (8) organizing capacity building of the university's IT professionals as well as cooperation and exchange both with domestic and international digital community.[60] By contrast, PKU's Computing Center 'is a large-scale university-wide comprehensive laboratory…responsible for the construction, development and operation of the university's information infrastructure'.[61] In some universities, their computing/IT centers may play a role in the development of educational resources. Tsinghua University is a case in point.[62]

When it comes to development of digital educational resources, it tends to be a multi-department endeavor. For example, PKU establishes its Instruction Steering Committee for Online Education whose responsibilities include organizing and developing open online courses as well as coordinating the sharing of these resources both intra-institutionally and inter-institutionally. Its Center for Excellence in Teaching and Learning, which is a unit of the Department of Educational Affairs, is to provide professional training and technical support such as video production and editing to their open online course teams, as well as cooperate both intra-institutionally and inter-institutionally in supporting faculty to develop digital educational resources (PKU, 2018). Any individual or team interested in developing digital educational resources will submit an application to the faculty/school/department that they are affiliated to. After a preliminary review and approval from head of the faculty/school/department, their application will be submitted to the Department of Educational Affairs and will be included in the university's overall scheme for educational resource development after another round of review, as stipulated in its Regulations on Implementing MOOCs (PKU, 2014). This document sets down the university's regulations on governance; training, review and approval; implementation and monitoring (from course development to course delivery); guarantee and support (including workload recognition, funding and rewards, and technical support); and intellectual property and related issues.

Individual universities may vary, to some extent, in governance and support structures for digitalization transformation, including educational resource development. Nevertheless, the big picture should be rather similar among public

colleges and universities.

Institutional quality assurance

As mentioned above, there are association and national standards in place for digital educational resource development despite the fact that they are not mandatory unless specifically designated to be applied to a particular project. In addition to these standards, MOE also issued evaluation indicators as criteria for reviewing and awarding honorable titles to high quality educational resources. For example, MOE's (2005) Evaluation Indicators for HEI State-benchmarking Courses include evaluation criteria for six areas: course team, course design and organization, readiness (course material, practical teaching and online teaching environment), means and methods of instruction, instructional effectiveness, and uniqueness and institutional policy support.

Take another example. In addition to Technical Specifications for State-benchmarking Shared Courses Construction (MOE, 2012b), MOE (2013) issued Evaluation Indicators for State-benchmarking Shared Courses (Undergraduate Level), which is used to evaluate the course team, progress made in relation to State-benchmarking Courses and upgrading, course design and development, required course materials (components), extended course materials, intellectual property right protection, and course features and intended outcomes. Despite the fact that rubrics of this kind are for the purpose of evaluation and prize-awarding, individual institutions tend to stick to these criteria in their development of digital educational resources. In this sense, these rubrics are conducive to quality assurance. Also, as pointed out earlier, some platforms, for example, CUM, require that courses to be uploaded should meet their criteria. This can also contribute to quality assurance at the institutional level.

Moreover, as expounded above, university alliances of (digital) educational resources also establish their own quality assurance mechanisms that their member institutions should follow. If individual institutions want to share or co-develop educational resources with other partner institutions, they will have to follow the relevant guidelines and ensure that educational resources to be shared or developed meet the requirements.

Institutionally speaking, many colleges and universities develop and implement their own specifications, standards, guidelines or regulations in their digitalization process. For example, South China University of Technology (SCUT) introduced a series of standards in relation to digital course resources and subject-specific platform construction. SCUT started to implement its subject-based platform development scheme in 2005 (SCUT, 2005). The first phase of the project aimed to develop five subject-based series of online courses, including mechanics foundation courses, mechanical engineering courses, chemistry and chemical engineering courses, electric and electronic engineering courses, and computer science courses. It divides each series into several modules and stipulates what courses are included in each module, how many learning hours are required for each course, and who the target students of each module are. In addition, it also specifies the deliverables of each series of courses. The scheme also sets forth the procedure for course development. SCUT issued another document - Specifications for Online Course Development, which provides detailed guidelines and (technical) requirements for online course development, syllabus preparation and learning outcome setting, course content selection, overall course design and its implementation (including instructional design, content organization, content presentation, and content navigation), script writing, material preparation (for example, audio, video, animation, case study, and so on), courseware development, learning activity design, as well as instructional environment design (SCUT, n. d.). Two appendixes are attached to this document. One is a list of required materials of an online course to be uploaded to the platform and the other is a sample format for preparing the syllabus and learning outcomes. Later, SCUT (2010) implemented its specific regulations on online course development which, among other things, deal with technical specifications by reiterating that course development should be in line with the university's Specifications for Online Course Development (SCUT, n.d.). The other contents of this document are also intended to contribute to the quality assurance of online courses, including the overall goals of online course development; stakeholders, intellectual property rights and division of dividends; production cost provision; application, review and approval procedures; course development management; maintenance and updating; and marketing (SCUT, 2010).

Other examples of institutional quality assurance mechanisms include PKU's (2014) Regulations on Implementing MOOCs, and PKU's (2018) Opinions on Strengthening the Development and Application of Open Online Courses, as mentioned above. As for RUC, its quality criteria for online courses (RUC, 2015) draw on MOE's (2005) Evaluation Indicators for HEI State-benchmarking Courses. BNU (2016) issued its Instructional Digitalization Acceleration Program, according to which its Teaching Affairs Office [63] , Graduate School, Human Resources Office, and Center of Information and Network Technology are assigned to work out the university's regulations on high quality courses and digital resources construction and management. Other measures proposed in this document can also impact positively on the quality of its digital educational resources, either directly or indirectly. Overall, the quality assurance measures of individual institutions may have nuances, varying slightly one way or another, but the core is basically the same (for example, Jilin University, 2015; Tonghua Normal University, 2016; Yanbian University, 2017).

5.3 (O)ER and digital educational resources

The Chinese government views higher education as an integrated part of the nation as a whole, and sees it as a way of achieving the aim of increasing China's competitive strength in the world. Although there appear to be particular multi-layered power relations and ideological precepts that operate in Chinese society and culture, China's top-down approach to developing digital educational resources has to a large extent pushed universities to take actions forcefully and swiftly. As a result, many online courses, databases, platforms, repositories and sophisticated digital infrastructure that connect administrators, professors and students have been developed and successfully demonstrated.

As stated earlier, OER was first defined at the UNESCO conference in 2012, and later introduced in China. In the process of creating more world-class universities, China did not redefine the term, but rather used it as an international and umbrella term to refer to the country's existing domestic practices (e.g. courses and resources). Unlike many Western countries, the Chinese government is continuing to invest heavily in its elite institutions, which aim to obtain a permanent leading position in global rankings. As part of this process, China is employing OER as leverage to improve the quality of learning and teaching throughout the higher education sector, and to augment the reputation of Chinese institutions worldwide.

The existing OER practices are discussed below, with regard to the way they are developed, (re)used, provided and integrated.

'Top-quality Courses'

In 2003, China launched a large-scale project, the 'Top-quality Courses' project, for sharing educational resources using digital means. Adhering to the core OER values of openness and being cost-free, the 'Top-quality Courses' Project focused on improving the quality of higher education teaching (MOE, 2003). This understanding towards 'Top-quality Courses' positioned China to take a unique approach to implementing the 'Top-quality Courses' Plan, in terms of scale, financing and quality assurance.

The 'Top-quality Courses' Project went through two stages: 2003–2007 and 2007–2010. The first stage, called the 'Top-quality Courses' Plan, focused on selecting exemplary undergraduate courses for national-level designation, while the second stage created 3,000 national-level 'Top-quality Courses' (referred to above as 'State-benchmarking Courses'), including not only undergraduate courses but also distance education courses and others (Wang & Håklev, 2012). By 2010, more than 12,000 courses had been developed by 700 universities and institutions. Between 2003 and 2010, 3,790 course were selected for national-level designation, including 2,528 undergraduate courses, 1,037 vocational course, and 209 distance education courses (Wang & Håklev, 2012). These courses mostly included lesson plans, teaching materials, courseware, and audio or video recordings, but the actual development of these digital resources across universities remained variable.

The development of 'Top-quality Courses' (2003–2007)

How 'Top-quality Courses' were developed at macro and micro level has been detailed in the work of Wang and Håklev (2012), and this section provides some examples to illustrate how 'Top-quality Courses' were developed by professors at the institutional/meso level.

The case of Tsinghua University

As the implementation of 'Top-quality Courses' involves both lesson plans and teaching materials, as well as a technical platform, faculty members have to spend time both on course desgn, and website development, courseware and video recordings. Since the workload for technical development is heavy, the effort that is put into developing lesson plans and teaching materials has to be proportionally reduced.

To make sure that professors put maximum effort into course design, the project management for implementing the 'Top-quality Courses' Project at Tsinghua University took place under a system of unified planning, carried out by the university's Office of Academic Affairs, focusing on designing instructor-led courses, as supported by professional and technical staff at the university (Yang & Duan, 2008). The Office of Academic Affairs was responsible for the selection of 'Top-quality Courses' and the organization and management of the courses, and the instructors were in charge of the actual design of the courses. The e-Learning Center provided technical support for the entire process. The sustainable implementation of 'Top-quality Courses' was ensured through a division of labor between, and cooperation among, multiple departments of the university. As a technical support department, the e-Learning Center provided professional technical services throughout the entire process. For different courses across the disciplines, the same approach and method was adopted in the production of courseware, and audio and video materials, which ensured the design of all of these 'Top-quality Courses' was consistent and professional. During the implementation period, a professional R&D team was also created, which included researchers from the Department of Educational Technology, as well as those specializing in the area of media art design and media production, and program designers, etc. Tsinghua relied on scientific management, world-class equipment, technology and professional teams to ensure the quality of these technology-mediated courses (Yang & Duan, 2008).

An example of a Top-quality Course: Chinese Geography

In 2005, the Chinese Geography course offered by BNU was certified as a national top-quality course. In addition to the Chinese Geography course being used in teaching on the BNU campus, it was also designed to provide quality teaching materials for use in similar courses offered at other Chinese universities. In addition, the Chinese Geography course aimed to provide demonstrations on how the course should be taught, and thus the course materials were openly shared, mainly for in-service teacher training. Bearing these goals in mind, the Chinese Geography course was designed to cover who was to do the teaching (the teaching team), what was to be taught (the course syllabus), how it was to be taught (online classroom), how content would be learned (student practice), an assessment of the teaching (teaching evaluation), and a list of teaching resources, etc. (Wang, Su & Yu, 2013).

Logistical issues associated with the first-stage development of 'Top-quality Courses'

In 2004, during a re-examination of 151 national 'Top-quality Courses' that were designated as 'Top-quality Courses' in 2003, 33 course websites could not be visited (Sheng, 2009). A review by the National 'Top-quality Courses' Working Group of Higher Education Institutions in June 2005 also reported that about 12.78% of the national 'Top-quality Courses' websites were unavailable, and other accessible websites suffered from low access speeds (as cited in Liu & Wu, 2008). A 2007 investigation also found that up to 38.02% of the national 'Top-quality Courses' were unavailable, and 15.7% of those courses that could be accessed did not have either lesson plans, courseware or videos (Huang & Xiang, 2007). A 2008 investigation of 22 national-level 'Top-quality Courses' offered by five universities identified problems such as the fact that some of the course webpages could not be browsed (40%), that the access to course websites was too slow and the response and waiting times were too long (30%), and that there was no access to the course websites (20%). Also, only a few courses had been implemented in actual teaching activity (18.2%) and in e-book form (36.4%) (as cited in Zhou & Zhang, 2010). In total, of the 3,582 national 'Top-quality Courses' surveyed (Hu, Yang, Wei & Yang, 2014), whether for undergraduate or vocational college teaching, less than 60% could be accessed. In some cases, due to the lack of specialized technical maintenance, the 'Top-quality Courses' websites of some universities or individual professors did not function, which undermined their supposed role of setting a positive example for the public and also affected the reputation and authority of the 'Top-quality Courses' Plan.

Intellectual property

A survey of 185 professors whose courses had been given the national-level designation as a 'Top-quality Courses' found that 31.5% of professors preferred for their 'Top-quality Courses' to be available for browsing but not for downloading, and 45.1% preferred that they be downloaded but not revised; only 18.5% preferred that their courses be browsed, downloaded and revised (Zeng, Fang & Huang, 2010). The research team of "the sharing mechanism of national 'Top-quality Courses'" conducted a survey of 212 faculty members from BNU and Beijing Jiaotong University. Their unpublished pilot-study (as cited in Zhou & Zhang, 2010) also revealed that although the majority of professors whose courses had received the national 'Top-quality Courses' designation held positive views on the extent to which their courses could be shared – e.g. 100% were in favor of sharing their courses within their own universities or with collaborative universities (100%) and 86% were in favor of sharing them with the public within China (86%), nevertheless, they favored setting the conditions for sharing – especially explicitly declaring the copyright to the publishers. It is worth noting that many professors did not think that the funding provided by the state met the cost associated with the intellectual property rights underlying the courses. As they had worked for years with their teaching team to produce these courses, even before the 'Top-quality Courses' Plan, they believed their intellectual property needed to be protected, to avoid plagiarism.

The use of 'Top-quality Courses' (2003–2007)

The technical standards of the 'Top-quality Courses' websites adopted by different universities were diverse, which meant that the 'Top-quality Courses' websites were inconsistent in style, and highly varied in performance. Consequently, it was difficult to identify or navigate national 'Top-quality Courses'. Students whose own university offered a particular designed course were more aware of how to access that course. For example, the research team of "the sharing mechanism of national 'Top-quality Courses'" conducted a survey of 212 faculty members from BNU and Beijing Jiaotong University. Their unpublished pilot study looking into teachers' interest in using national 'Top-quality Courses' found that 71.7% respondents used 'Top-quality Courses' to acquire teaching resources, 54.7% used them to learn about different teaching methods and approaches, 52.8% were interested in teaching principles and design, and 50.5% were keen to re-use the 'Top-quality Courses' (as cited in Zhou & Zhang, 2010). Those who declared themselves to be not interested in using 'Top-quality Courses' cited reasons such as 'the resources are not suitable for their own needs' (33.0%) and 'there are limited access rights' (23.1%). Of those who had completed campus version of 'Top-quality Courses', 70% were keen to download the lecture notes or PowerPoint sides, and 50% were interested in exercises (such as homework, test papers, etc.). There was also a demand for the 'Top-quality Courses' syllabus (48%) and teaching videos (43%), while the demand for simulation experiments was relatively low (19%).

Thirty students from Peking University were interviwed, and the extent to which students used these resources also varied. About 50.8% of students visited the 'Top-quality Courses' website on average one to three times or less per month; only 26.5% of students visited them one to three times on average per month. About 70% of students believed that 'course resources need to be updated frequently' and that 'more resources need to be put up online, such as classroom videos, courseware, test questions, etc.' (as cited in Zhou & Zhang, 2010). Another survey of 350 science students also found that only 9.1% of the students frequently browsed the websites, while 51.4% occasionally browsed the websites (Ding, Wang, Feng, Shen, Tian & Jin, 2006).

Quality assurance

To achieve the goal of improving the overall quality of higher education teaching, MOE has particularly highlighted the importance of using information technology to open up access to these 'Top-quality Courses'. All the courses were required to be shared through the internet, and the percentage of annual updates (or new additions) was required to be not be less than 10%.

The principal investigators of 'Top-quality Courses' Project were asked to submit an 'annual self-review form' to report improvements in each course within five years. The MOE organized the committee to review the annual self-review forms with regard to the course proposals. For those courses that did not pass the annual evaluation, the designation of 'Top-quality Courses' was to be cancelled and all professors in that university were to be banned from applying for

national-level designations for one year (MOE, 2005). A continuous process of development and quality improvement was required by the 'Top-quality Courses' Plan (Wang & Håklev, 2012). This can be regarded as a top-down approach to ensuring quality assurance.

The 2005 review of Beijing municipal's 'Top-quality Courses' investigation showed that 10% of the courses had made great progress in terms of updating their resources, 20% were just about meeting the basic criteria, 33% did not meet the basic requirements, and 37% had not been updated at all (as cited in Liu & Wu, 2008). One of the reasons for these results was professors' motivation and the awarding mechanism. Professors who applied for 'Top-quality Courses' status made an effort to pass a pre-assessment in order to receive the designation for their courses, but they then put less effort into subsequent resource updates and website maintenance. This was also partly due to the funding mechanism. The original plan of the 'Top-quality Courses' Project was to develop 1,500 courses, but the actual number of designated courses greatly exceeded this, reaching 2,439 in 2008, and increasing year by year. Thus, more universities and disciplines were constantly required to enter the competition to have their courses awarded 'Top-quality Courses' status. This increasing number required the state to either invest more funds or see the quality of the courses being threatened.

The continuous increase in the number of designated courses and the unstable funding sources had a negative impact on the 'Top-quality Courses' policy, showing that the system was not sufficiently flexible and adaptable (Zhou & Zhang, 2010). In fact, in 2004, the support provided to each 'Top-quality Courses' was reduced from 80,000 yuan to 30,000 yuan. Zeng and her colleagues (2010) found that in their investigation that 80.6% of 184 faculty members from 15 universities stated that the problems associated with updating their courses were due to a lack of funding. Thus, due to insufficient funding, the actual implementation of these courses after they had been given the national-level designation of 'Top-quality Courses' was unfortunately flawed.

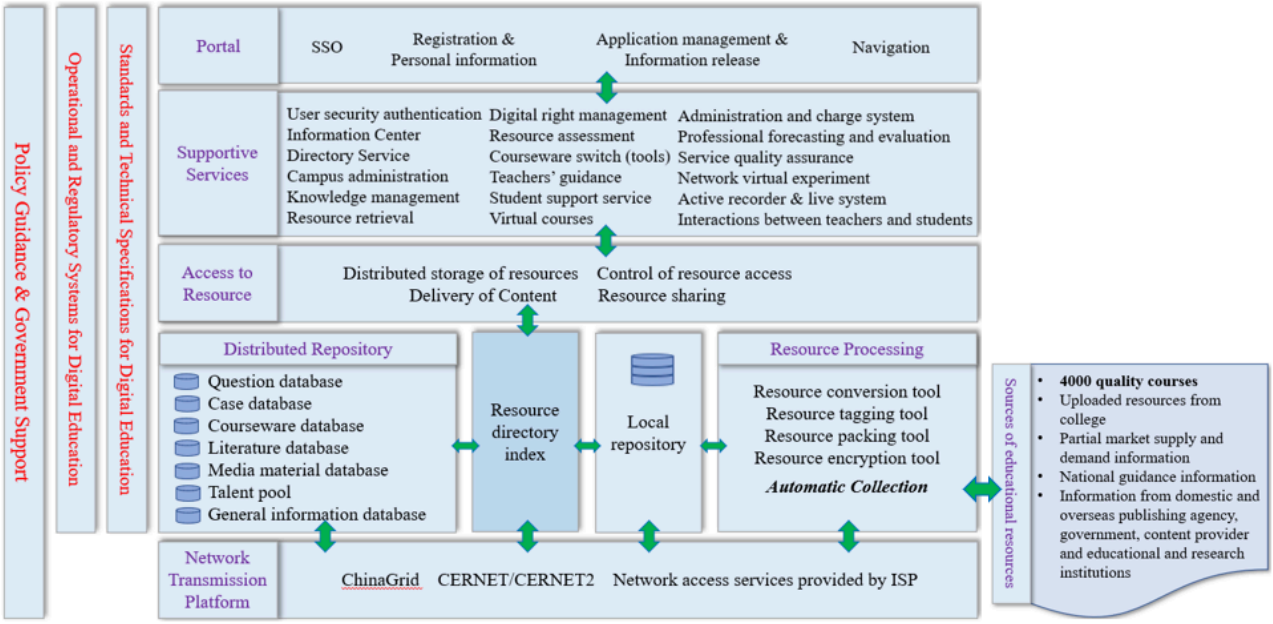
The development of 'Top-quality Courses' (2007–2010)

Due to the problems identified earlier in regard to the development of 'Top-quality Courses' in the first stage, a different approach was taken between 2007 and 2010. During this period, the integration of 'Top-quality Courses' Project was led by Tsinghua University, in collaboration with Huazhong University of Science and Technology, Higher Education Press, etc (MOE, 2007). The goal was to formulate information technology standards and specifications to create a supporting online platform for the storage, retrieval and operation of 4,000 integrated national 'Top-quality Courses'. The emphasis was on creating a mechanism for sharing and re-using national high-quality courses, in order to enable teachers and students to use these freely available 'Top-quality Courses' more conveniently and quickly.

The integration of national 'Top-quality Courses' project (MOE, 2007) required that the strategic focus remain centered on developing and contextualizing the fundamental infrastructure that supported the development and use of 'Top-quality Courses' (see Figure 1).

Figure 1

Infrastructure of 'Top-quality Courses' (2007–2010)



The main work between 2007 and 2010 included four overarching dimensions of action and support for digitalization:

1. Establishing national standards and norms for sharing courses online, including carrying out R&D in respect of standards, including curriculum description standards, curriculum structure specifications, resource processing and technology standards, data storage standards, resource packaging standards, structured definitions of materials, construction specifications for shared open service systems, and specifications for shared monitoring and evaluation.
2. Constructing an information service platform for sharing 'Top-quality Courses'. Six subsystems were created, including a 'Top-quality Courses' shared portal, a directory retrieval subsystem, a personalized active service, shared multimedia service, a shared grid service grid, and an evaluation subsystem.
3. Building a national portal for 'Top-quality Courses' (http://www.jingpinke.com), involving cooperating with the construction of national 'Top-quality Courses' and digitizing the course resources in order to establish a core course resource portal that supported the storage of 4,000 national 'Top-quality Courses', which could be freely shared to the public.
4. Building a National 'Top-quality Courses' Resource Center, operated by Higher Education Press, and building a Regional Resource Sub-center for National 'Top-quality Courses' (created within Huazhong University of Science and Technology).

By April 2011, the National 'Top-quality Courses' Resource Center had published a total of 20,283 'Top-quality Courses' at all levels, including 3,835 at national level, 8,279 at provincial level, and 8,169 at university level. Among them were 14,233 undergraduate courses, 209 distance education courses, and 5,837 vocational courses. A total of 125,659 resources and 44,832 textbooks were included in the online database. 10,460,025 visitors had accessed the 'Top-quality Courses', and the total number of page views was 57,030,860. 54,861 resources had been uploaded, which had been downloaded 178,762 times. There were 327,373 interactive Q&As (National 'Top-quality Courses' Resource Center, 2011).

'Top-quality Open Courses'

In 2011, MOE launched another project to develop 'Top-quality Open Courses', with the aim of producing 1,000 top-quality video open courses and 5,000 top-quality shared courses. The iCourse platform was created to host all the courses, and some universities were also expected to create an aggregator linking to their own course (e.g. Peking university . Up to January 3, 2019, 992 video open courses and 2,884 shared courses were publicly available on the iCourse platform.

The purpose of creating national ‘Top-quality Open Courses’ was to effectively strengthen the development and popularization of high-quality educational resources, to further improve the quality of higher education, and to build a learning society. ‘Top-quality Open Shared Courses’ were normally undergraduate courses or professtional courses that had been prepared for use by college teachers and students, while ‘Top-quality Video Open Courses’ generally covered popular science and cultural and socially-oriented subjects, and were designed for the public. As an initiative that followed the ‘Top-quality Courses’ Plan (2003–2010), the ‘Top-quality Open Courses’ Plan took a similar approach to course planning, development and evaluation.

Examples of ‘Top-quality Open Shared Courses’

In 2012 and 2013, the focus was on the transformation and upgrading of the former national ‘Top-quality Courses’ to top-quality shared courses. Previously, ‘Top-quality Courses’ focused on developing a syllabus setting out how to teach the course, but top-quality shared courses also set an exemplary course structure, making clear how learning should take place (Wang, Su & Yu, 2013). For example, Chinese Geography, after receiving the national-level ‘Top-quality Courses’ designation, was awarded the title of ‘Top-quality Open Shared Courses’ later. Building on their previous teaching material, the teaching team aimed to strengthen the course design in terms of its breath, depth and accuracy, and in terms of the extent to which teaching resources were shared. Therefore, the core of curriculum construction was around the integration and sharing of teaching resources, the visualization of teaching processes, and the transmission and sharing of regional multimedia geographic information to better meet the needs of learners. With the core value being ‘quality and sharing’, the key to developing open courses is to improve the actual use of these courses. In 2014, the previously existing course Physiology of PE, awarded as the national-level ‘Top-quality Courses’, was also transformed and upgraded to one of the national-level ‘Top-quality Open Shared Courses’. The new updates and improvements made to this course included providing support for students' autonomous inquiry and collaborative learning, supporting research activities in collaboration with k-12 teachers, proving different teaching strategies, improving the quality of talent training, and serving the construction of a learning society.

Figure 2

Top-quality open shared course, Chinese Geography, on the iCourse platform

An example of a ‘Top-quality Video Open Courses’

In 2013, Beijing Forestry University's ‘Chinese Plantation Cultivation’ was selected as one of the national-level ‘Top-quality Video Open Courses’. The course was officially offered on the iCourse platform at the end of 2013. As a video open course, this course brought together a large number of ancient and contemporary cases to illustrate the following subjects: how trees were planted in ancient times; what the current state of tree planting is in modern China; what technologies are needed for tree planting; what are the expected future developments in tree planting; and what problems need to be solved in the area of tree planting. The course had six lectures in total, each lasting less than 50 minutes, with 60–80 slides per lesson. The videos were recorded at Beijing Forestry University, which is equipped with three high-definition cameras and two sets of professional recording and broadcasting software, and which strictly follows the recording requirements of the Technical Standards for the Production of Top-quality Video Open Courses (2013 Edition) issued by MOE.

In contrast to the production of ‘Top-quality Courses’ (2003–2010), the video recordings used by ‘Top-quality Video Open Courses’ were greatly improved. For example, the ‘Top-quality Video Open Courses’ produced by universities such as Beijing Institute of Technology, the University of Science and Technology of China and Jilin University were filmed in large auditoriums, while Northeastern University, Nanchang University, and Qinghai Virtual studios were used for producing ‘top-quality Video Open Courses’ (Hu, Yang, Wei & Yang, 2014).

Figure 3

Top-quality video open course, Chinese Plantation Cultivation

MOOCs

Since Peking University and Tsinghua University joined forces to offer Chinese MOOCs in 2013, China has seen a steady growth MOOCs. Following the 'Top-quality Courses' Plan (2003–2010) and quality open courses (2011–), the development of MOOCs is also regarded as a key strategic choice for improving the quality of higher education in China. Although different policies, plans, initiatives and practices have been issued and carried out continuously over the past 20 years, the key aim of MOE's strategies to improve the quality of teaching and learning in higher education has not changed.

Since 2015, following MOE's policy entitled 'Guidelines on Strengthening the Construction, Use and Management of MOOCs in HEIs' (MOE, 2015), individual universities have issued internal/external calls for MOOC proposals, offering funding to support the development of MOOCs by individual professors. In the process of developing MOOCs, many different actors, including university administrators, academics, educational technologists, instructional designers etc., knowingly and unknowingly played a role in shaping policy and designing MOOCs (Zhang, Sziegat, Perris & Zhou, 2019).

Calls for MOOC proposals

We collected calls for MOOC proposals from universities' official websites in order to understand in what ways universities recruit or encourage their faculty members to offer MOOCs for free. As different universities seem to have

very similar regulations, the majority of these documents are to some extent similar, with only minor variations (e.g. removing some constraints on course types or increasing the number of courses that members are allowed to offer), except in the case of Peking University (see below). Two typical approaches were taken in the calls for proposals. The majority of universities followed a typical, routine procedure: the Office of Educational Affairs acted under the authority of the university leadership office and disseminated calls for MOOCs via emails and through internal/external websites. The university called for MOOC proposals in a way that compelled attentiveness from potential course-creators, underlined the importance of the activity, and imposed restrictions on the process. The call for proposals set out the prerequisite qualifications, the obligatory format of the course, and compulsory pre-defined requirements. For example, in terms of which course to offer, one call required that the proposed courses 'should be combined with the curriculum offered on campus', and that 'teaching resources must include videos that contain key points of knowledge that are taught on campus'. Anyone who applied to offer a MOOC 'need[ed] to select those courses that are suitable for the form of MOOC, which can attract a wide range of audiences and spread influence', which also implied that instructors 'need[ed] to reform the current on-campus course design'. According to the call, proposed courses 'should be selected by college/department before reporting to university registrar', and the approved course design and implementation 'should follow the specified timelines', as the 'university will arrange inspections accordingly'. As can be seen, while universities gave freedom to instructors to decide when to offer MOOCs, which course to apply for, and in what ways to prepare, the modal verbs used here, such as 'should,' 'must,' and 'need, reflect demands to make sure that the proposed MOOCs were selected, designed, and implemented in such a manner as to ensure a high quality and a high impact worldwide. This perhaps reflects quality assurance by universities in respect of MOOCs, but it is interesting to notice that most universities also required that the MOOCs offered be aligned with on-campus courses. This to some extent shows that the authorities considered on-campus courses as having qualified teaching resources, and that, by setting this prerequisite, they assumed that the offered MOOCs would be able to achieve the same quality standard as on-campus courses.

In contrast, Peking University took a different strategy to encouraging its faculty members to offer MOOCs. The call for MOOCs released by Peking University reads: 'if [teachers] decide to offer MOOCs in Spring 2015, please fill out the Peking University MOOCs Application Form'. The university also emphasized that 'during this period, professional technical support will be provided by the Educational Technology Center'. Few prerequisite qualifications were required; instead, the university 'welcome[d] all teachers to participate in the development of MOOCs', and stated that 'currently there is no restriction on teachers' qualification or course type.' The word 'if' suggests a subjunctive mood, and 'will' is the future tense – both soften the tone in the modal expression. Nevertheless, this is not to say that Peking University did not intend to review the proposed MOOC offerings. Similarly to other universities, it stated: 'the registrar is responsible for the overall planning of MOOCs development', 'the courses will be approved by the registrar or graduate school', and 'the MOOCs committee will review the teachers' preparation and understanding of MOOCs teaching' (Peking University, 2014, Official Document [64]).

Furthermore, quality assurance formed a part of the process of implementing MOOCs, e.g. offering technical support, and recruiting active and experienced instructors to provide tutorials. For example, at Peking University, the Office of Personnel and the Office of Educational Affairs jointly established a MOOC training program. Starting from 2014, for a period of five years, 100 teachers were trained each year, with the aim being to improve the professors' ability to use ICT in teaching. On March 22, 2019, the 22nd workshop for MOOC training was held – more than 20 professors and student assistants from different departments of Peking University participated.

The role of professors and universities in the process of developing MOOCs

We collected about 500 documents related to MOOCs released by 49 universities that offer MOOCs. By analyzing these documents we learned that universities typically assign multiple roles to instructors: being responsible for online lecturing, participating in the development and implementation of MOOCs, and being 'challengers' who are willing to try new things and are seeking change. In the view of those who offer MOOCs, they participate in MOOCs as a result of their own personal interest, rather than simply being influenced by their university. For example, when asked about why they are willing to offer MOOCs, most faculty members claim that they 'are interested in this new technology' (Peking University, 2015, interview [65]), they 'like the feeling of lecturing' (Peking University, 2015, interview [66]), or they '[like to]

try new things' (Tsinghua University, 2016, interview [67]). In addition, in interviews, many faculty members emphasize their roles as 'educators', and state that they are proud to 'have improved teaching skills' and 'successfully kept learners engaged' (Peking University, 2015, interview [68] [69] [70]).

Universities 'provide' funding/technological support (Lanzhou University, 2015, official documents [71]; Lanzhou University, 2016, official documents [72]; Henan University, 2018 [73], official documents), 'encourage/guide' teachers to participate in the development of MOOCs (Peking University, 2014, official documents [74]; East China Normal University, 2015, official documents [75]; Lanzhou University, 2015, official documents [76]), and 'implement/launch' the registration of MOOCs (Lanzhou University, 2015, official documents [77]; East China Normal University, 2016, official documents [78]). By doing this, the universities' central offices play an important role in regard to initiating MOOC activities, supporting the process and deciding who will provide an MOOC and what to offer.

Micro-courses

In 2010, the Foshan Education Bureau took the lead in organizing a micro-course for primary and secondary school teachers (Zheng, 2011). Since 2012, China has held numerous 'micro-teaching' competitions among universities (MOE, 2012). A national university micro-teaching competition platform was created to curate all of the micro-course resources (https://edtechbooks.org/-gUm). As shown in Figure 4 (see the links to the bottom-left), the platform embeds the icons of social sites/platforms that can be used to share courseware. As shown in Figure 4, the micro-course provided by Jinlin University was shared 139 times, used 1,027 times, played 69,384 times, and commented on 93 times. The users of these resources can also rate them on the platform, from one star to five stars. Also, different universities have created their own micro-courses platform to host courses (e.g. Central South University, http://netclass.csu.edu.cn/weike2016/). In practice, the nature of micro-courses has changed, moving from being 'micro-resources' to being 'micro-teaching activities' and to being 'micro-web courses', with the belief that micro-courses are an important component of online learning and teaching online video courses, with micro-video as the core (Hu, Huang & Li, 2013).

Figure 4

National university micro-teaching competition platform

作品标题：哲学的自我追问
所属课程：哲学通论
课程性质：公共基础课（必修）
所属省份：吉林省
所属学校：吉林大学
参赛项目：全国高校微课教学比赛
评比结果：初赛推荐、复赛推荐、决赛（特等奖）
第一作者：孙正聿　　参赛方式：学校选拔
团队成员：无团队成员
学校类别：本科　　播放次数：69384
参赛类别：文史　　评论次数：93
作者职称：教授　　分享次数：139
作者学历：博士　　投票指数：4.6
作品介绍：

“哲学通论”课程创建于1994年，于1995年在吉林大学开设此门课程，授课对象包括哲学专业本科生和非哲学专业本科生两部分，年平均授课人数为500人左右，共约8000人左右。近年来，全国普通高校哲学专业大多已开设此..[查看全部]

Taking Jianghan University as an example, in order to strengthen the course design, promote the sharing of course resources and innovate teaching methods, the leading MOOC working group decided to call for micro-course proposals in March 2014. Clearly stated in the call for micro-course proposals was the fact that there must be clear teaching goals, learning designs, study guides, practical tests and other learning resources. The call emphasized that it was important to choose the most difficult and error-prone points of knowledge as the subject of micro-courses, which should last 15 minutes or less. According to the call, topics that students can learn about by reading are not suitable for micro-courses. A detailed evaluation was provided by Jianghan University, including nine categories (e.g. the topic, the design, structure, technical specifications, and format). The leading MOOC working group also required that each college/department must apply to develop three to four micro-courses, and must implement these micro-lectures. Making the design and implementation of micro-courses compulsory was a way to push professors to get involved in this process (Jianghan University, 2014a).

In April 2014, the implementation plan for micro-classes (trials) was released by Jianghan University (Jianghan University, 2014b). A detailed schedule was planned (March to May – design; May to July – recording; July to October – revise and assess; November to December – go online), and it was pointed out that each course would receive seed funding of 5,000 yuan, and more funding might be invested according to the quality and quantity of implemented micro-courses.

The implementation of micro-courses follows a strategy of organizing micro-class competitions. There are national and provincial competitions, and universities and some colleges also actively organize their own micro-class competitions. For example, Beijing University of Science and Technology, Southeast University School of Medicine, Central South University School of Basic Medicine and Guangdong University of Foreign Studies successfully held their first micro-class competitions in January 2013, May 2014, January 2015 and April 2015, respectively. Some colleges and universities require faculty members to participate. For example, Guangdong University of Foreign Studies (Guangdong University of Foreign Studies, 2015) proposed that ‘each college recommends at least two faculty members to participate, and colleges with less than 50 faculty members recommend at least one faculty member participate.’ Also, universities encourage faculty member to participate by providing training for participations and recognizing 18 hours of training credits for annual evaluation. Those who win the first prize are awarded ‘Outstanding’ in the annual teaching

quality assessment, and have the opportunity to be recommended to represent the university in national micro-class competitions. However, some universities limit the number of faculty members who can participate in micro-class competitions. For example, the University of Science and Technology Beijing stated that 'the recommended quota for each college is limited to no more than five for first-level subjects and no more than three for second-level subjects'.

5.4 Institutional infrastructure and integration

The changing/extended responsibilities of the informatization office

As discussed earlier, all universities have an office/offices that is/are in charge of the management of digitalization, with different names used for these offices. The roles and responsibilities of these offices have changed over time. Take Central China Normal University for example. In 2005/6, the Modern Educational Technology Center was renamed the Center for Network and Educational Technology, having responsibility for the development of the digital campus, in addition to its previous roles of maintaining network devices and facilitating teaching mediated by technology. In 2011, the Center for School Card Management was created within this Center, to further take charge of the management of school card development. In the same year, the university created its Digital Educational Resource Center at the division-head level, in charge of developing all the digital educational resources across the campus. In 2012, the Digital Educational Resource Center and the Center for Network and Educational Technology were combined, and renamed the Center of Network and Informatization Service. It was not just the names that changed over time: the responsibilities of the center were greatly extended. The center's responsibilities were extended to being in charge of: (1) developing and maintaining basic infrastructure; (2) developing and maintaining the application system; (3) developing and managing campus cards; (4) creating and maintaining multimedia classrooms; (5) maintaining the campus TV network; and (6) creating and operating digital educational resources. In 2013, this center was closed and the Office of Informatization was created, integrating all the work relating to digitalization or informatization, which further includes: (1) development planning; (2) overall coordination; (3) formulating standards and specifications; (4) supervision and evaluation; (5) procurement of all informatization equipment and facilities; (6) innovating and operating the management information system; (6) creating a smart learning space; and (7) developing digital learning resources. Currently, all of these activities are under the responsibility of the Office of Informatization. In 2018, the university further assigned confidentiality management to the office. In the meantime, a subordinate unit, the School Service Center, was created. The Center of Informatization School Service Center is an administrative unit within the university, with roles and responsibilities that are explicitly defined and extended.

Integrated infrastructure

Technical barriers to digital transformation, coupled with challenges in coordinating with different administrative units, as well as academic departments, have been a major obstacle to digitalization. At the same time, informatization offices, with their specific roles, capabilities and duties, have become the gateway to the implementation of a digitalized higher education system. ICT officers working in these offices need support and resources to understand the requirements of individuals working in different departments and offices, as they have varied educational and administrational needs.

The solution to digitalization lies in an integrated system, with systematic coordination of general administration and learning and teaching support. In the current higher education system the best outcomes are produced by integrating administration, digitalization office, and smart learning classrooms, together with learning and teaching support; this is the most effective approach to accommodating administrators, instructors and students with multiple educational needs.

Figure 5

Digital Jingshi portal at Beijing Normal University

The Digital Jingshi portal at BNU provides an example of integrated infrastructure. To fully implement the Twelfth Five-Year Plan for Informatilization Development (Action) at BNU, the Digital Jingshi portal was created in 2015 to resolve previous problems, such as piecemeal implementation of technology, poor use of educational resources, data interoperability, etc. The portal aims to build more effective organizational support systems and innovative and

sustainable operating mechanisms to further promote the exploration and development of education reforms, teaching methods, and evaluation and service models (China Education Network, 2015). The Digital Jingshi portal includes five components: campus information, office hall, data center, resource center and campus community. It provides unified access to all online information and resources, such as school information, system applications, online services, digital resources, etc. This integrated infrastructure provides a single gate for releasing and sharing university information; processing necessary office work online across departments and units; obtaining all sorts of teaching and learning information and data; aggregating all the implemented digital resources; engaging in group communication and collaboration; and providing personalized services for administrators, professors and students (Beijing Normal University, 2015).

Building on BNU's previous systems, such as IPv6 and digital libraries, a unified Service Center for Educational Resources (shown in Figure 5) has been established within the Digital Jingshi portal, in order to provide different groups of users with high-quality learning resources, including online courses, teaching courseware, and scientific and technical literature. The Service Center for Educational Resources supports massive retrieval, storage, publishing, uploading and downloading of various types of digital files, thus effectively promoting the co-construction and sharing of high-quality educational resources.

5.5 Specific intended digitalization targets

Digitalization practices and processes are contextual and likely to be influenced by their specific institutional contexts. Taking Beijing Foreign Studies University, in the Tenth Five-Year Plan period the university focused on the R&D of educational resources for foreign languages, attaching great importance to the use of educational technology to assist foreign language teaching. It built an educational database of foreign language resources and 23 online teaching apps (Beijing Foreign Studies University, 2017). During the Eleventh Five-Year Plan period, the university focused on the R&D of information technology, and organized in-depth discussions on digital campuses, networked educational environments, construction of educational resource banks and educational application platforms, and development and utilization of foreign language educational resources (Beijing Foreign Studies University, 2017).

Since the beginning of the Twelfth Five-Year Plan, the university has moved its focus to the digitalization of educational resources, and has established advanced, efficient and practical information infrastructure systems, information management systems with big data, and high-quality university-based resource systems. At the same time, it has completed a batch of high-level multimedia teaching courseware that are closely integrated with the on-campus teaching, such as 'Into Russia', 'Negotiation', 'Character and Cultural Characteristics of Russian Literature', 'Italian Humanism' and 'the Renaissance' (Beijing Foreign Studies University, 2017).

Figure 6

Cloud Service for Digital Resources at Beijing Foreign Studies University

As shown in Figure 6, the Cloud Service for Digital Resources platform contains massive multimedia resources. At present, the platform has a capacity of 50TB, including 7TB of educational resources, covering a total of 64 languages (Beijing Foreign Studies University, 2020). The topics covered by these resources include general education, Beijing Foreign Studies University lecture series, videos of on-campus teaching, academic lectures, classic foreign language films, foreign language recordings and texts, etc. At the same time, the platform also has a resource production functionality, which provides editing and synthesizing tools for teachers. The platform is embedded with an IPTV satellite TV live broadcast system, which allow students to watch real-time TV programs in 20 languages and across 48 channels in Chinese and foreign languages. The platform also includes four apps: an on-demand system for audio and video resources, network satellite TV, a materials production system and private repositories (Beijing Foreign Studies University, 2020).

5.6 Learning management system

Commercialized products

The majority of Chinese universities use Blackboard as the official learning management system (LMS), but different LMSs have also been adopted by individual professors.

Figure 7

LMS at Zhejiang University

Taking Zhejiang University for example, 'Learning in Zhejiang' (https://c.zju.edu.cn) is an international LMS that was developed based on Blackboard. Officially launched in August 2016, Learning in Zhejiang (see Figure 7) was set up to provide online learning and teaching for all the campuses of Zhejiang University. Professors and students can log in using the school's unified identity authentication system, and learning and teaching data is transferred and shared with the university's educational administration system. The system supports various learning and teaching activities, including syllabuses, learning sessions, assignments, examinations, interactive Q&As, teaching management, information and resources, video on demand, etc. (Zhejiang University, 2017).

The system supports multiple approaches to online learning and teaching, such as online teaching, blended learning, MOOCs, SPOC, flipped classrooms, explorative learning, mobile learning, etc. The system also supports co-teaching online across different universities/departments, in 18 different languages. It also provides an interface for exporting

and importing curriculums, developing teaching tools, and engaging in secondary system development using international standards (Zhejiang University, 2017).

Cloud classrooms and smart classrooms

In recent years, Central China Normal University has progressed with research into, and the construction and use of, smart classrooms to promote the modernization of educational resources and teaching methods, for which it won the 2018 National Higher Education Teaching Award Special Prize (Huang, 2018). Relying on the National Digital Learning Engineering Technology Research Center and the Educational Big Data Application Technology National Engineering Laboratory, Central China Normal University has developed its own cloud classroom platform, which aggregates 6,587 teaching courses for 80,000 professors and students (China Education Daily, 2019).

In order to realize a seamless connection to the cloud classroom platform (as shown in Figure 8), the all-in-one card system and the student affairs system, the university developed an in-house starC teaching system, which integrates tools for teaching preparation, classroom interaction and third-party applications.

Figure 8

Cloud classroom platform

Central China Normal University holds teacher training on smart classroom teaching every year. Since February 2017, 11 training workshops have been held. Professors at China Normal University must train for more than 360 hours every five years, and this training counts toward their credits.

Learning Cell Knowledge Community

BNU has independently developed the learning system 'Learning Cell Knowledge Community' (LCKC) (PI: Shengquan Yu), which includes six modules: learning cell, knowledge group, knowledge cloud, learning tool, learning community, and personal space (Yang, Yu & Zhang, 2013). In 2010, the LCKC was officially released, including the modules, e.g. learning cell, knowledge group, curriculum, resource center, learning community, and personal learning space. In

contrast to the existing learning management system, the core functions of the LCKC include the creation of learning cells, collaborative editing, interpersonal network construction and sharing, a collaborative creation of knowledge ontology, community learning and interaction, personal knowledge maps, intelligent recommendations, and personalized learning (Beijing Normal University, 2020). These functions provide learners with an open environment in which to access, and to create, resources. Up to 2020, 26,948 students and teachers had created 91,807 learning cells, and there were 7,098 knowledge groups of resources, 629 learning resources and 4,479 active learning communities.

Using the learning object model, the concept of a learning cell implies that a learning resource is open, generative, evolvable, connected, cohesive, intelligent, adaptive and social (Yu, Yang & Cheng, 2009). Learning cells are the smallest resource organizational units and a group of these learning cells creates an LCKC. To enable the learning resource to evolve like a cell, the property of time and an interpersonal cognition network are introduced to the learning resources. As the cells evolve over time, generative information and revisions are recorded and the interpersonal network helps to form a knowledge network, which allows students to construct knowledge (Yu, Yang & Cheng, 2015).

Figure 9

The cloud storage model for ubiquitous learning resources

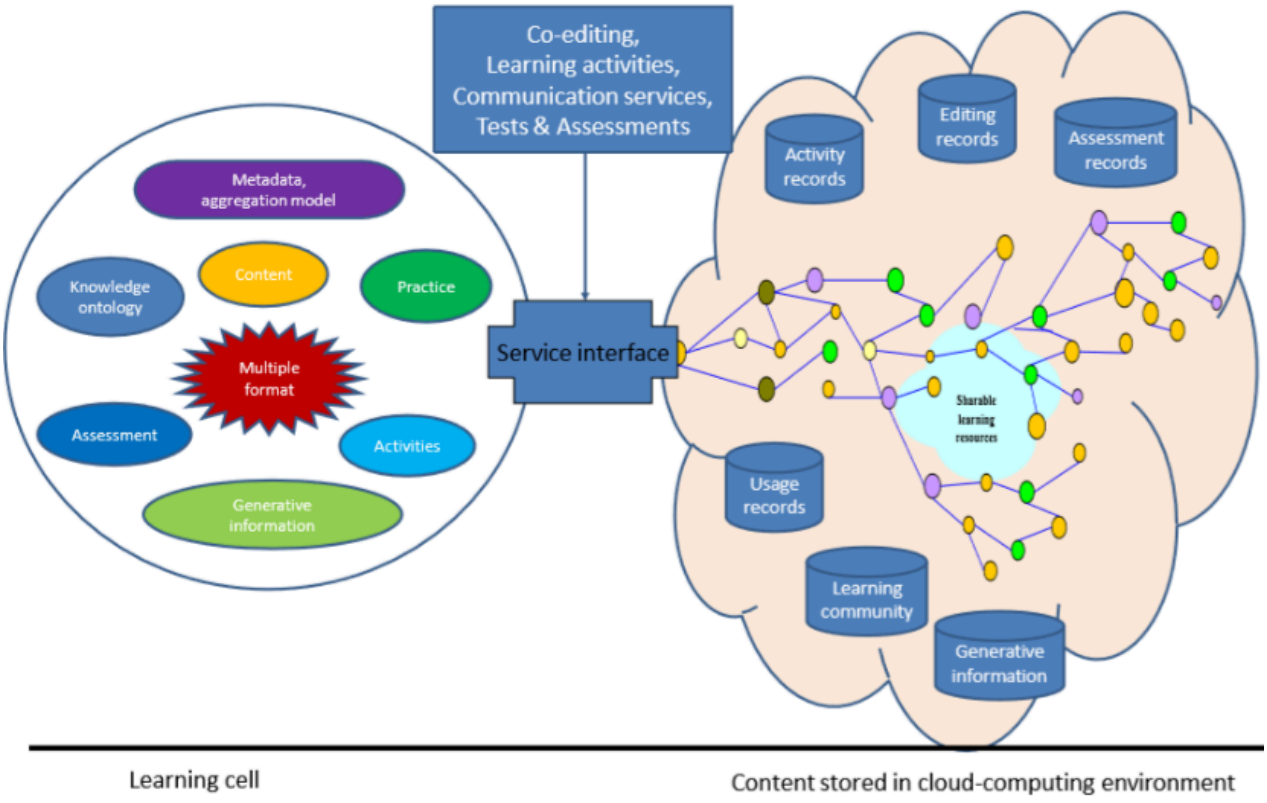


Figure 4. The Cloud Storage Model for ubiquitous learning resources

On the LCKC platform, a learning resource can be created independently or co-developed by connecting to a personalized knowledge network, which contains metadata, aggregation models, knowledge ontology, learning content, learning assessments, learning activities, generative information, learning service interfaces and other resources(see Figure 9). Metadata is used to describe the attributes of learning cells, so that they can be easily categorized, indexed and shared (Yu, Yang & Cheng, 2015).

Figure 10

Collaborative content editing

As shown in Figure 10, users grant permission to edit and revise the resources. To ensure the security of data revision a content version management function is implemented in the LCKC (Yu, Duan & Cui, 2019). A correlational study (Zhang, Zheng, Chen & Xu, 2014) using clickstream data stored on the LCKC has identified that the number of versions has a significant impact on learners' behavior as regards viewing and editing content, and that the number of knowledge groups is the most important factor influencing behavior in respect of sharing and bookmarking; additionally, the type of learning activity also significantly affects whether users make comments.

6. Micro Level

6.1 Policy-related issues and concerns

Faculty's engagement with (O)ER: A policy perspective

As mentioned earlier, in addition to the policies formulated by the MOE, municipal governments and higher education institutions have also released a number of policy documents that set the local guidelines and principles for constructing and maintaining online courses, addressing their use and evaluation, including the application of online courses, curriculum operations, evaluation of faculty members' workloads, student credit certification, and evaluation of teaching quality. Examples include: UOOC Rules for MOOC Production and Guidelines on Course Development issued by China HEI Computer Education MOOC Alliance in 2015 [79]. The Construction Standards of Top-quality Online Open Courses for Colleges and Universities in Henan Province (trial) [80], the Construction Standards of Municipal High-quality Online Open Courses for Colleges and Universities in Chongqing (Trial) [81], and the Construction Standards of Xiamen University (Trial) [82]. To understand how these policies are interpreted at the faculty level, we sought to conduct semi-structured interviews at different universities. However, only three participants could be interviewed before the COVID-19 outbreak. Thus, we used these interview data only as a supplementary account to shed light on staff involvement in the practices of (O)ER in line with their universities' policies. For example, a key person who works at the Information Resource Centre at BNU stated that BNU has a free network tariff policy in place to enable students to use educational resources on platforms including XuetangX, China University MOOC, and Rain Classroom, which are provided by third-party organizations. This policy also indicates that BNU's information portal should provide links to these educational

resources (see screenshot in Report 3). The participant pointed out that the central portal regularly releases updated educational resources that can be accessed by BNU's students who have credentials to log on to the internal portal.

An interview participant who previously held a managerial role at Beijing Open University (BOU) stated that BOU has policies to award 'high-quality courses' and 'teaching excellence' to faculty members who prove themselves able to create high-quality educational resources or who demonstrate excellent instructional designs in their courses every year. In addition, all the faculty members are required to curate one course online which will be integrated into their university learning portal. These online courses are reviewed by a university management group. Moreover, this interviewee mentioned that BOU offers educational resources that are either for academic qualifications or non-academic qualifications, with the purpose of enabling lifelong education for adult learners.

Faculty members' and students' awareness of (O)ER policies

Few studies have examined faculty members' involvement in the policy-making process. According to a field study at a university in Nanjing, faculty members were invited to attend seminars to give feedback on the policy for calculating their workloads related to using online courses to develop flipped classes, with face-to-face tutorials. The university administrators took their advice and feedback into consideration in policy formulation (Meng, 2018). Beyond participation in policy-making through seminars in the higher education sector, awareness of these policies is rather low.

Xu's study (2018) reports on faculty members' and students' awareness of (O)ER policies. In 2018, Xu undertook a survey study at a number of representative universities in different regions of eastern, central and western China. The selected sample included Peking University, Renmin University of China and East China Normal University in the eastern region; Huazhong University of Science and Technology in the central region; and Southwest University, Shaanxi Normal University, Western University of Electronic Science and Technology and Sichuan University in the western region. In total, 450 students and 172 faculty members participated in this survey research.

For more than half of the students and nearly one-third of the faculty members, their understanding of the policy documents related to online courses was limited mostly to specific aspects, and they lacked overall knowledge. Students were found to have low awareness of relevant policies: 55.7% of students replied "Unclear" to the question "Does your university have a policy document on the construction of online courses?", whereas only 22.4% answered "Yes". Of the faculty members, only 33% were aware of relevant national policies, and 37.2% knew about relevant university policies. The degree to which faculty members were familiar with policies was ranked by participants from high to low, with the following results for different policies (from high to low rankings, from most to least familiarity): (1) course management; (2) changes in teaching methods; (3) course content; (4) course resources; (5) course structure; (6) the training system; (7) the training system for technical personnel; and (8) support for relevant resources. Policies regarding (O)ER outline different orientations for developing and using educational resources, and faculty members had different levels of awareness and understanding of certain aspects of (O)ER. This indicates that faculty members had a low level of understanding of relevant policies, and mainly lacked an understanding of training programmes and policies regarding evaluation that might act as incentives for them to develop more resources. The study by Zhang and colleagues (2015) also pointed out that faculty members' lack of understanding about the standards of (O)ER and open courses is problematic, because their perceptions of the universities' policies and standards of (O)ER can influence their (O) ER practices. Wang and Wu (2013) conducted a survey (153 questionnaires) in over 20 departments at Peking University, and faculty members argued that policies and mechanisms for motivating faculties to develop (O)ER by protecting their intellectual properties are key to promoting (O)ER, and more policies are needed in these aspects. The extent to which faculty members and students understand the (O)ER policies has implications for how these policies can be disseminated, circulated and received by them. Additionally, academic and administrative staff members' awareness of these policies is also a factor influencing how effectively these policies can be carried out.

Policies on how to manage online resources

On 21 July, 2017, the General Office of the Ministry of Education issued the "Notice of the 2017 National Excellent Online Open Course Accreditation Work", which set out constructive suggestions about application procedures,

requirements, evaluation approaches, standards, and management at the macro level, but no detailed evaluation indexes were developed subsequently, resulting in unsuccessful evaluation work within individual institutions. In addition, higher education institutions need to demonstrate innovative approaches to evaluating (O)ER, for example, the lack a third-party evaluation (Yang, 2018).

Taking Xu's (2018) study as a case, we found that only 13.4% responded with "completely agree" to the statement that "the university conducts regular inspections and evaluations" and 50% responded with "disagree" or "completely disagree" to the statement that "the university frequently revises policies with regard to the problems that occur in practice". Only a few faculty members responded with "strongly agree" to the statement that their universities had established a credit transfer system (6.4%), whereas 38.3% completely disagreed that there was an inspection process and 28.6% completely disagreed that a credit transfer system existed. Xu (2018) argued that this problem was related closely to the absence of specialized online course management offices in universities. In addition, 13.4% and 16.8% of the faculty members responded respectively with "completely agree" and "agree" to the statement that "the university has a teaching team for developing online educational resources", whereas 25% responded with "completely disagree". Regarding the mechanism in place for providing support and incentives, the survey results showed that the majority of faculty members either responded with "disagree" or "completely disagree", and only 14.5% responded with "completely agree" to the statement that the university had operated well.

Xu's (2018) survey found that faculty members from the eight universities generally considered the courses well developed, but that there was a lack of understanding about how to manage these resources. Of 172 faculty members, 30.2% responded with "completely agree", and 28.5% responded with "agree" to the statement that "their university provides a complete curriculum plan and teaching schedule", and more than 50% responded "completely agree" and "agree" to the statement that "their university provides reasonable requirements for developing and implementing course content", suggesting that the current online course or educational system was relatively complete.

Follow-up interviews with these participants found that, although the university seemed to have established principles and regulations on curricula and schedules, in reality, problems, such as the misalignment between teaching plans and course objectives and integration of online teaching with face-to-face courses were not resolved in further policy-making (Xu, 2018).

Regarding faculty members' awareness of how courses or educational resources were managed, Xu's (2018) survey found that only 10.6% knew that their university had an office that specialized in online courses, and 45.9% reported that that they were not aware of such an office, whereas 43.5% stated that there was no such office in their university. This shows that most faculty members were not aware that policies regarding online courses and educational resources were managed from a central and specialized office.

In addition, these faculty members stated that they had yet to be given the type of administrative and technical support that should be provided by professional teaching teams. In addition, they said there was a lack of teaching quality supervision to ensure that faculty members implemented online teaching of a high quality.

Regarding information technology (IT) training, only 14% of faculty members responded "completely agree" and 16.9% responded "agree" to the statement that "the university conducts special training and assessment for faculty members", indicating that IT support for faculty members to develop online resources and courses was not sufficient.

The survey also investigated why the above issues occurred; 69.8% of the participants considered online educational resource or courses incompatible with traditional instruction. In online resources and courses, the methods of organizing content, scheduling time and making the course plan are different from those required for face-to-face teaching, and ineffective coordination significantly impacts the effectiveness of online teaching. Additionally, the lack of a scientific approach to resolving the tension between fragmented learning and integrated disciplinary knowledge is an important factor that accounts for the current problems in developing (O)ER online. This was also echoed in the interviews, which will be detailed later in this report.

The impact of university administrator and managers' ICT literacy on (O)ER policy implementation

An interviewee from the BNU Centre of Information & Network Technology believed that the country and the universities had issued relevant policies and action plans to promote the digitalization of educational resources but that the implementation depends on the actions that ICT offices take in individual universities. The most important factor that impacts on the implementation is IT literacy among leaders and administrative staff who are involved directly in digitalization work at the institutional level. The interviewee explained as follows:

"The problem in the digitalization of educational resources in colleges and universities lies not in the quality of learning platforms and the learning system, but more importantly in the IT literacy of personnel. If the IT literacy of the personnel involved in the informatization process does not reach a certain level and the university wants to promote the reform, there is no way for the university to effect such a change".

This interviewee indicated a belief that if university leaders have proficient IT literacy, the digitalization transformation of educational resources will be accelerated.

"In a very small number of universities, whose leaders also served as the director of the centre of ICT, the university's digitalization transformation has been promoted relatively quickly."

An example pointed out by one interviewee was the great work done by Professor Yang Zongkai, the president of East China Normal University, on the digitalization transformation of educational resources at the learning and teaching level, whereas other universities have only managed the digitalization of routine office work.

Without a leader who can coordinate resources from different university offices, problems occur. One interviewee pointed out that the ICT office and the office of academic affairs need to work together to promote the use of (O)ER at the learning and teaching level:

'[Work on both sides is] separate. Our team built a lot of things, however, if faculty members want to use our system, what I said doesn't count. For example, I wanted to provide faculty members with information services; when the job was done, those people [who were in charge of academic affairs] said: "Forget it, we're here, don't mess with us". Most universities need someone to coordinate these things.'

The interviewee also said: 'I don't know what the current high-level management is.'

Incentive policies and implementation of open courses: A case study of X University in Nanjing

In recent years, colleges and universities have continuously improved the system for identifying the workloads of faculty members who are involved in online courses. Faculty members who participate in developing online open courses receive a certain workload subsidy; their involvement is also related directly to their professional career development. Meng (2018) conducted a survey of faculty members at X University in Nanjing and the results showed that an incentive policy to encourage (O)ER development was aimed mainly at two kinds of faculty members: those who chaired online educational projects and those who directly used online courses or used them for offline tutoring. Specific policies were divided into four aspects (Meng, 2018).

First, the university provided financial support for the project, which included all course-related expenses. Faculty members received funds as soon as the online class started. The funding was provided either by the university or by the college. The amount of funding differed, according to different disciplines: ¥ 30,000, ¥ 50,000 and ¥ 100,000. According to the faculty members interviewed:

'Students were recruited as teaching assistants to produce the video of the course "Network Technology and Application" in X University and thus the production cost was relatively low, about 60,000 yuan. As for the course "Basic

Circuit Analysis", the videos were recorded by lecturers in front of the computer, so the budget was also very low, about 50,000 yuan, which consisted of fees to buy recording devices and hand-written boards for producing the videos.'

However, some videos for arts courses were made by companies because of the special effects needed. These videos were expensive. However, no matter how expensive the online course was, the universities provided sufficient financial support and encouraged the development of more such quality materials

Second, in order to encourage faculty members to participate actively in producing online open courses, X University provided additional subsidies for faculty members' additional workloads. According to the faculty member:

'There is a huge amount of work for faculty members to do during the process of making an online course. So, the university defined the workload of a faculty member in making an online course as equivalent to the time needed for teaching in a traditional face-to-face course.'

Third, faculty members were entitled to three times the workload of traditional face-to-face teaching in the first round of the flipped class, 2.5 times in the second round, and twice in the third round and beyond. This was due to the extra workload when faculty members developed a flipped class.

Fourth, funding was provided to faculty members who ran online courses. The director of academic affairs stated:

'Faculty members will receive ￥15,000 per round for the first online class, and ￥8000 for the second round and beyond. Besides, the specific funding process is as follows: iCourse allocates the national funds to universities. And then the university distributes it to the relevant faculty members after deduction of taxes. That is to say, the university is the intermediate link in the state funding process.'

6.2 Quality-related issues and concerns

The quality of (O)ER from the perspective of faculty members

In the Chinese literature, a great number of studies have proposed quality assurance systems from a variety of perspectives. For example, Chen (2008) proposed the development of a control system, process monitor system, tracking evaluation system, and quality feedback system. Wang and colleagues (2011) used prior, during, and post control mechanisms to establish a quality assurance system including planning, management, and evaluation. Wan and Zhao (2013) proposed a quality assurance system from the user perspective, including quality monitoring, quality evaluation, quality feedback and resources update systems. Wu (2015) argued that it is difficult to evaluate educational videos from educational, scientific, technical, artistic and usability perspectives. In the light of this, he proposed evaluating video teaching resources by using expert peer evaluation and student evaluation. In terms of expert peer evaluation, the focus should be on instructional design, instructional content, instructional scenarios, instructional strategy and instructional art evaluation (Wu, 2015). Although Chinese scholars have actively proposed different approaches and ways to evaluate the quality of OER, few documents address how the quality of educational resources is evaluated at the learning and teaching level in practice.

Another survey investigated staff working in MOOC offices, information centres, educational resource offices, and multimedia offices from 50 universities in China (Liu, 2016). The majority of participants (96.15%) believed their offices played a role in overall regulation and planning, and only 23.08% considered that their offices managed or examined formative evaluations of the quality of (O)ER.

In addition, interviewees from BOU mentioned that its development of educational resources had been in accordance with national policies, and therefore the focus of quality evaluation had changed accordingly.

According to this interviewee, at the time of the interview the online course quality depended mainly on the evaluation carried out before it was implemented, and the feedback received after it was developed:

'Before developing the online courses, at the departmental level, several faculty members give collective lectures and send several selected courses to the university. The university then invites experts to evaluate these courses, and the

experts will also select the qualified courses. After the selection of the courses by the experts based on the required criteria, our team started to develop the courses. Additionally, after the development of the courses, only those which are confirmed to be qualified can be run online. There will be teaching supervision during the learning process, which will supervise the compliance of faculty members' educational resources and activities. But the tools we have now can only ensure quality compliance and there is no particularly effective way to distinguish good lessons from bad lessons.'

'After the class, questionnaires are arranged to ask participants for their feedback on the course. However, from the responses students give, our team has realized that the feedback and suggestions do not actually reflect students' true experiences with the course. They only answer the questionnaires, with the only aim being to help them to get their degrees faster.'

As we can see, quality assurance at the learning and teaching level is rather difficult to implement. This requires further investigation.

The National Top-Quality Course project's contribution to educational resource quality: An interview study

Hou and Wang (2012) conducted an interview study in a research-oriented national key university (University A), and a provincial normal university (University B). Seven faculty members were interviewed: an academic staff member at University A, who was in charge of coordinating the construction of the National Top-quality Courses; faculty members at University A; the Director of the Academic Affairs Office at University B; and faculty members at University B (one of them also participated in the evaluation of the provincial-level high-quality courses).

According to the Director of the Academic Affairs Office, the National Top-quality Courses program has improved the quality of the faculty members' offline courses and deepened their understanding of instructional methods and standards. Some interviewees also mentioned that all teaching staff know the national standards for each course, and these standardized instructional methods set guidelines for faculty members, to improve the quality of their teaching.

In addition, a member of the National Top-quality Courses Review Committee explained that standardization did not mean a lack of innovation. This was confirmed by one of the interviewees. He mentioned that, in the past, some faculty applied more traditional teaching methods, with little discussion and interaction embedded in the classroom, but that the attempts to redesign their courses in order to apply for the National Top-quality Courses had changed their teaching philosophies and instructional design.

'Faculty members used to just go to their own classes and rarely attended other faculty members' classes to learn from peers. However, it is not just the members of course teaching teams who are sharing and reflecting internally around the course materials (i.e. the National Top-quality Courses) – all the course resources published online can be watched by a wider range of people. Also, due to the requirement to maintain the high quality, faculty members are also getting more familiar with information technology and making more use of educational technology in the classroom. Meanwhile, those students who couldn't keep up with the lesson can review the videos after the class.'

Most interviewees thought that top-quality courses were used mainly by peer colleagues from the same university or other universities. One faculty member from University A, whose course was a National Top-Quality course, mentioned that many universities used the course materials they produced, and that this was very helpful in order to broaden the influence of their course in the country. Faculty members from other universities had contacted them about how they produced their resources and some faculty members even visited their university in person to learn more about the course. In addition, another interviewee's course was very influential. He believed that his National Top-quality course had played an important role in improving the standards of instructional design and had had an impact on similar courses in many domestic universities. His course had an extremely high usage frequency, because it was also offered by other universities, and many faculty members browsed his course resources or contacted him when developing their own courses (Hou & Wang, 2012).

6.3 Educational resources and technologies in use

Use of (O)ER and technologies among faculty members

In 2011, a survey study of 246 faculty members was conducted in Chongqing, Hebei, Beijing, Jiangsu and other cities. The study showed that faculty members had a high demand for digital resources, and that the top three frequently used digital resources were multimedia, e-learning materials and instructional resources (Xu, 2011). Regarding their access to digital educational resources, most faculty members mentioned that they obtained these resources through the Internet, using various network platforms for high-quality courses. Very few faculty members obtained resources through the campus network.

A 2013 survey of early-career faculty members under the age of 40 from three universities in Xi'an found that 59% of 202 faculty members had developed courseware by themselves. However, in-depth interviews showed that most faculty members chose to use PowerPoint as the digital courseware. In addition, 38% mentioned that they downloaded resources from the Internet to help them develop courseware. By contrast, only 3% used educational resources developed by their universities and paid recourses (Li & Ma, 2013). Similar findings were reported in a 2011 survey, and 64.6% of participants chose to use PowerPoint resources. The challenges for faculty members to use OER were reported to be lack of awareness (41.5%), lack of skills (24.6%), and lack of time (9.2%) (Li & Li, 2012).

Moreover, in 2015, an interview study of 87 faculty members at Northwest Normal University found that 75% chose to design courseware either by themselves or by integrating teaching materials by themselves, whereas the others adopted multimedia resources either from CDs, websites, QQ sharing or WeChat (similar to WhatsApp). Most interviewees used text, images, audio, animations and videos in their daily teaching. Image processing technology was used by 92%, 69% used audio processing technology, and only a few faculty members used video or animation technology. In addition, 75% of interviewees added interactions in class.

Nevertheless, 70% of the participants still stated that they could not make full use of multimedia equipment (Li, 2015). As in previous studies, 71% mainly used PowerPoint in teaching, whereas only a few faculty members used advanced technologies, such as Authorware or Flash (Li, 2015).

Zheng and colleagues analysed 603 courses from 14 Chinese MOOC platforms, of which 266 (44.11%) were recorded lectures given in classrooms. Animation, Khan's style, discussion and interviews were rarely used in MOOCs, accounting for less than 4% across 603 courses (Zheng, Li, & Chen, 2015).

Use of open courses among students

Students tend to use different types of education resources. In 2012, a survey of 319 university students was conducted in the area of Xiuzhou (including China Mining University, Jiangsu Normal University, Jiangsu Vocational Institute of Architectural Technology and Jinzhou Polytechnic) and another 185 university students from universities all over the country, with a total of 504. The results showed that the most popular learning resources among students were open courses offered by NetEase Open Class (56.75%), open courses from overseas universities (36.90%), video open courses (36.11%), online courses in domestic universities (34.33%), and National Top-quality Courses (33.13%) (Dong, 2013).

In relation to the Top-quality Courses, many problems have been reported. Wang (2010) conducted a survey of 483 students studying at higher education institutions, and found that they rarely used top-quality courses. The results showed that 76.92% of students logged into the platform for less than one hour per week or per day. In Wang's survey (2010), students commonly highlighted that there were problems with using Top-quality Courses. For example, 63.14% thought that the hyperlinks led to the wrong (O)ER, 61.35% stated that it took too long to load (O)ER, 55.25% indicated that the internet speed was slow, 50.37% mentioned that they were inaccessible, and the majority were not satisfied with (O)ER that was provided to them. In a survey by Wang and colleagues (2012), only 27.2% of students thought the Top-quality Courses were user-oriented, whereas 56.2% considered the sharing and reusing of these sources to be relatively low. In Wei's (2019) investigation, only 20.4% of students considered open instructional resources good

enough to facilitate their learning, and 38.6% thought that these resources rarely helped them to improve their learning performances.

According to a study of frequency of use in the area of Suzhou (near to Shanghai) (Dong, 2013), 33.93% of students rarely visited online classes over the whole semester, 22.22% visited fewer than three times per semester, 22.42% visited one to three times per month, 17.06% visited once or twice per week, and only 4.37% of students visited more than three times per week. This indicates that the utilization rate of open courses is relatively low for university students (Dong, 2013). Another study (Wang, Liu & Zhu, 2013) investigated students from 11 provinces from the east, west, and north of China. Of 1125 students, 23.9% indicated that they did not used top-quality courses.

In terms of preferences, 66.67% of participants preferred to use teaching video/audio, 40.08% preferred to use downloadable lecture notes, 37.3% chose references, 18.06% tended to use course assignments, 16.87% preferred to use interaction and communication, and 15.28% tended to use online tests for learning. This implies that university students preferred to follow a course in video/audio format that could be downloaded for later use. In addition, it seems that they were also interested in references provided by open courses, to deepen their understanding of the course content.

In addition, the university students' participation in interaction and discussions was found to be relatively low. According to the survey, less than 20% of the students participated in interactions frequently, with a non-participation rate of approximately 40%. This is a clear indication that participation in open course interactive discussions is generally not high. Nevertheless, the survey showed that students thought that the communication and interaction module was important (Dong, 2013).

A successful story of (O)ER adoption by students

Ten universities are located in Guangzhou University Town, including Sun Yat-sen University, South China University of Technology, Guangzhou University of Traditional Chinese Medicine, South China Normal University, Guangdong University of Technology, Guangdong University of Foreign Studies, Guangdong Pharmaceutical College, Xinghai Conservatory of Music, Guangzhou Academy of Fine Arts and Guangzhou University (see Figure 11). These universities allow students to learn from other online sources through several approaches, such as offering online courses in their specialized disciplines for other universities, offering minor degrees for other universities, and providing flipped classes using online courses offered at CNMOOCs.

Figure 11

Map of Guangzhou University Town (adapted from 'Speculative urbanism and the making of university towns in China: A case of Guangzhou University Town')

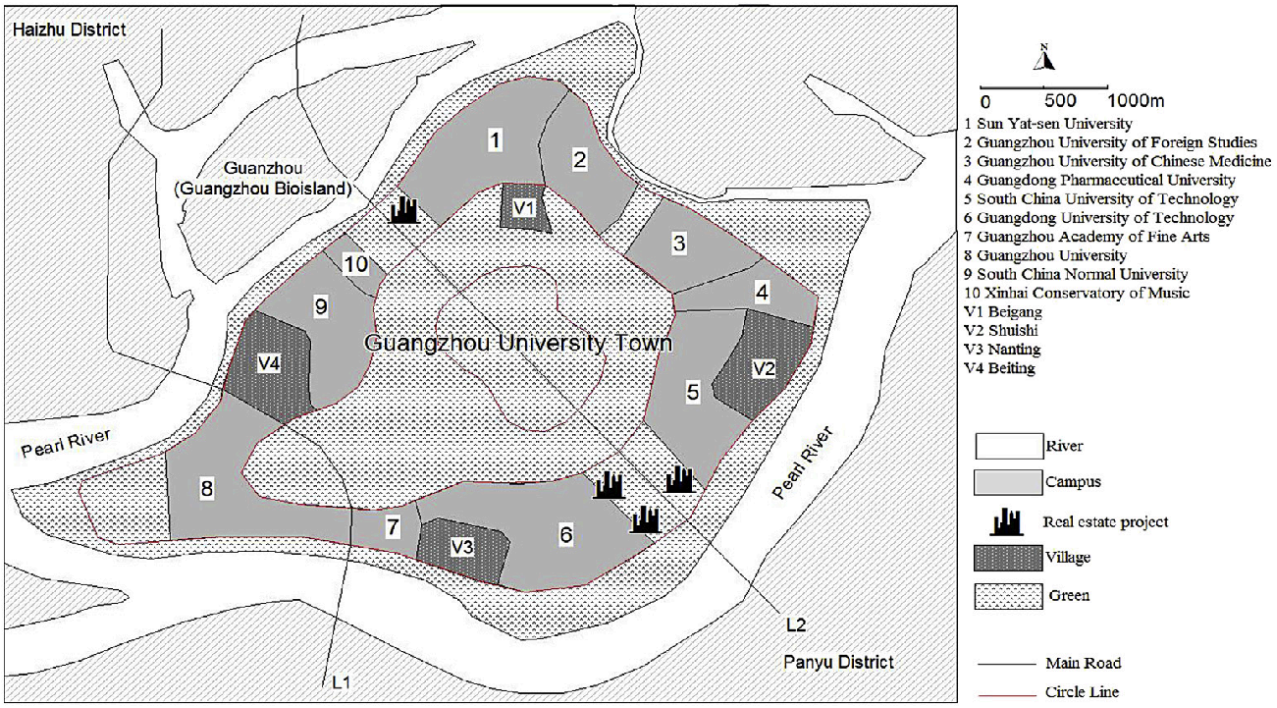


Fig. 3. The map of Guangzhou University Town.

In 2006, the Department of Education of Guangdong Province issued documents designed to encourage cross-registered courses and credit recognition among colleges and universities in Guangzhou University Town. However, the article 'Guangdong University Town: Mutual Recognition of Credits, No one Applauding', which was published by People's Daily on July 18, 2011, reported a dilemma regarding the policy in Guangdong University Town. According to this article, only 2% of the total number of students in the town chose to learn through cross-registered courses in the first semester of the 2011/2012 academic year. Interviews showed that students generally believed that most cross-university courses were not practical and that the extra tuition was not cost-effective.

However, since 2008, South China Normal University has launched two online elective courses, Pedagogy and Psychology, both of which have achieved good reviews and have been improved continuously to this day. These two online public courses each has one lecturer, assisted by two tutors, and the number of registered students is approximately 300 per semester. Both courses are taught by a teaching team led by associate professors, involving lectures. According to a 2013 survey, 172 students of Pedagogy and 143 students of Psychology rated the quality of the resources of these two online courses highly, and preferred to learn online to avoid high tuition fees and travel (Wu & Zhang, 2013).

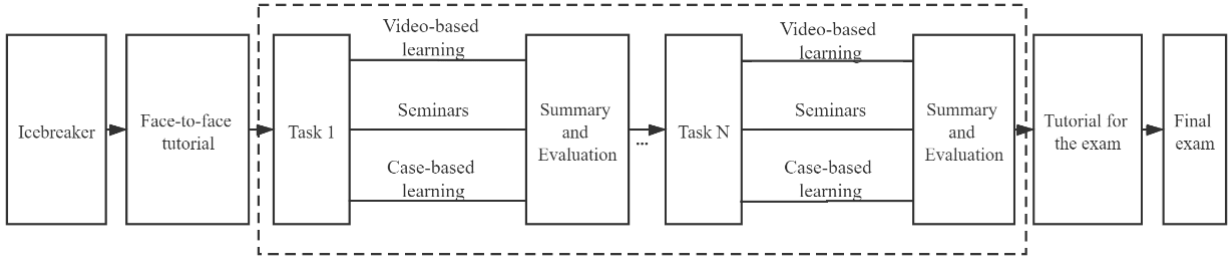
The success of these two courses is also attributable to the fact that a new teaching method support system was adopted.

Innovation in instructional mode – Facilitation rather than lecturing

At the beginning of these two courses, the lecturer organizes a first face-to-face session, introducing the course content, characteristics, learning methods and assessment, in order to familiarize students with online learning, in preparation for later online sessions. During the face-to-face session, lecturers provide students with feedback on how to progress step by step, and give them tasks, including learning materials, discussion topics and cases to solve. After one session, focusing on one topic, the lecturers summarize the topic and provide scaffolding for students to develop knowledge construction. In this way, this course is no longer a conventional online one, including 'video + forum'; it has more interactions. Before the final exam, lecturers offer tutorials on difficult knowledge through face-to-face sessions or online sessions, with the aim of helping the students to prepare for the final exam (see Figure 12).

Figure 12

The teaching process of intercollegiate network public elective course (adapted from 'On Curriculum Elect and Learning Credit Recognition in Guangzhou University Town: From the Perspective of Interscholastic Online Teaching')

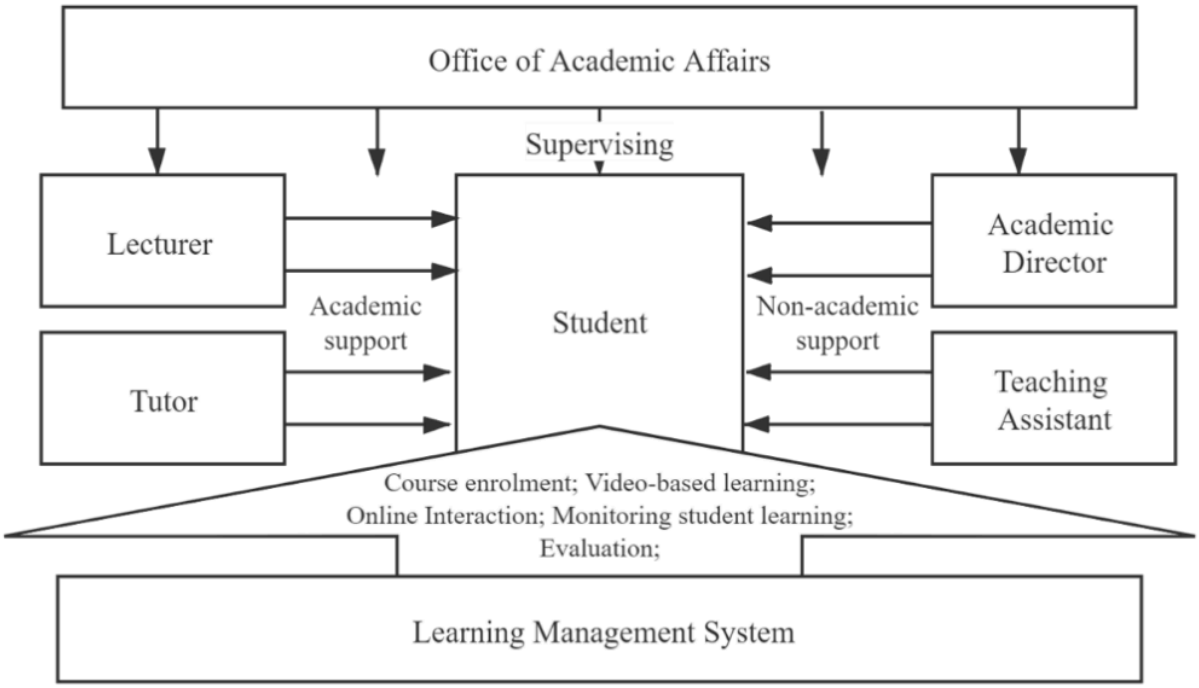


Innovation in the support system

Approximately 300 students take Pedagogy and Psychology each semester; they come from different universities (see Figure. 11). After a long exploration period, South China Normal University has developed a comprehensive learning support service system to provide better support to students who learn online, as shown in Figure 13 (Wu & Zhang, 2013). This ensures low dropout rates. Feedback from students is generally good.

Figure 13

Support system for sharing online courses (adapted from 'On Curriculum Elect and Learning Credit Recognition in Guangzhou University Town: From the Perspective of Interscholastic Online Teaching')



Online education resources construction during COVID-19

Coronavirus-19 broke out in China during the Spring Festival 2020. In February, the Ministry of Education issued a Guideline Regarding Online Teaching and Management of Colleges and Universities during the Epidemic Prevention, requiring that teaching and learning should continue uninterrupted while all colleges and universities were closed down.

At present, little research has been conducted on the infrastructure used by faculty members at Chinese colleges and universities during this epidemic. A few studies have provided descriptive accounts of how universities pivoted quickly to online learning. For example, Professor Gong from Peking University introduced the use of platforms and tools. On February 17, 2020, Peking University started the new semester, with 2,836 faculty members and 218,853 students taking online courses.

First, in terms of course formats, undergraduate courses mostly adopted live streaming, accounting for 50% of the total number of courses, whereas most of the graduate courses were more diverse, including seminars and live streaming and other formats. About 25% of these graduate courses adopted two or more instructional forms to improve the teaching quality (Gong, 2020).

As for platform selection, Peking University encouraged faculty members to use multiple platforms simultaneously to reduce pressure on the university's ICT infrastructure. Faculty members used diverse platforms, such as the Peking University teaching platform (Blackboard), ClassIn, and Canvas, and Zoom. Most faculty members chose ClassIn. In addition, faculty members who needed to organize seminars and record course videos primarily chose the Peking University teaching platform (Blackboard). For students, the most popular website for MOOC learning was China University MOOC. However, there are advantages and disadvantages of having a great number of platforms to support online learning: it, on the one hand, provides great convenience for faculty members and, on the other, also requires students to switch to different learning platforms frequently (Gong, 2020).

Although different platforms had been adopted within universities, there were still some problems rooted in the IT infrastructure for online teaching across the country (especially earlier in the term). During the peak time, the learning platforms and software are likely to encounter network congestion because too many students were using them at the same time (Han, 2020). For example, when using some platforms such as China University MOOC and XuetangX, there were lags and delays because too many students were watching videos and taking online classes, and sometimes they even failed to log in during certain peak hours. In addition, a small number of students could not attend classes due to the poor Internet access in rural areas.

Regarding quality assurance, different college and universities acted in their own ways. For example, Peking University organized a teaching research group, composed of experienced professors, to investigate online courses to ensure their quality. In the first two weeks of the teaching research group, this group attended more than 60 classes. They found some problems, such as the incorrect angle of the faculty member's camera and light problems. These problems were reported back to the faculty members in a timely fashion, and then the faculty members quickly made adjustments. Additionally, the group gave some suggestions about the instructional design of online classes.

In addition, many colleges and universities, such as Shandong Normal University and Inner Mongolia Normal University, surveyed undergraduate students and faculty members about teaching quality and published reports on this. The surveys also covered the attitudes of students and faculty members towards online teaching, as well as the expectations for future teaching modes, as seen in the report from Shandong Normal University.

During this epidemic, many faculty members were nervous about teaching online; for many of them this was the first time they had used the online mode to teach. For these faculty members, urgent technical support was needed.

As Peking University, the Centre for Excellent Teaching and Learning held a training programme for faculty members very quickly. Specifically, the programme was carried out in two stages with the idea that the first priority was to solve technical problems to ensure the development of online teaching and then to increase the instructional design and strategy gradually to improve the quality of courses (Gong, 2020).

The first stage of the programme, which started before the beginning of the semester, focused on using software tools, lasted five days and involved 15 lectures (over seven hours). This trained 2,062 faculty members at Peking University. The content included using resources such as ClassIn, and the Peking University teaching platform (Blackboard).

The second stage of the programme, which was held during the second week of the term, focused on instructional design strategy. At that time, faculty members had gradually adapted to online teaching and had begun to focus on how to promote teacher–student interaction. Training sessions included instructional methods and online teaching skills.

In addition to these, regular training for young faculty members and teaching assistants is still continuing, also focusing on online learning and teaching. To promptly solve the faculty members' problems in online teaching, the centre opened a hotline, a consultation mailbox and a WeChat group to provide 24/7 support.

7. Conclusion

Given that educational digitalization is a national strategy in China, it is hardly surprising that the Central Government is the key driving force behind educational digitalization and that macro-level policies and measures guide and in some cases define the direction and the growth of the digitalization drive, resulting in a concentric phenomenon, with all efforts at macro-, meso- and micro-levels directed towards the national digitalization objectives. Nevertheless, with increasing awareness of the resulting benefits, more and more HEIs have shifted from responding, somewhat passively, to the national strategy to intrinsically-motivated engagement with digital technologies in their attempt to have more competitive advantages over their counterparts. Another point worth noting is that following the guidelines imposed at a higher level does not mean the sacrifice of initiative, ingenuity, creativity and innovation at a lower level, as evidenced by the ways in which digital technologies are utilized in practice. A key lesson concerning the top-down approach is that great care should be taken to ensure that there is no flaw in the higher-level policies and/or initiatives. The damage caused by higher-level flaws can be very expensive and even disastrous. Luckily, no such costly mistake has ever occurred in China.

From the perspective of the Central Government, the overarching goal of digitalization is to modernize the country's education, enhance (higher) educational quality, and achieve educational equity by investing in digital infrastructure construction, staff capacity building, technology-enhanced learning and teaching, and developing and sharing of high quality educational resources. Measures taken to ensure the successful implementation of these policies include providing funding, incentive or subsidy; strengthening leadership and coordination; creating a favorable innovative atmosphere; and promoting international cooperation. Compared with the Central Government, HEIs are not an impressive force in terms of pushing the digitalization drive. However, this situation is changing as a result of the COVID-19 pandemic. Having learned cruel lessons from the COVID-19 crisis, more and more HEIs now realize the imperative of digitalization in the future. Therefore, we have reasons to believe that efforts from the macro-, meso- and micro-levels will result in a better synergy in the days ahead.

Amazing achievements have been made in such areas as digital infrastructure construction and high quality digital educational resource development and sharing. For example, China has a well-developed network composed of digital platforms at national, regional or provincial and institutional levels, which greatly facilitate dissemination, sharing and using of digital educational resources such as MOOCS as well as course delivery. As a matter of fact, infrastructure construction and resources development are top on the agenda at the macro-, meso- and micro-levels. In contrast, more attention should be given to staff capacity building so that they can make the best use of digital technologies in their teaching, research and administration. Lack of adequate skills in using digital technologies may explain in part the gap between construction and application. With well-developed digital infrastructure and rich digital educational resources, it is time to shift the focus to practice, supporting innovation in micro-level practice to realize the overarching goal mentioned earlier. Unless the infrastructure and resources already available are put to effective and productive use, we have yet to reach this goal.

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[1] All statistics are applicable to mainland China only; statistics from Hong Kong Special Administrative Region, Macau Special Administrative Region and Taiwan Province are not included in this report.

[2] It should be pointed out that this website has been restructured and re-purposed and is no longer used exclusively for this purpose.

[3] For a list of these 75 universities, visit http://www.moe.gov.cn/jyb_zzjg/moe_347/201708/t20170828_312562.html

[4] For a list of national standards (updated on September 10, 2016), visit http://www.celtsc.org/channel/bzlist.html

[5] All the national standards are available from the national standardization information system of Standardization Administration of the People’s Republic of China.

[6] Retrieved January 2, 2019 from http://www.xuetangx.com/global

[7] For results of the first review, visit https://edtechbooks.org/-MRbW

For results of the second review, visit
http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s5972/201212/146264.html

For results of the third review, visit
http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s6871/201306/153010.html

For results of the fourth review, visit
http://www.moe.gov.cn/srcsite/A08/s5664/s7209/s6871/201311/t20131111_159561.html

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http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s5972/201404/167525.html

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http://www.moe.gov.cn/srcsite/A08/s5664/s7209/s6871/201602/t20160223_230198.html
[8] See https://edtechbooks.org/-LLIC. Also see
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[9] http://www.moe.gov.cn/srcsite/A08/s5664/s7209/s6872/201607/t20160715_271959.html

[10] http://www.moe.gov.cn/srcsite/A10/s7011/201702/t20170216_296448.html

[11] https://edtechbooks.org/-hNjW and
http://www.moe.edu.cn/s78/A08/A08_gggs/s8468/201812/t20181217_363767.html

[12] Retrieved January 3, 2019 from http://resource.jingpinke.com/

[13] http://www.jingpinke.com/my/point/introduction

[14] We keep the English names of all the alliances/platforms as provided on the websites; otherwise, we will use our own translations.

[15] See 'About us'

[16] Retrieved January 13, 2019 from https://www.cnmooc.org/portal/frontCourseIndex/course.mooc

[17] Retrieved January 16, 2019 from http://www.uooc.net.cn/league/union/intro#contact

[18] Retrieved January 16, 2019 from http://wemooc.zhihuishu.com/union/pages/notice/notice02.jsp

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[20] Retrieved January 16, 2019 from http://wemooc.zhihuishu.com/union/pages/Member/member.jsp

[21] Retrieved January 15, 2019 from http://www.fooc.org.cn/fooc/index.jsp

[22] Retrieved January 16, 2019 from https://jslm.cnmooc.org/portal/frontCourseIndex/course.mooc

[23] Retrieved January 16, 2019 from https://hlj.cnmooc.org/school/alliance-402.mooc

[24] Retrieved January 14, 2019 from https://edtechbooks.org/-GPUX and http://jiangsu.icourses.cn/jiangsu/school.jsp

[25] Retrieved January 14, 2019 from http://hebei.icourses.cn/

[26] Retrieved January 16, 2019 from http://shanghai.icourses.cn/

[27] Retrieved January 14, 2019 from http://hubei.icourses.cn/

[28] Retrieved January 14, 2019 from http://henan.icourses.cn/

[29] Retrieved January 14, 2019 from http://sichuan.icourses.cn/

[30] Retrieved January 14, 2019 from http://guangxi.icourses.cn/

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[36] Retrieved January 15, 2019 from http://hnmooc.zhihuishu.com/static/pages/course.jsp

[37] Retrieved January 15, 2019 from http://jlmooc.zhihuishu.com/static/pages/school.jsp

[38] Retrieved January 15, 2019 from http://www.cmooc.cn/pages/lmjj.html

[39] The People's Republic of China is composed of 34 provincial-level administrative divisions, namely 23 provinces, 5 autonomous regions, 4 municipalities directly under the Central Government, and 2 special administrative regions. Retrieved January 15, 2019 from http://www.gov.cn/guoqing/2005-09/13/content_5043917.htm

[40] Retrieved January 15, 2019 from http://computer.icourses.cn/

[41] Retrieved January 15, 2019 from https://se.cnmooc.org/school/alliance-93.mooc

[42] Retrieved January 15, 2019 from https://se.cnmooc.org/portal/frontCourseIndex/course.mooc

[43] Retrieved January 15, 2019 from http://www.moe.gov.cn/s78/A08/moe_745/201703/t20170302_297912.html

[44] Retrieved January 15, 2019 from http://lis.icourses.cn/

[45] Retrieved January 15, 2019 from http://music.icourses.cn/#zxkc

[46] Retrieved January 15, 2019 from http://fet.zhihuishu.com/static/pages/notice01.jsp

[47] Retrieved January 15, 2019 from http://fet.zhihuishu.com/static/pages/course.jsp

[48] Retrieved January 15, 2019 from http://zyymooc.zhihuishu.com/static/pages/newsList.jsp

[49] Retrieved January 15, 2019 from http://zyymooc.zhihuishu.com/static/pages/school.jsp

[50] Retrieved January 15, 2019 from http://www.pmphmooc.com/web/about?type=1

[51] Retrieved January 15, 2019 from https://edtechbooks.org/-eMTT and from http://www.pmphmooc.com/web/open?type=1

[52] Retrieved January 16, 2019 from http://moocs.unipus.cn/union/introduction

[53] Retrieved January 17, 2019 from http://www.cmooc.cn/index.html

[54] Retrieved January 17, 2019 from http://ucc.sh.zhihuishu.com/statics/pages/Announcement/interactionPage.jsp

[55] Retrieved January 17, 2019 from http://ucc.sh.zhihuishu.com/statics/pages/Announcement/videoPage.jsp

[56] Retrieved January 17, 2019 from https://www.docin.com/p-775830849.html

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[58] Retrieved January 17, 2019 from http://jlmooc.zhihuishu.com/static/pages/newsPages/unionConstitution.jsp

[59] Retrieved January 17, 2019 from http://zyymooc.zhihuishu.com/static/pages/unionrules.jsp

[60] Retrieved January 20, 2019 from http://oi.pku.edu.cn/

[61] Retrieved January 20, 2019 from http://english.pku.edu.cn/intro_organization_admindetail.shtml?id=045

[62] Retrieved January 20, 2019 from http://www.tsinghua.edu.cn/publish/thuitc/10719/index.html

[63] Teaching Affairs Office is the name used on the BNU website (English). The English equivalent of the same department is the Department of Educational Affairs on the PKU website (English). It may be called differently elsewhere, for example, Office of Undergraduate Education on the website of Jilin University (http://global.jlu.edu.cn/User/Index/newsDetail?id=39).

[64] http://mooc.pku.edu.cn/mooc/news.php?id=7

[65] http://mooc.pku.edu.cn/mooc/news.php?id=37

[66] http://mooc.pku.edu.cn/mooc/news.php?id=35

[67] https://www.tsinghua.edu.cn/publish/newthu/10249/2016/20160113081920309193611/20160113081920309193611_

[68] http://mooc.pku.edu.cn/mooc/news.php?id=31

[69] http://mooc.pku.edu.cn/mooc/news.php?id=35

[70] http://mooc.pku.edu.cn/mooc/news.php?id=29

[71] http://jwc.lzu.edu.cn/lzupage/2015/06/04/N20150604102458.html

[72] http://www.lzush.com.cn/Item/20101.aspx

[73] http://zgy.henu.edu.cn/info/1107/2407.htm

[74] http://mooc.pku.edu.cn/mooc/news.php?id=7

[75] https://www.ecnu.edu.cn/_s294/ec/82/c10614a126082/page.psp

[76] http://jwc.lzu.edu.cn/lzupage/2015/06/04/N20150604102458.html

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[79] Retrieved January 17, 2019 from http://www.cmooc.cn/index.html

[80] http://www.haedu.gov.cn/2016/09/01/1472703477251.html, 2016-08-31.

[81] http://jwc.swu.edu.cn/s/jwc/download2qtcl/20171114/2116030.html, 2017-11-14.

[82] http://jwc.xmu.edu.cn/cb/60/c2194a314208/page.htm, 2017-10-25.

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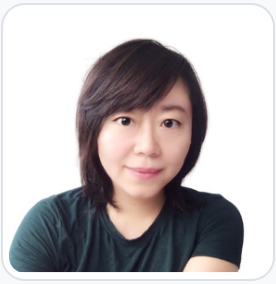
https://edtechbooks.org/-APQF



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