Lecture Notes in Educational Technology

Chee-Kit Looi
Hui Zhang
Yuan Gao
Longkai Wu *Editors*

ICT in Education and Implications for the Belt and Road Initiative

Springer

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Abstracted/Indexed in:

Scopus, Web of Science Book Citation Index

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ISSN 2196-4963 ISSN 2196-4971 (electronic)
Lecture Notes in Educational Technology
ISBN 978-981-15-6156-6 ISBN 978-981-15-6157-3 (eBook)
https://doi.org/10.1007/978-981-15-6157-3

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

This book highlights the burgeoning of Information and Communication Technology (ICT) in education along the countries of the "Belt and Road" (BRI) Initiative. ICT has increasingly played important roles in education including seeking improvement of the quality of teaching and learning, as well as the the promotion of equity in education. The significant contribution of ICT in education is a bridge to the purpose of the BRI Initiative that have received much global attention. The BRI Initiative proposed by the Chinese government aim to promote regional development covering regions in Asia, Europe, and Africa.

The various chapters in this book describe the state-of-the-art of ICT in education in several countries, based on six major themes (policy perspectives, infrastructure, educational resources, ICT integration into practices, students' ICT competence, and teachers' professional development). ICT in education in Belt and Road Initiative countries serves as a groundwork for inspiring and innovative integration of ICT into educational processes.

This book comprises 13 chapters. Chapter 1 discusses the background of the BRI and its main contents in general, the Education Action Plan, and the supportive role of education to the BRI, and further expounds the main values of ICT in education and its relationship with this key initiative.

Chapters 2–12 present the current developmental situations of ICT in education for eleven countries along the BRI. Different countries along the routes will separately present and analyze their current situations of ICT in education, and discuss the opportunities as well as the challenges faced by them for ICT in Education. The eleven chapters are for the different countries of China, Croatia, India, Korea, Malaysia, New Zealand, Russia, Singapore, Slovenia, South Africa and Sri Lanka. These countries are, geographically, distributed along both land-based and maritime routes suggested by the BRI; from the developmental level, are at the different stages of social economy and national average income; and from the cultural perspective, have different cultural backgrounds, educational systems, religious beliefs and multiple languages. By the comprehensive presentation of the overall picture of ICT in education for the countries along the routes, these chapters provide the reference for the countries to compare their educational policies with, promote mutual understanding and learning, and conduct in-depth exchanges and cooperation.

Chapter 13 provides a summary by presenting a comparative account of the developmental situations of ICT in education for these eleven different countries. It provides a unique macro perspective that will help readers gain a deeper understanding of the opportunities and challenges of planning and implementing ICT in Education in the different countries each with its unique historical, cultural, and economic contexts, and different priorities.

ICT in education provides great opportunities for educational development, and at the same time, it is also a common challenge faced by all countries in the world. At present, in the context of BRI, China is actively implementing a number of educational actions to promote educational development, advocating equal, inclusive, reciprocal and dynamic educational cooperation among the countries along the routes. It is expected that the overall development trend of ICT in education provided in this book can serve as a foundation and reference for the countries along the routes to build communication platforms for research and practice of ICT in education and strengthen exchanges and cooperation among governments, schools, experts and enterprises.

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Part I
Introduction

Chapter 1
Introduction to the Belt and Road Initiative, and ICT in Education

Yuan Gao and Huaqing Wang

1.1 The Belt and Road Initiative

The Belt and Road Initiative (BRI, or the Initiative) is a trans-continental strategy of collaborative development proposed by the President of the People's Republic of China, Xi Jinping, in 2013. BRI is rooted in the history of the ancient Silk Road with both land-based and maritime routes (National Development and Reform Commission [NDRC], 2015). The ancient Silk Road connected the major civilizations in both the East and the West as a bridge for cultural, knowledge and economic exchanges and contributed to the civilization of human race in the trans-continental regions of Asia, Europe and Africa. With the spirit of "peace and cooperation, openness and inclusiveness, mutual learning and mutual benefit" (United Nations Development Programme [UNDP], 2017, p. 11), the BIR, as asserted by President Xi, inherits and extends the ancient Silk Road spirit and aims to build a Silk Road Economic *Belt* and the twenty-first Century Maritime Silk *Road* (Yamei, 2017). It emphasizes connectivity and cooperation between China and the countries[1] along the Belt and the Road (or the countries along the routes) to realize the China's Asia Dream of 'community of shared interests, destiny and responsibility featuring mutual political trust, economic integration and cultural inclusiveness' (Caixin, 2015; Callahan, 2016; NDRC, 2015).

According to the Action Plan issued by National Development of Reform Commission of China in 2015, countries along the Belt and Road should strengthen

[1] As of April 30, 2019, China has signed cooperation documents on BRI with 131 countries and 30 international organizations (https://eng.yidaiyilu.gov.cn/info/iList.jsp?cat_id=10076).

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_1

cooperation in the following key areas: policy coordination, facilities connectivity, unimpeded trade, financial integration and people-to-people bonds (NDRC, 2015).

- *Policy coordination* guarantees the implementation of the Initiative with a multi-level intergovernmental macro policy exchange and communication framework. Through the framework, countries along the routes will foster shared interests and enhanced trust, which are the fundamentals to regional cooperation projects and negotiations to solve any cooperation-related issues.
- *Faciliting connectivity* is a priority area for implementing the Initiative. On the basis of respecting each other's sovereignty and security concerns, countries along the routes will cooperate to improve their national transport, energy and communication infrastructures and better connect their individual infrastructures to others through unified construction plans and technical standard systems.
- *Unimpeded trade* focuses on the major task of investment and trade cooperation in building the Initiative. Participating countries should strive to facilitate investment and trade cooperation by removing barriers and creating a sound business environment in order to unleash full potentials for expansion.
- *Financial integration* is an important underpinning for implementing the Initiative. The Initiative is a trans-continental and multi-decade project. The amount of funding and the financial cooperation needed to support a project with such a geographical and chronological expansion are phenomenal. Countries along the routes will need to deepen financial cooperation to strengthen their currency stability system, investment and financing system and credit information system in the region, as well as to expand the scope and scale of bilateral currency exchange with other participating countries and to contribute to the establishment of regional financial organizations dedicated to support the Initiative.
- *People-to-people bond* ensures the public support for implementing the Initiative. The wide support from the public of the participating countries along the routes is the key to the success of the Initiative. The spirit of friendly cooperation of the Silk Road needs be embedded in every bonding effort, such as extensive cultural and academic exchanges, talent and personnel exchanges and cooperation, media cooperation, youth and women exchanges and volunteer services.

While the Initiative and the Sustainable Development Goals (SDGs) proposed by UNESCO (United Nations [UN], 2015) are different in their nature and scope, they share in many respects a similar vision and some basic principles. The SDGs resolves to create conditions for sustainable, inclusive and sustained economic growth, shared prosperity and decent work for all, taking into account different levels of national development and capacities. In comparison, the BRI stressed to be harmonious and inclusive, advocating tolerance among civilizations, respects the paths and modes of development chosen by different countries. The essential spirit of the Belt and Road Initiatives is to a large extent in line with that of the SDGs (Hong, 2016).

Although cooperation in economic and infrastructure related projects is the main focus of the Initiative, education and people-to-people exchanges are also high on the agenda. The BRI provides a great opportunity to promote the opening, communication and integration of regional education. The cooperation and joint action of education in countries along the routes are not only the important part of the Initiative, but also provides talent support to the execution and development of the initiative. Working with countries along the Belt and Road, China has been dedicating to expand people-to-people and cultural exchanges, strengthen personnel training and jointly create a brighter future for education.

1.2 Education Under the Belt and Road Initiative

Education contributes greatly to the ‘people-to-people bond’ aspect, and plays a fundamental and guiding role in preparing talents to support the other four aspects of the Initiative. Interaction and cooperation on education can help build bridges among the peoples and cultures of the countries along the Belt and Road. In order to support and guide the implementation of the BRI and promote the development of education in the countries along the routes, the Ministry of Education of China issued an Education Action Plan for the BRI (referred to “Education Action Plan” hereafter) in July 2016 which defined the mission of education together with the vision, principles, and priorities of educational cooperation. It also proposed Chinese educational actions towards the Initiative and a mobilization for the jointly educational action in the countries along the routes (Ministry of Education [MOE], PRC, 2016). The following section will briefly describe several important aspects of the Education Action Plan.

Mission of Education. Education is the foundation of a country’s prosperity, national prosperity, and people’s happiness. China will remain committed to her open policy in education and involve deeply into the global educational reform and development. China is willing to undertake as many responsibilities and obligations as possible and make greater contributions to the development of education in the countries along the routes.

Vision for Educational Cooperation. The countries along the routes will work collaboratively to establish a Belt and Road educational community for developing equal, inclusive, mutually beneficial, and dynamic cooperation in education, promoting the development of the education in region and thus comprehensively supporting the BRI. Specially, the countries along the routes will work together to (1) Strengthen people-to-people ties by promoting talent and personnel exchanges at a larger scale and at a higher but deeper level, and by improving mutual understanding among peoples along the routes; (2) Provide talent development and cultivation to meet the urgent need of the BRI and support countries along the routes in the other aspects of the Initiative—namely, policy connectivity, facility connectivity, unimpeded trade and financial integration; (3) Achieve common development by deepening educational cooperation and promoting mutual learning to enhance the overall impact of the region’s education.

Principle of Educational Cooperation. Four principles are proposed to guide the cooperation for the countries along the routes, including (1) Education first, humanity first—which refers to focusing on nurturing of the people and giving priority to people-to-people exchanges; (2) Government guidance and society involvement—which refers to strengthening the role of government on communication and coordination, and allowing full involvement of the various social resources such as schools, enterprises, and other social sectors; (3) Common development through consultation and open cooperation—which refers to promoting integration and coordination in the development of national education plans among the countries along the routes, and (4) Harmony, inclusiveness, mutual benefit, and win–win outcomes—which refers to encouraging dialogues between different civilizations, seeking the best integrating point in educational development, and promoting mutual benefits in education among the countries along the routes.

Priorities for Educational Cooperation. Countries along the routes have distinctive educational features and abundant educational resources in the region, making huge spaces for complementation and cooperation. China will carry out cooperation in the three main areas, including educational interconnectivity, cultivation and training of talent, and establishment of cooperation mechanisms, to align with the wills of countries along the routes, to learn advanced educational experience from each other, to share quality educational resources, and to eventually promote the accelerated development of education in all countries.

Taken together, cooperation and exchange are the main ways for countries along the route to build the Belt and Road education community, through which high-quality talents could be cultivated, economic and social development could be promoted, and the well-being of peoples in the countries along the routes could be improved. Thus, people-to-people ties will be further strengthened by educational cooperation and exchanges and the cornerstone for regional peace will be stronger. This is the common aspiration and also the common responsibility for all the countries along the routes. Meanwhile, it is also highly consistent with the SDG4, which resolves to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, and Incheon Declaration by UNESCO regarding the Education 2030 Agenda (UNESCO, 2015).

In the process of establishing the Belt and Road education community to promote the common development in education for all countries along the Belt and Road, a factor that cannot be ignored is the application of ICT in education, which is able to facilitate education systems, knowledge dissemination, information access, quality and effective learning, and more efficient service provision (Qingdao Declaration, 2015). It conforms to the trend of the development of the society and provides a great support to the development of education.

1.3 ICT in Education

ICT stands for Information and Communication Technology, which is defined as a diverse set of technology tools and resources used to communicate, create, disseminate, store and manage information. It covers the emerging technologies and tools such as Computers, the Internet and information systems, as well as the traditional but still popular applications of Broadcasting Technologies (radio and television) and Telecommunication Technologies (Ciroma, 2014). With ICT as the lynchpin of contemporary society, it is difficult to conceive of any aspect of people's lives without it (Soomro, Kale, Curtis, Akcaoglu, & Bernstein, 2017). People are able to connect with other individuals and obtain knowledge and information across the globe at high speeds anytime anywhere through ICT (Danes, Jellema, & Janssen, 2014). This dramatic improvement and adoption of ICT in almost every aspect of modern life means that the traditional education and simple training are no longer in line with the needs of citizens (Talebian, Mohammadi, & Rezvanfar, 2014). With the progress of integration of ICT and education, school becomes an important environment in which students participate in a wide range of computer activities, while the home serves as a complementary site for regular engagement in a narrower set of computer activities, indicating that ICT has become one of an important part in our education and even our daily life (Kent & Facer, 2004). In order to deal with this situation, ICT has been, at a large scale, used into every field of education to promote the education outcomes.

Fu (2013) put forward seven benefits of using ICT in education: (1) assist students in accessing digital information efficiently and effectively; (2) support student-centered and self-directed learning; (3) produce a creative learning environment; (4) promote collaborative learning in a distance-learning environment; (5) offer more opportunities to develop critical (higher-order) thinking skills; (6) improve teaching and learning quality; and (7) support teaching by facilitating access to course content. Following the understanding of these benefits, a number of empirical studies have shown that an appropriate use of ICT can improve educational quality and connect learning to real-life situations (Ciroma, 2014; Lowther, Inan, Daniel Strahl, & Ross, 2008; Weert & Tatnall, 2005). Ciroma (2014) pointed out that ICT in education leads to improved teaching methods and better student learning outcomes, paving way for attaining additional instructional materials for study, research, and development across borders.

Although "education for all" has been included in Millennium Development Goals (MDG) in 2000 and great progress has made to reach this goal since then, there are still a significant number of children who are excluded from basic education in some developing countries, such as sub-Saharan Africa and Southern Asia (Umar & Asghar, 2017). The provision of education for all seems to be impossible for the developing countries with scarce resources, because the government cannot afford to establish educational institutions filled with qualified teachers and quality teaching facilities for every single citizen. Fortunately, ICT are able to bring new opportunities to the undeveloped and disadvantageous areas. With its help, these countries or regions can start planning and implementing digital opportunity initiatives and thereby address their problems in education (Nawaz, 2013). Generally, there are three important roles that ICT are able to play for the goal of "education for all". Firstly, ICT provides inexpensive, user friendly, actively motivating, and widely accessible approaches for the students all over the world to enhance or support learning and teaching (Gay, Mahon, Devonish, Alleyne, & Alleyne, 2006). ICT covers a continuum of educational technologies, from the applications that have been widely used in classroom like MS-Word and PowerPoint to some emerging technologies that are still new but have significant impacts on learning and teaching strategies such as Virtual Reality (VR). Previous researches have proved that working with ICT tools is beneficial for the aggregation and organization of knowledge (Abdullahi, 2014; Kundi & Nawaz, 2010; Nawaz & Kundi, 2010; Noor-Ul-Amin, 2013). Secondly, ICT is able to disseminate quality educational resources throughout the world more efficiently and effectively. One of the popular examples is the Massive Open Online Courses (MOOCs). Comparing with the traditional courses that charge tuition fees, carry credit and limit enrolment to only a few dozen students, the MOOCs are usually with no or low fees, credit-less and massive (Pappano, 2012). These courses provides access to education for a wide audience and thus increase the access to education (Rohs & Ganz, 2015). By the means of ICT, students from all over the world can receive the quality education resources that they need in anytime and anywhere. Thirdly, ICT contributes to the professional development of teachers and educators, ensuring the quality teaching. The Education for All Global Monitoring Report (2013/2014) states that an education system is only as good as its teachers can perform in an effective way (Du Toit, 2015), indicating the significance of professional development for teachers. The potentials of ICT to promote the training of teachers as well as the quality have proved by a number of previous studies (Liu, 2011; Donnelly, McGarr, & O'Reilly, 2011). With the support of ICT, teachers tend to reduce their time spent on their daily departmental activities such as preparing notes, upgrading knowledge, keeping administrative records, searching information for basic purposes, etc., and are therefore able to focus on teaching. Moreover, ICT can provide an interactive communication platform for teachers to communicate about teaching skills and methods, share teaching materials, and learn experience from each other so as to improve teaching quality. Through the use of ICT, both developed and undeveloped countries and regions have equal opportunity to obtain quality learning resources, advanced teaching and learning approaches, and skilled teachers and educators, reaching the goal of education for all.

At the International Conference on ICT and Post-2015 Education held in Qingdao, China, the Qingdao Declaration (2015) was released and it suggested using ICT to achieve SDG4. It states that "the remarkable advances in Information and Communication Technologies (ICT) and the rapid expansion of internet connectivity have made today's world increasingly interconnected and made the knowledge more accessible for every girl and boy, woman and man", which is highly consistent with the vision for educational cooperation in Education Action Plan to establish an education community for the countries along the routes.

Apart from the benefits that ICT can bring in to the education development and cooperation in the courtiers along the routes, the developmental level of ICT in education itself is an important indicator to evaluate the overall educational development in a country. It is determined by many factors such as educational policy, educational investment, educational resources, etc. Therefore, learning about the current situation of the development and application of ICT in Education for the countries along the routes would be helpful to understand the strengths and weakness of education development for each of these countries, identify their developmental stages on education as well as the special needs, so as to quickly identify the problems and issues that they come across, provide effective support from an appropriate way, and thus promote the common development of education and people-to-people bond among the countries along the routes. This will be the focus of this book and also the main contributions that the authors are trying to make for the Belt and Road Initiative.

1.4 Scope of the Book

This book is divided into three parts. The first part is the General Introduction, including one chapter. This chapter discusses the background of the BRI and its main contents in general, Education Action Plan, and the supportive role of education to the BRI, and further expounds the main values of ICT in education and its relationship with Initiative.

The second part of the book presents the current developmental situations of ICT in education for the countries along the routes, including a total of eleven chapters from the countries of China, Croatia, India, Korea, Malaysia, New Zealand, Russia, Singapore, Slovenia, South Africa and Sri Lanka. These countries are, geographically, distributed along both land-based and maritime routes suggested by the BRI; from the developmental level, are at the different stages of social economy and national average income; and from the cultural perspective, have different cultural backgrounds, educational systems, religious beliefs and multiple languages. With the characteristics of diversification, these nine countries can, to a larger extent, represent the countries of different categories along the routes. By the comprehensive presentation of the overall picture of ICT in education for the countries along the routes, this part is expected to provide the reference for the countries to make educational policies, promote mutual understanding and learning, conduct in-depth exchanges and cooperation, and eventually establish Belt and Road education community.

The last part of this book provides a summary for the whole book. Chapter 13 makes a comprehensive comparison of the developmental situations of ICT in education for different countries along the routes, analysing their similarities and differences and puts forward some suggestions on this basis.

ICT in education provides great opportunities for educational development, and at the same time, it is also a common challenge faced by all countries in the world. It is expected that the overall development trend of ICT in education provided in this book can serve as a foundation and reference for the countries along the routes to build communication platforms for research and practice of ICT in education and strengthen exchanges and cooperation among governments, schools, experts and enterprises.

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Part II
Country Reports

Chapter 2
ICT in Education in China

Yongbin Hu and Hui Zhang

Abstract China has the largest population in the world, and although still a developing country, has built up a worldwide largest education system covering all types of education at all levels, such as basic education, vocational education, higher education and continuing education. The system has benefited about 316 million people among the total population of 1354 million in mainland China. Since 1990s, a series of national key projects and policies of ICT in education have been implemented, laying a solid foundation for its sustainable development. By new, the system of ICT in education has been constructed to match the objectives of education modernization, aiming at providing everyone with quality digital learning resources, creating an ICT-based public service system to support life-long learning, and expanding the coverage of the broadband internet connections to all schools and universities. ICT-based educational management and the infusion of ICT in education will be greatly improved. The experiences of ICT in education of China could be summarized that the core of ICT in education is to provide connecting schools through broadband network, connecting classrooms with quality learning resources, connecting teachers and students in cyber learning spaces.

Keywords ICT in education · China ICT policy · School education · ICT infrastructure · Educational resources

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_2

2.1 Educational Context in China

China has the largest population in the world, and it has built up the largest worldwide education system covering all types of education at all levels, such as basic education, vocational education, higher education and continuing education. Ministry of Education (MOE) is in charge of the national education development, making national plans and coordinating the management of the educational undertaking throughout the country. The structure of China's schooling includes four different levels: pre-school, primacy, secondary, and higher education (Fig. 2.1). Pre-school education refers to the educational process of children aged 3–6 in pre-schools or kindergartens. Primary education refers to the process of primary education for children aged 6–12. Secondary education refers to the process of receiving education in secondary schools between the age of 12 and 18. Higher education refers to specialized, undergraduate and postgraduate education following secondary education.

According to *National Statistical Bulletin on the Development of Education* (Ministry of Education of the People's Republic of China, 2017), there were pre-schools, and 46,001,393 young children enrolled in pre-schools. In terms of primary

Fig. 2.1 Education system in China

education, there were 176,718 primary schools, and 101,691,216 pupils enrolled in primary schools. In terms of secondary education, there were 52,400 junior secondary schools and 24,618 senior secondary schools. 44,547,631students enrolled in junior secondary schools and 39,709,871students enrolled in senior secondary schools. In terms of higher education, there were 2631 regular higher education institutions, as well as 815 institutions providing postgraduate programs. 27,535,869 undergraduate students enrolled in regular higher education institutions, 2,277,564 postgraduate students enrolled in Master programs, and 361,997 postgraduate students enrolled in Doctoral programs. Statistics regarding number of schools and students across different education levels presented in Table 2.1. Furthermore, with regards to enrollment rate, the gross enrollment rate of pre-school education reached 79.6%, the net enrolment rate of primary school-age children was 99.91%, and the gross enrollment rate of junior secondary school was 103.5%, the gross enrollment rate in senior secondary school was 88.3%, the gross enrollment rate of higher education reached 45.7%.

Moreover, government expenditure on education has increase fast over last decades in China. As shown in Fig. 2.2, the total expenditure on education was 86.7 billion CNY in 1992, while it has increased 48 times over last 25 years, and it reached 4, 255.7 billion CNY in 2017.

Table 2.1 Statistics of education system in China in 2017

Education level		Number of schools	Number of students
Higher education	Postgraduate	815	2,639,561
	Undergraduate	2631	27,535,869
Secondary education	Senior secondary schools	24,618	39,709,871
	Junior secondary schools	52,400	44,547,631
Primary education		176,718	101,691,216
Pre-school education		254,950	46,001,393

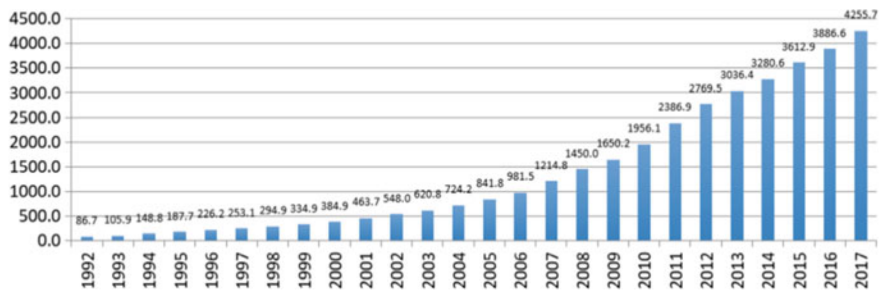

Fig. 2.2 Total investment in education funds (Billion Yuan)

2.2 ICT Policy

Since 2000, the development of ICT in Education in China entered the fast lane. In 2001, in order to speed up the process of ICT in education, MOE issued a notice of school to school, which aimed to promote infrastructure construction. After 2010, China's ICT in education has entered a new stage of development. In response to the new needs of education in the new era, China has also formulated a series of development plans to ensure promotion of ICT in Education more rapidly and effectively. In order to actively promote the development of "Internet + education" and accelerate the modernization of education and the construction of a strong education country, MOE proposed an action plan in 2018. The outstanding policies of China's ICT in education since 2000 are listed in Table 2.2.

2.2.1 Notice on MOE on Implementing the "School-School Network" Project in K-12 Schools

In 2000, MOE issued the Notice on implementing the "School-School Network Project" in K-12 Schools. This Notice emphasized on the construction of infrastructure in K-12 schools. The goals of this project are: (1) 90% schools in China get access to Internet. (2) All K-12 teachers could open their educational resources by Internet. (3) Get qualified instruction with ICT. This project was expected to achieve rich and quality teaching resources and courses at a lower cost. And the ultimately goal is to achieve resource openness in 5–10 years. In order to achieve these goals, the MOE developed relevant implementation plans and safeguard measures.

Table 2.2 The outstanding policies on ICT in education since 2000

Year	Policy
2001–2010	Ministry of Education of the People's Republic of China—"Notice of the Ministry of Education on Implementing the School-School Network Project in K-12 Schools"
2010–2018	State Council of China—Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010–2020) Ministry of Education of the People's Republic of China—"Ten-year development plan for education informatization (2011–2020)" Ministry of Education of the People's Republic of China—"The 13th Five-Year Plan for ICT in Education"
2018–	Ministry of Education of the People's Republic of China—"ICT in Education 2.0 action plan"

2.2.2 *Outline of China's National Plan for Medium and Long-Term Education Reform and Development (2010–2020)*

In 2010, "*Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010–2020)*" (hereinafter referred to as the "Outline") clearly stated: China will initially establish an educational information system with Chinese characteristics, which is close to the international advanced level.

China will accelerate the process of ICT in Education by strengthening the development and application of quality educational resources, intensifying the application of information technology, and building a national education management information system.

The "*Outline*" integrated education information into the overall strategy of national information development, and deployed educational information networks ahead of schedule. By 2020, an educational information system covering all types of schools in urban and rural areas will be basically established to promote the modernization of educational content, teaching means and methods. Besides, China will basically form a learning-oriented society, and enter the ranks of powerful human resources.

2.2.3 *Ten-Year Development Plan for ICT Education (2011–2020)*

In 2012, MOE officially issued "Ten-year development plan for ICT education (2011–2020)", which depicted the blueprint for ICT in Education the next decade (period 2011–2020). The goal of the plan is forming an educational information system that is compatible with the development goals of the national education modernization till 2020. ICT in Education is close to the international advanced level as a whole, and the support and leading role for education reform and development is fully manifested. Including, (1) building smart learning environment with supporting every single student, (2) forming an information-based support service system for a learning society, (3) realizing all regions and the comprehensive coverage of broadband networks of various types of schools, (4) The level of informationization of education management has been significantly improved (5) and the level of infusion development of information technology and education has increased significantly.

2.2.4 *The 13th Five-Year Plan for ICT in Education*

In 2016, *the 13th Five-Year Plan for ICT in Education* (hereinafter referred to as the "Plan") was officially issued, which focused on deeply promoting the integration and innovation of information technology and education. By 2020, China will basically (1) establish an educational information system that "Anyone can learn anywhere at any time", which adapting to the goal of National Education Modernization Development; (2) promote educational information to achieve comprehensive development of students; (3) form a path of educational informationization with Chinese characteristics at the international advanced level, which can infuse and innovate information technology and education. This plan showed that the strategy position of ICT in education is confirmed. That's means the stage of ICT in education are shifting from application to infusion, the role of this plan shifted from serving education system to serving society and economy, and the developing ways are shifting from self-exploring to internarial corporation.

2.2.5 ICT in Education 2.0 Action Plan

MOE issued the policy document, entitled "ICT in Education 2.0 action plan", which lead and push the promotion of ICT. This plan showed that the type of education resources will be shifted from special to big, the ways of promoting teacher-student from application ability to information literacy. In addition, it emphasizes on building a new model of talent cultivation under the condition of "Internet+", developing a new model of Internet-based education services, and exploring a new model of education governance in the information age. The goals of this plan are as follows till 2022, (1) All teachers will be covered by teaching application, all school-age students will be covered by learning application, and all schools will be covered by digital campus construction; (2) information application level and information literacy of teachers and students will be generally improved; (3) "Internet + Education" platform will be built-up.

2.3 ICT Infrastructure

ICT infrastructure has been considered as a key element in the process of successful ICT integration into education. China has thus carried out the following nationwide projects, which aim to establish and renew ICT hardware, software, services, procedures, and processes over last two decades.

2.3.1 Campus Access to ICT (CA-ICT) Project (2000–2002)

MOE held a National Conference of Information Technology Education in Primary and Middle Schools in 2000. It planned to conduct a Campus Access to ICT Project the primary and middle schools, and invested 20.8 billion CNY and provides 5.84

million computers to primary and secondary schools across China. It provides around 90% of public primary and middle schools all over China access to the Internet or connect to Chinese Education Satellite Broadband Network, so that teachers and students in primary and middle schools can share online educational resources.

2.3.2 Modern Distance Education Project for the Rural Schools (MDEPRS) (2003–2007)

MDEPRS aims to basically facilitate secondary schools with computer classrooms, and facilitate primary schools with satellite teaching receiving devices, teaching CD player devices and teaching CDs, and primary teaching stations with teaching CD player devices and teaching CDs in rural areas of China within five years. More specifically, The project aims to equip 37,500 rural junior middle schools across the country with computer classrooms, 384,000 rural primary schools across the country with satellite teaching receiving stations and about 11 rural primary teaching points with teaching CD player devices and sets of teaching CDs; to strengthen the construction of teaching resources with more than 4000 h of CD teaching resources, more than 11,000 h of satellite teaching resources and more than 6000 h of computer network teaching resources; to strengthen teacher trainings such as to train 1–2 faculties who are familiar with teaching and technical management for each rural primary and middle schools so as to actively promote the application of the three modes in the teaching in rural primary and junior secondary schools. The budget of the project is 10 billion CNY, while 11.1 billion CNY totally invested. The central special fund invested 5 billion CNY, accounting for 45.1%; local governments invested 6.1 billion CNY, accounting for 54.9%. It was mainly used in the allocation of equipment, the construction of teaching resources and corresponding teacher trainings.

The project mainly adopted three teaching modes, which include the teaching CD player station, the satellite teaching receiving station and computer classrooms. Based on the completion of the basic equipment, different schools could enhance the standards according to local situations (Ministry of Education, 2006).

- Mode 1: Teaching CD Player Stations

The teaching CD player stations were equipped with televisions, DVD players and sets of teaching CDs (Fig. 2.3). The average budget of each station is 3000 CNY. Teaching CDs are played to teach and help students, to help teachers prepare lessons, as well as to carry out training activities for peasants. The mode is easy to operate, with low cost and easy to maintain and use, which is very suitable for rural primary schools, especially for rural primary school teaching points in remote and poor areas in the central and western China.

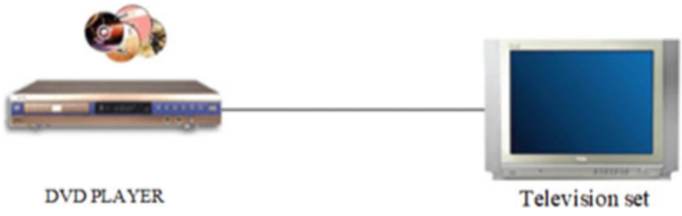

Fig. 2.3 System structure of teaching CD player station (Mode 1)

- Mode 2: Satellite Teaching Receiving Stations

Except for the equipment demonstrated in Mode 1, satellite teaching receiving stations are provided with outdoor satellite receiving equipment (antennas, LNB, etc.), satellite TV equipment (satellite TV receiver, TV set, etc.), satellite data reception equipment (satellite data reception card, modem, CD writer, computer, etc.), Internet access devices, printers, UPS power supply and other equipment (Fig. 2.4). The average budget for each station is 16,000 CNY. The equipment can receive a great number of quality educational resources quickly via Chinese Education Satellite Broadband Transmission Network. It can not only adopt the applying functions in Mode 1, but also realize the live and taped "classroom in air" for synchronous and asynchronous teaching and learning, study tutoring both in and out of the class, help teachers to prepare lessons and carry out teacher trainings, and carry out community education in rural areas, etc.

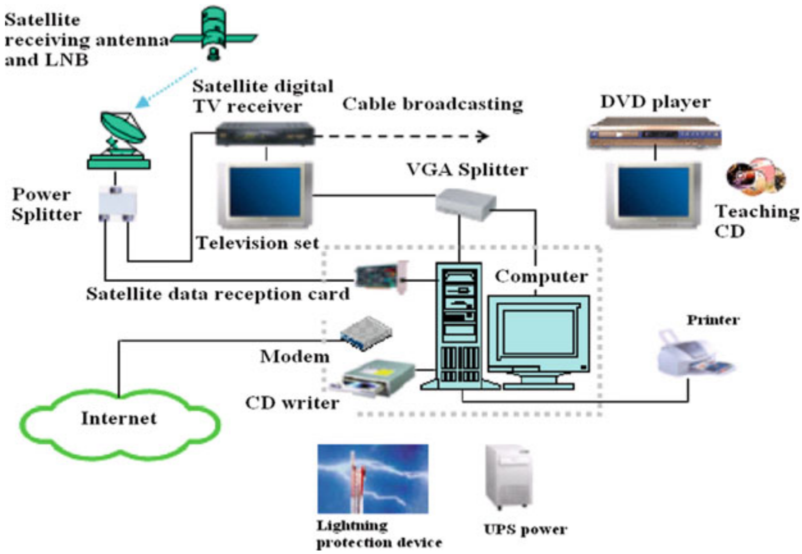

Fig. 2.4 The system structure of satellite teaching receiving station (Mode 2)

- Mode 3: Computer Classrooms

On the basis of Mode 2, the computer classrooms were upgraded as multimedia classrooms and included a projector, central control system, DVD player, TV set, computer network which included a server, switch, teacher's computer and student's computer, and network printer (Fig. 2.5). The average budget for each classroom is 150,000 CNY. The equipped targets are rural junior middle school. In addition to all functions of Mode 1 and Mode 2, the computer classroom could also provide online learning environment for students to participate in distance education. It is used to open IT courses, to carry out lesson planning, the activities of teaching and research and teacher trainings in the network environment, and also implement peasant training, access to and publish information online to provide service for trade for peasants, etc.

Why were these three technical modes chosen? At that time, there was the "digital divide" between China's urban and rural areas. The transportation is challenging in rural areas, where many primary and middle schools are widely dispersed. In order to solve the "last-kilometer" problem of the ICT in rural schools, it was impossible to introduce Internet access in urban households in the short term. Consideration had to be given to rural information infrastructure environment and their shortage of technicians and funds as well as the cost related to infrastructure development. It was a realistic choice to use CDs, satellite receiving equipment and computer classrooms as carriers of low cost and high efficiency content without the space constraints. Indeed, this technical route was just integrated at primary school level. It could not solve the two-way transmission of data or realize interactive learning

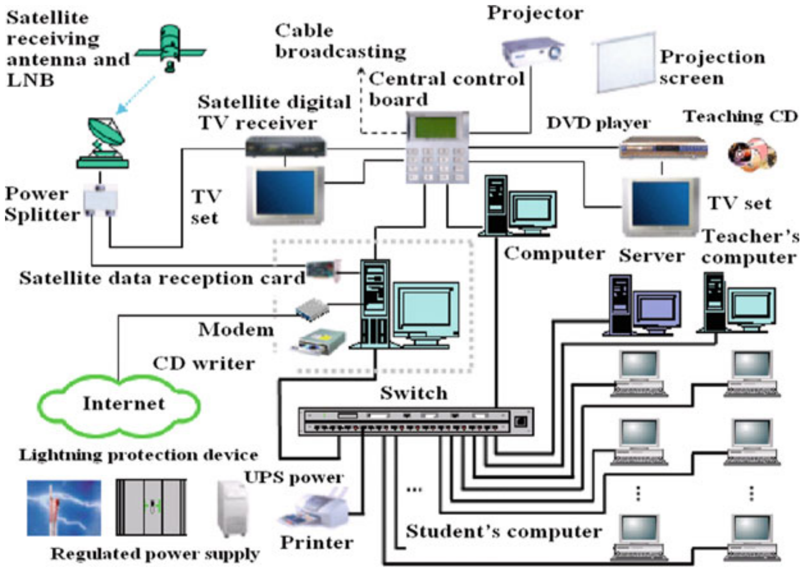

Fig. 2.5 The system structure of computer classrooms

in the network environment. It needed to be improved by gradually adopting some new technical solutions that combine new technologies and conventional ones in the future development.

2.3.3 *Three Connection and Two Platforms (TCTP) Project (2012–2017)*

TCTP Project aims to establish educational resources platform and to learning management platform, on the basis of three connection. "Three Connection" refer to access (1) to the Internet for each school; (2) to high quality educational resources to each classroom; (3) to virtual learning space for each student. "Two Platforms" refer to platform (1) for educational resources; (2) for learning management system (Fig. 2.6).

In order to establish platforms for educational resources and learning management system, TCTP Project made effort to the following three aspects:

Firstly, TCTP Project focused on connecting schools through Broadband Network. It includes three aspects:

- Providing Internet access to each school, which includes providing Internet access to each school; improving ICT infrastructure in primary and secondary schools; building effective mechanism for supporting and maintaining ICT infrastructure.

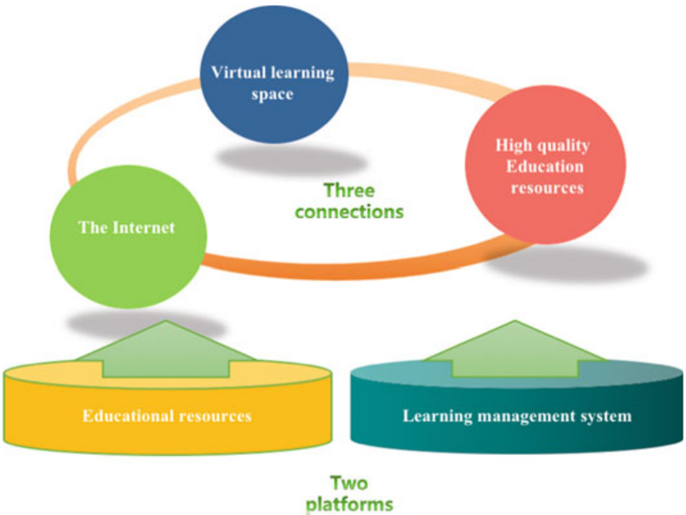

Fig. 2.6 The framework of "Three Connections, Two Platforms" Project

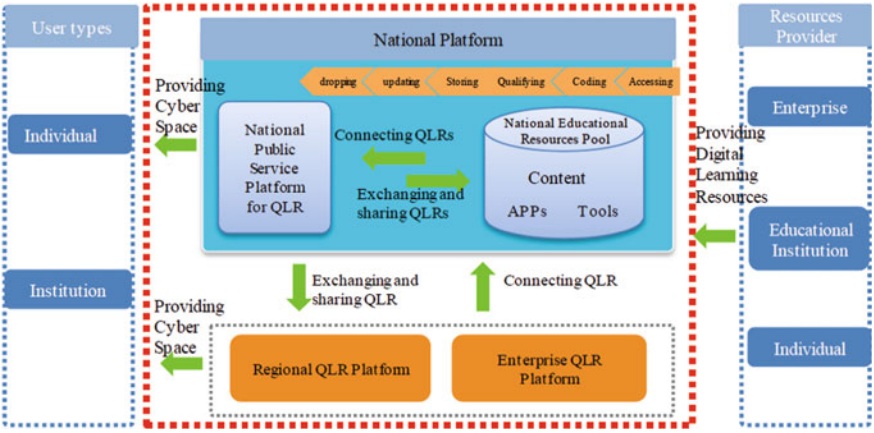

Fig. 2.7 Framework of National Public Services for Educational Resources

- Providing ICT infrastructure (i.e. hardware, software, digital educational resources) to each classroom, which includes providing basic ICT infrastructure to each classroom; providing ICT-based instruction tools to each teacher; providing digital learning resources to each classroom.
- Providing teacher training on ICT integration to each teacher, which includes equipping each teacher with computers and other digital devices; encouraging teacher integrating ICT into their classroom; providing teacher training on ICT integration.

In terms of cost-sharing, both central government and local government made contribution to the ICT infrastructure. ICT infrastructure of primary and secondary schools in rural and remote areas were funded by the central government, while ICT infrastructure of schools in urban areas were funded by local governments.

Secondly, TCTP Project focused on connecting Classrooms with quality digital resources. It involves the following three aspects:

- Expanding the coverage of quality digital educational resources, which includes providing each teacher and student with access to quality digital educational resources; encouraging teachers integrate ICT into the classroom and generating new quality educational resources; promoting teachers integrate ICT into teaching, researching, et al.
- Based on ICT integration, improving quality and efficiency of teaching and learning, which includes improving students' academic performance, improving students' learning efficiency; and improving the efficiency of teaching.
- Based on ICT integration, catalyzing education innovation, which includes reconstructing teaching and learning process; improving learning environment; exploring the approach for teaching and learning innovation.

As shown in the Fig. 2.7, National Public Service Platform for Educational Resources (https://www.eduyun.cn) was built up to promote the effectiveness of infusing ICT in education. It is a cloud-based software platform for interacting and sharing resource among providers and users in all schools and universities.

At National Public Service Platform for Educational Resources, educational resources from different fields are selected to build up a non-profit pool of quality digital learning resource and index repertoire to link social educational resources with certification. With the aid of intelligent pushing and navigating technology, the platform can push BASIC educational resources for free and others on demand to user spaces of institution, teacher, student and parent through professional service. It helps students and teachers to use the digital resources in daily activities.

Thirdly, TCTP Project focused on connecting students with virtual learning space. It involves the following four aspects:

- Providing interactive and communicative platform for students, teachers, and parents, which includes interactive learning community for students; supportive professional development community for teachers; and seamless joint of physical and virtual learning space.
- Supporting teaching, research, as well as students' self-regulated learning, which includes supporting teachers' preparation, teaching and teaching experience sharing; supporting teacher collaborative research and professional development; supporting students' self-regulated learning.
- Constructing a flexible system that contributes to quality educational resources sharing. The system aims to provide digital educational resources, based on students' learning needs; benefit to stakeholders; establish criteria for assessment of educational resources.
- Building a management and service system for the virtual learning space, which requires real-name registration and management. The management system aims to enhance the organization and management of the virtual learning space; secure personal space; supporting teaching and management.

2.4 Educational Resources

In December 2012, National Education Resource Public Service Platform was officially launched. It provides convenient teaching services for schools, teachers, students and parents (Wang, 2012). Digital education resources are gradually becoming an important support for student self-cooperation, inquiry learning and authentic assessment. By the end of June 2018, this platform has registered 12.48 million teacher spaces, 5.89 million student spaces, 5.34 million parents spaces and 400,000 school spaces. It has been connected to 65 online platforms. The number of registered users has reached 68.6 million, and the number of active users has reached 3.37 million. In addition, the number of the discipline resources of National Education Resource Center which covers primary, middle and high schools has reached nearly 26 million. These resources involve many aspects, such as core values, legal system, security, national unity, and national defense, etc.

2.4.1 Learning Resources for K-12 Education

In April 2017, MOE implemented the "Full Coverage Project for Education Resources in Rural Primary and Secondary Schools" (Ren, 2017). This project developed resources for 106 h of English, music and art in elementary school. In August 2017, the development of bilingual digital education resources for mathematics in Xinjiang was completed, and the development of Mongolian and Tibetan resources in the Department of Mathematical Chemistry was completed and delivered to the relevant provinces and regions. MOE also initiated the development of Uyghur and Kazakh resources of physics and chemistry (Li, 2017). In addition, 81 high-quality resources in five subjects of PEP digital textbooks were completed, and a resource construction system was formed.

2.4.2 Learning Resources for Vocational Education

In 2010, MOE identified the professional teaching databases for vocational education, which belongs to the only symbolic teaching reform achievements construction project that received funding from central finance (Ministry of Education of the People's Republic of China, 2010). At present, 88 professional teaching resources databases and 10 child databases which promotes the inheritance and innovation of national culture have been established. There have been 1000 colleges and 3094 companies participating the project of professional teaching databases for vocational education. The project has built more than 1.95 million multimedia resources and the total number is 32.3 TB. Furthermore, the number of registered students is over 1.58 million and the accumulated access amount is more than 250 million. 150 resource databases were identified as national resource pools.

2.4.3 Learning Resources for Higher Education

In the beginning of 2018, MOE identified 490 "National Quality Online Open Courses", involving 120 universities and covering 70 undergraduate majors and 10 higher vocational majors (Dai, 2018). In recent years, many companies have participate in developing Online Learning Course, such as Chinese universities MOOC, (https://www.icourse163.org/), Chaoxing Erya (https://erya.mooc.chaoxing.com/), and Xuetang Online (https://www.xuetangx.com/) and other online learning platforms. It is estimated that the number of users is over 12 million, the number of courses is over 4,000, and more than 200 universities involved in. In addition, MOE issued “the Notice of the General Office of the MOE on the Construction of a Model Virtual Simulation Experiment Teaching Project from 2017 to 2020”, and organized the identification of 2017 demonstration virtual simulation experiment teaching project (General Office of the Ministry of Education, 2014).

2.4.4 Learning Resources for Continuing Education

MOE positively promote the openness of digital learning resources for continuing education and the alliance construction of online education. For promoting continuing education, MOE implemented E-action Initiative in universities for different industries and companies (General Office of the Ministry of Education, 2017). At present, there have been more than 300 universities and 100 companies participating the initiative. National Open University established a national digital learning resource center, which has opened virtual learning spaces for 30,000 full-time and part-time teachers and 5.76 million enrolled students. Furthermore, this center has gathered 33,000 high-quality online courses at home and abroad. Approximately, this center has a total resource of 60 TB. many companies launched their online education platforms, such as Baidu Library (https://wenku.baidu.com/), Taobao University (https://daxue.bbs.taobao.com/home.html), Netease Cloud Classroom (https://study.163.com/), Tencent Classroom (https://ke.qq.com/) and so on. For example, Baidu Library provides over 180 million high quality professional documents, covering 31 mainstream and segments, with 164,406 certified users. Taobao University has more than 5 million trainees, and the number of NetEase cloud classroom courses has reached more than 4,100. The total number of classes has exceeded 50,000. Tencent Classroom has provided 30,000 high quality courses with more than 140,000 students.

2.4.5 Learning Resources for Chinese Language and Culture

In order to provide Chinese language and excellent culture for Chinese culture lovers and learners freely, MOE has promoted the construction of the Belt and Road Initiative language communication public service platform and multilingual databases (Ministry of Education Network Security and Information Leading Group Office, 2018). In order to promote openness and utilization of language resources, MOE pushed excellent culture resources by new media platform, such as WeChat official account. National Language Committee designed and constructed a language resource website. MOE also provided special funds to support the development and application of local language and cultural resources networks. MOE constructed

Confucius Institute Online MOOC, which include Chinese language learning, international Chinese teacher training, China overview, and traditional culture, etc. The total number of visiting is 2.58 million, and users reached 650,000.

2.5 ICT Integrating into Teaching and Learning

With the construction and improvement of infrastructure such as broadband network (BBN) and information classroom environment, quality education resources have been able to interface with classrooms, and information technology has been widely used in classroom teaching. In all these technology-rich classrooms, the role of ICT in classroom are innovations instructional model, improvements in teaching and balance in education.

2.5.1 *Innovation of Classroom Teaching Model*

New technology, such as cloud technology and e-Textbooks, are widely employed to explore new teaching patterns with the combination of formal and informal learning, which helps to transform learning through technology. For example, Sandao Street primary school in Wuhan used cloud-based integration of preparation, instruction and reflection. This school has 22 classes, 56 teachers and 880 students. With a support a company, this school established a cloud-based platform for lesson preparation, instruction and interaction between teachers and students. This platform was developed collaboratively with IT corporations to promote TWT and resource sharing (Ren, 2014).

The digital learning environment based on ICT and quality digital teaching resources can transform traditional passive learning to self-regulated, cooperative and inquiry-based learning, which helps to motivate learners to be more devoted to their learning. For example, No.2 Middle School in Zhengzhou (https://zz2z.zzedu.net.cn) used self-regulated learning with tablets. This school has 78 classes, 217 teachers and nearly 5000 students. It has built up a Ubiquitous-learning environment, in which each student is provided with a free tablet for self-regulated learning. Besides, the school has established recourse pools of instructional plan, courseware, model lessons, and teaching reflections (Li, 2014). In addition, the learning process can be tracked by the system for the students' self-regulation and teachers' check.

2.5.2 *Promotion of the Balance of Education*

The use of receiving equipment and digital broadcasting through satellite to deliver quality teaching resources to remote rural areas helps the rural schools offer all national compulsory courses to school-age children in remote areas. The exploration of infusing ICT in education in the project of "Experiment of Leapfrog-Development in Basic Education Innovation" (Institute of Modern Educational Technology in Beijing Normal University, 2018) shows that it is possible for the experimental schools in underdeveloped areas to reach the teaching quality of schools in developed areas. Through distance live teaching, the students in remote schools can receive instruction from elite teachers. Therefore, ICT in education has been an important approach to promoting educational equity in China.

The "Experiment of Leapfrog-Development in Basic Education Innovation" project initiated by Beijing Normal University (https://www.etc.edu.cn), is one of the innovative projects on ICT in basic education with the widest and most lasting influence in China. Since September 2000, the project has developed an advanced system and service model after long-term research and trial.

In April 2000, Chengdu No. 7 Secondary School (https://www.cdqz.net) opened an online school jointly with Chengdu Dongfang Wendao Science and Technology Development Co., Ltd. The online school started distance live teaching for full-time senior secondary schools in 2002, which enabled remote schools to receive live classroom teaching in Chengdu No. 7 Middle School. By September 2013, it had benefited over 180 remote schools in 6 provinces, with nearly 600 classes and over 40,000 students, covering the subjects such as Chinese, mathematics, English, physics, chemistry, biology, politics, history and geography. Two teaching models are explored in this project. Therefore, ICT in education has been an important approach to promoting educational equity in China.

2.5.3 Improvement of the Quality Teaching

The diversified models of ICT in education have changed the learning time, space, contents and peers, which could satisfy the requirements for personalized learning. The exploration in the "One-to-one Digital Learning" project (360 Baike, 2018) satisfies the requirements of students in the new era and helps a teacher to get more understanding of every individual student's development and to promote students" subject learning and acquirement of twenty-first century skills.

For example, RDFZ Xishan School (https://www.fjxsxx.com) in Beijing initiated the "One-to-one Digital Learning" project in August 2010. Every student is provided with a device such as laptop or tablet for ubiquitous learning and conducting research. The project helps to acquire subject knowledge, as well as foster their twenty-first century skills, such as critical thinking, collaborative capability, communication ability, media literacy and creative ability.

2.6 Students' ICT Competence

According to the China Internet Network Information Center (2015), the majority of Internet users are from the younger generation aged between 10 and 39 years of age (78.1%), with the age group of 10–19, in particular, accounting for 22.8%. Teenagers and adolescents have therefore become an important group of Internet users in China. Such a fact is tremendously challenging the Chinese traditional K-12 education. As such, the importance of being digital literate has been recognized by Chinese researchers and policy makers. To respond to such challenges, since 2000, the Minister of Education in China has carried out several nationwide projects, which include 'ICT-Accessing or Internet-Connecting Engineering Project for All Elementary and Secondary Schools' (MOE of China, 2000a), 'Curriculum of ICT Education for All School Students' (MOE of China, 2000b), 'New Cycle of Curriculum Innovation for Basic Education and Integrating of ICT into Curriculum' (MOE of China, 2002) and 'Modern Distance Education for Rural Elementary and Secondary Schools' (Ministry of Education of the People's Republic of China, 2003). However, a previous study adopted an Instant Digital Competence Assessment (iDCA) tool to measure junior secondary students' ICT competence, which including technological, cognitive and ethical domain (Li & Ranieri, 2010). The results show that the 317 respondents' average performance in the iDCA was just 'pass' rather than 'good' or 'excellent'. There were big disparities among ninth grade students' digital performance. In the assessment, only one-fourth of the students could get 70% of the items or more correct. The correction rates of another one-fourth were between 60 and 70%. The other half of the students failed to obtain a correction rate equal to 60%. Among the three domains, students' performance in the technological domain was better than their performance in the cognitive or ethical domain.

In order to promote students' ICT competence, MOE released the New ICT Curriculum Standards for Senior High School in China in 2017. It emphasized promote students' ICT competence, which including four components: (1) information consciousness, (2) computational thinking, (3) digital learning and innovation, (4) the responsibility in the information society.

2.7 Teacher Professional Development

Teachers' ICT competence has been considered as an essential factor that impact on the ICT integration into education. MOE released "Opinions on the implementation of the national information technology application capacity improvement project for primary and secondary school teachers" in 2013 and "Opinions 2.0 on Implementing National Information Technology Application Skills for Primary and Secondary School Teachers" in 2019.

In order to promote teachers' ICT competence, China has carried out several large-scale teachers training projects, which aim to develop teacher' competence to use technology effectively in the classroom. For example, the National Teacher Education Alliance (NTEA, https://www.tuchina.cn) is an innovation project on teacher education, supported by MOE and jointly sponsored by more than 10 well-known domestic normal universities and research institutions. It is conducted to integrate quality learning resources depending on online support platform for the change of teacher education pattern and for the cultivation of qualified teachers in this information age. It provides pre-service and in-service teacher training on ICT competence.

Moreover, there are also some innovation of primary and secondary pre-service teacher training models, such as teacher training conducted by Central China Normal University (CCNU). CCNU plays an important role in pre-service teacher education with an annual training of 1800 normal university students. To help students meet the challenges and requirements of ICT in education, CCNU has proposed the development theory of "Advanced classroom, Digital teachers, Future education", making use of ICT to promote the innovation of teacher education. CCNU has established more than 30 demonstration areas for teacher education innovation experiment, providing practice base for normal university students.

2.8 Conclusion

Chinese government has taken ICT in education as the decisive strategy of educational reform and innovation and has gained valuable experiences in infusing ICT in education by connecting schools through broadband network, connecting classes with quality digital learning resources and connecting students in cyber learning space. The following experiences are gained in the past few years.

2.8.1 Adhering to the Core Idea of Infusing ICT into Education

ICT brings new ideas and driving forces to the development of education, which profoundly transforms the educational contents, methods and modes. This transformation goes with a process of mutual influence and promotion between ICT innovation and education development in the knowledge society, which is recognized as the essence and objective of ICT in education by Chinese government.

The value of ICT in education will appear only if ICT is integrated into education by changing traditional education ideology and models, and by developing new teaching methods and patterns. The reform of education and the innovation of educational ideas require the support of advanced ICT, therefore providing new field for the development of ICT.

2.8.2 Adhering to the Basic Principle of Needs-Driven, and the Policy of Mechanism Innovation

The purpose of ICT use focuses on integrating ICT into classroom learning activities and the effectiveness of ICT in education. The policy-makers and stakeholders promotes the infusion of ICT into the whole instruction process and all subjects. Furthermore, the use of ICT in daily teaching activities is enlisted in ICT application ability in the qualification system of teachers.

During the process of ICT infrastructure construction, all sectors of society, who have the advantages of market-allocated resources and professional service provided by the enterprises and other institutions into full play, are motivated. In order to get early experiences, a number of model schools, teachers and courses should to be breed to explore the teaching organization methods and effective teaching models in different ICT conditions, and accumulate typical experience for wider promotion.

2.8.3 Taking Connect-SCS as an Anchor to Serve Students, Teachers and Administrators

The core of ICT in education is to provide connecting schools through broadband network, connecting classrooms with quality learning resources, connecting teachers and students in cyber learning spaces.

- ICT helps to improve the teaching conditions in the underdeveloped areas, narrows the digital divide and promotes the educational equity so as to lay the foundation for the development of ICT in education.
- Quality learning resources triggers the reform of traditional teaching and learning, advances the full infusion of ICT into education and promotes the teachers' capability and awareness of applying ICT so as to effectively elevate the quality of education.
- Cyber learning spaces expands the external environment of education, provides supporting conditions for fostering students' twenty-first century skills and deeply plants the idea of ICT in promoting educational reform so as to advance the formation and development of the educational ecology with ICT.

2.8.4 Using ICT-Based Management Systems to Improve Educational Administration

ICT-based management systems, such as student and teacher e-portfolio, public service platform and educational decision support system for administration, are an efficient and effective tools to improve educational administration efficiency.

- Establish a life-long e-portfolio for each student by promoting "one code one person" to effectively elevate the service level for learning and advance the innovation of evaluation methods for learning.
- Establish teacher development portfolio, integrate the process of the pre-service learning, in-service learning, working and training, so as to promote their teaching capabilities and professional development.
- The establishment of public service platform and decision support system for educational administration helps to get accurate real-time information of students, teachers, school buildings and other affairs for educational administration. The data mining and analysis via decision analysis system greatly improves the degree of precision and scientificity of educational administration and decision-making.

Acknowledgements We express our appreciation to Cuiru Wang, Huiwen Ni, Depeng Zhao, Peipei Xu, Yanjie Li, and Meng Li, who contribute to this chapter.

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Chapter 3
ICT in School Education in Croatia

Branka Vuk, Vedran Mornar, and Ivica Boticki

Abstract This chapter presents the state of the art of ICT in education in Croatia by focusing on six major elements: policy perspectives, infrastructure, educational resources, ICT integration into practices, students' ICT competence and teachers' professional development. The authors describe the role of technological innovation and its potential in transforming Croatian educational landscape, ranging from primary to secondary schools and to a lesser extent the universities. Although local and European Union funds are available and ready to be utilized for educational resource procurement, the priorities in choosing adequate national strategies and infrastructure elements are still discussed, as well as the means of resource integration into everyday teaching and learning practices. This is especially relevant in Croatia, as the gap between students' digital competences and teachers' professional development in usage and application of digital technologies is widening.

Keywords ICT in education · Croatia · Digital maturity

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_3

3.1 Introduction

This chapter provides a descriptive account and analytical view of the use of ICT in Education in Croatia. It describes the policies backing new developments in the field of ICT in education that are to spawn the innovation in the educational sector in terms of increased and adequate use of ICT for educational purposes.

The population of Croatia is 4,292,095 people (2011 census, 2017 estimation is similar to the figure). Population growth rate is −4.0 per 1000 population with the life expectancy of 78 years (2012). The decline in population is mainly due to aging population and out-migration (Croatian Bureau of Statistics, 2018). Croatian GDP per capita is 21,880.00 US$, with the estimated GDP composition being: 4%—agriculture, 26.5%—industry and 69.5%—services (UNESCO Institute for Statistics, 2018). According to the Croatian Bureau for Statistics report in 2017, there are in total 2049 primary schools, 440 secondary schools in Croatia and 105 institutions of higher education, amongst which 8 public universities. According to the 2017 Croatian Bureau for Statistics data there were 318,960 students enrolled into primary schools, 168,786 into secondary schools and 160,361 students across all higher education institutions.

Although Croatia is a developing economy, quite a few ICT systems to support both administrative and educational processes have been developed in the last decade, such as e-Registries or online repositories for educational content. Nevertheless, the question of aligning these systems and novel pedagogies with the educational system is still a challenge, especially due to lack of focus on teacher development and individual school on-site equipment. Croatia was recently successful in acquiring a large-scale EU-funded initiative e-Schools (e-Škole in Croatian). E-Schools is a concept overarching the implementation of digital infrastructure and e-services in schools for both administrative and educational purposes, as well as in the daily use of digital technologies and resources for better quality in teaching and learning. The project establishes a comprehensive platform for ICT in educational development in the decade to follow and has recently been highlighted as a model for digitalizing schools on a national scale by the European Commission (Publications Office of the European Union, 2017) as well as shortlisted for the UNESCO ICT in Education Award as one of the 12 best projects in the world in 2017 (UNESCO, 2018).

This chapter focuses on primary and secondary educational levels in Croatia due to the fact that current educational challenges and policies are mostly targeted at these levels. However, higher education will also be discussed in order to provide the readers with the necessary information on the educational sector as a whole.

3.2 Policy Perspectives

Despite successfully adjusting the educational sector to new national and existing EU legislation, policies and programs, the Croatian educational system structure and organization are slowly adjusting to allow for innovations including ICT. Since 2014, the most notable policy document is the Strategy of education, science and technology (Croatian Parliament, 2014). This comprehensive document, drafted in the period from 2012 and 2014 by more than 130 experts, outlined goals and objectives in the following areas: Early pre-school, Primary and secondary upbringing and education, Higher education, Adult education, Lifelong learning and Science and Technology. The strategy was adopted by the Croatian parliament in autumn of 2014, without any opposing votes. Those who abstained did not have any substantial objections to the content, with the only remark that the implementation of the strategy requires considerable funding which was not secured in the state budget at the time.

The strategy strongly encouraged the penetration of ICT in teaching as well as in learning. It defined functional knowledge of computer usage as the "new literacy" and outlined measures that would stimulate the development and proliferation of e-learning, the use of expert systems and ICT-based technology for teaching. One of the major activities was a comprehensive curricular reform, which was initiated energetically in February 2015, but has met a lot of ideological opposition and with the change of government in early 2016 was virtually brought to a halt. The main goals of the reform were to move away from a very extensive set of facts students currently have to acquire, to introduce learning outcomes in order to relax the students' workload, to move towards competence-based education, to provide more autonomy and accountability for the teachers, and more flexibility for the schools in organizing their classes and combinations of subjects.

With the nomination of a new minister of education in 2017, the activities around the curricular reform started to revive. The minister decided to proceed with the reform, starting with the introduction of Informatics as a mandatory subject in the fifth and the sixth grades in the school year 2018/2019, as well as with the experimental implementation of the new curricula in the same year. She reassembled the committees which produced the curricular documents and completed the process of public consultation which commenced in 2016. Curricular documents were translated into English and sent to independent international reviewers, with the first reviews being favorable (Ministry of Science Education and Sports, 2016). School for Life (a new name for the project of experimentally introducing the new curricula in 72 selected schools) puts strong emphasis on activating the students, developing their generic competences and promoting the use of technology in the classroom. All students in the project will be equipped with personal devices for a 1:1 educational experience.

By joining the EU, Croatia has gained access to significant funding through the EU structural and investment (ESI) funds, most importantly for the education and research arena—ERDF and ESF funds (European Commission, 2018b). To facilitate that, in May 2017 e-Croatia 2020 Strategy (Ministry of Public Administration (Croatia), 2017) was adopted as one of the strategic documents necessary to take advantage of the ESI funds related to Thematic Objective 2—Digital growth, which will ensure EU funding for the development of e-services in the public sector, including education.

Croatia is also involved in the European Digital Single Market strategy, adopted in 2015 as one of the priorities of the European Commission (2018a). One of the key prerequisites for the development of digital single markets is having digital skills required to consume, among other things, public e-services, including education services. Croatia was encouraged by the EU to follow up by developing a separate strategy ensuring the development of digital skills in four user groups (Education and Training being one of them). The development of this strategy is currently under way and is expected to be further supported by the establishment of the National Digital Skills and Jobs Coalition in 2018, coordinated by the Croatian Central State Office for the Development of the Digital Society.

Perhaps the most significant development in terms of policy is the national development strategy Croatia 2030 (Ministry of Regional Development and EU Funds, 2018), an umbrella strategy initiated in 2018 which should overarch all the areas relevant for the development of the country (as well as all the other strategies), including digital society as one of the key thematic areas, and science, education and human resource development as key horizontal topics.

3.3 Infrastructure

School equipment in Croatia, including ICT infrastructure, is funded by school founders, which are mainly local government units. The central government, in principle, should not participate in this funding, but usually helps due to notorious lack of budget in some communities. Investment in ICT infrastructure in schools at a national level has been at best sporadic since the 1990s. Both local and central government bodies have funded periodic, but not frequent, procurement of computers as the main tools for teaching informatics in schools, which worsened with the economic crisis in 2008, so the infrastructure in many schools is less than satisfactory. According to the PISA 2015 school questionnaire student-to-computer ratio for Croatian classrooms is around 1 computer per 3 students, which is slightly below the PISA 2015 total average level across nation-participants of around 1 computer per 2 students. Almost all of the computers are connected to the internet, and only around 15% of available computers are portable (Programme for International Student Assessment (PISA), 2018).

Regardless of the fact that individual institutions, particularly schools, are relatively underequipped, the country has been systematically and continuously building national networking infrastructure and information systems for educational institutions. In 1991, the Croatian Academic and Research Network—CARNet[1] was established as a project of the Ministry of Science and Technology of the Republic of Croatia. CARNet became an institution in 1995 with the main purpose of supporting the educational, academic and research institutions in Croatia with network and Internet infrastructure, e-services and end-users. The University of Zagreb University Computing Centre SRCE (Sveučilišni računski centar—SRCE in Croatian)[2] is

[1]CARNet—www.carnet.hr.

[2]SRCE—www.srce.hr.

another major national infrastructural ICT institution in the area of research and higher education in Croatia. SRCE provides e-infrastructure for the research and education community.

Tertiary education institutions are funded through distributed budgets and are as a rule better equipped. Several public institutions provide centralized services for the entire education system such as cloud, AAI and access to Eduroam, hosting and super-computer services.

Main national information systems as of 2018 are listed in Table 3.1.

3.4 Educational Resources

The digital resource market in Croatia has so far remained rather conservative, both for schools and higher education, in terms of the digital transformation. Although there have been projects providing digital resources for teaching and learning, there has been no large-scale implementation of digital learning materials in Croatian educational community. Publishers dealing in textbooks and educational materials have mostly focused their digitalization efforts on supplementing the printed textbooks with multimedia, although some offer advanced systems with a combination of content, classroom management system and educational applications and multimedia.

An example of a state-run initiative with such a goal is distance learning portal Nikola Tesla[3] offering interactive digital materials for STEM subjects and English for secondary schools. Other state-run projects are websites with digital education materials such as eLektire[4] (a portal with mandatory readings for K-12, well accepted by the students and parents) and Portal for Schools[5] (founded in 2007), as well as online course portals run by CARNet and University Computing Centre—Srce, where teachers exchange their own teaching materials with their colleagues or upload digital education resources to be used in projects such as the Open Discovery Space, Inspiring Science Education, ICT Curricula etc. Additionally, publishers created their own sites with similar goals and are offering digital learning resources the teachers can use in their teaching, and the students can buy the printed textbooks, such as the School Portal[6] or Profil-Klett's Portal.[7] University Computing Centre SRCE has set up portal SRCE and Open Education[8] where all educational resources prepared by SRCE are free and available to use under CC licenses and an online course on Using Creative Commons licenses on educational resources. All online courses developed

[3]Nikola Tesla Portal—https://tesla.carnet.hr/.

[4]E-Lektire portal—https://lektire.skole.hr/.

[5]Skole portal—https://www.skole.hr/.

[6]School portal—https://www.skolskiportal.hr.

[7]Profil-Klett portal—https://www.profil-klett.hr/portal.

[8]https://www.srce.unizg.hr/en/tag/open-education.

Table 3.1 Main education-related national information systems in Croatia

e-Registry	• National information system containing data about every student, program and school at the primary and secondary level in Croatia, established in 2007
e-Class Register (e-Imenik)	• Digital class register, linked to e-Registry, established in 2011, currently in use in over 70% of schools
e-Enrollment	• National information system for application and enrollment at secondary schools, a 100% online nationwide system where all primary school graduates create lists of their preferred secondary school programs, established in 2012 • The system creates multicriterial ranking lists for every secondary school program, admitting the best students according to quotas and student preferences. Students are ranked mainly on the basis of primary school grades. Some schools are allowed to introduce entrance exam, as an additional criterion
National information system for application to higher education institutions	• A 100% online nationwide system, established in 2010, similar to e-Enrollment, with one significant difference: it takes into account also the results of the State Matura exams. In 2010, Croatia introduced State Matura, initially conceived as a final exam for gymnasium students, but immediately extended to be a substitute for former entrance exams at higher education institutions, which autonomously design the ranking criteria upon State Matura exams and secondary school grades • Currently, every candidate for higher education has to pass the mandatory State Matura exams (Croatian language, Mathematics, Foreign language) although that is not required to graduate from vocational schools
Students right information system (ISSP)	• Information System of Student Rights is used to gather data on students, relevant for the purpose of determining the level of student rights • The most well-known service the ISSP system provides is the system of student nourishment. The purpose of the system is the precise record keeping of student consumption and enabling various levels of subsidies, in accordance to the guidelines proscribed by the ministry

(continued)

Table 3.1 (continued)

Academic id-cards management system (ISAK)	• ISAK is used for running and managing processes tied to the life-cycle of official cards granted to students in the republic of Croatia, by their head institution. The cards are based on smart-card technology, and the system is in ownership of the Croatian Ministry of Science and Education
Croatian Qualifications Framework Register Information System (CROQF IS)	• The Croatian Qualifications Framework is a reform instrument for regulating the system of qualifications at all levels in the Republic of Croatia through qualifications standards based on learning outcomes and following the needs of the labor market, individuals and society • The Croatian Qualifications Framework Register Information System (CROQF-IS) has been established to store and manage information about all existing qualifications standards, educational programs and educational institutions which provide them
Information system for educational programs quality assessment (Mozvag)	• An information system whose aim is to support the evaluation procedures carried out by the Agency for Science and Higher Education (initial accreditation of study programs; re-accreditation of higher education institutions; external independent periodical evaluation of the quality assurance systems (audit) in higher education institutions)

by SRCE are freely open to teachers, students and citizens with aim to raise their digital skills.

Aside from the state and commercial initiatives, a significant push for digital educational resources in Croatia came from the grassroots through various teacher associations forming their own fora, websites and Facebook groups for development, exchange and review of digital resources, sharing their experience and pushing the market and public institutions to respond more promptly, with greater quality and a greater number of educational resources promoting the use of ICT in education.[9,10]

On the higher education level, the teachers have long been providing simple digital educational resources for their students, digitizing their notes or books and developing an ever-growing number of online courses the students increasingly attend.

[9]Nastavnici portal—https://nastavnici.org.

[10]Ucitelji portal—https://ucitelji.hr.

3.5 ICT Integration into Practices

Providing a framework and tools for digital education growth is a necessary step in ensuring that schools have all the resources and support to carry out the digital transformation. As was shown so far, there have been many steps in recent years to improve levels of digitalization in schools. Many have focused on providing infrastructure, others included providing education resources and teacher education as well as developing online services that will provide further incentive for a switch to digital education.

Such comprehensive actions and projects promise better results in terms of ICT integration in education. With e-services such as e-Class registry adopted by over 70% of Croatian schools, by simply providing tools that make teacher's administrative duties easier, technology is accepted more readily by the teachers in other fields of their work, and its use for teaching and learning seems to increase.

One of the key outputs of the e-Schools project[11] is a framework and a tool for evaluation of the use of ICT in schools on the K-12 level—framework for the digital maturity of schools. Although aligned with the European Framework for Digitally Competent Educational Organisations (European Commission, 2016), the framework for the digital maturity of schools was developed through the e-Schools project specifically for the context of Croatian schools taking into consideration the specifics of the Croatian school system. It consists of 5 areas (Leadership, Planning and management, ICT in Teaching and Learning, Digital Competences, ICT Culture and ICT Infrastructure) and 5 levels of ICT adoption, aimed at providing the schools as well as the educational system stakeholders with a clear indication of how ICT is being used in the educational context.

So far, adhering to the old and obsolete curriculum for primary and secondary schools presented a big hurdle for Croatian policymakers and the education system. Because of that, the continuation of the aforementioned curricular reform is on the top of the list of priorities, followed by large national projects developing new curricula and digital education resources for vocational education currently being planned by the state agencies for vocational education. Aligning important national projects such as the introduction of new and contemporary curricula and conducting nation-wide digitalization projects is of vital importance, and their effects should be visible and provide interesting and measurable results within a couple of years.

3.6 Students' ICT Competence

Croatia has participated in a handful of international surveys mainly related to children and students covering several fields of student competencies such as language, mathematics, science and ICT competence. The most prominent surveys are listed in Table 3.2.

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[11] E-Schools (E-Skole) project—https://www.e-skole.hr/en/.

Table 3.2 The most prominent international surveys evaluating the state of education in Croatia

Survey name	Study period and dataset
TIMSS (Trends in International Mathematics and Science Education Study)	2015 (TIMSS, 2015)
PISA (Programme for International Student Assessment)	2012 and 2015 (PISA, 2018)
PIRLS (Progress in International Reading Literacy Study)	2011 (TIMMS & PIRLS International Study Center, 2011)
ESLC (European Survey on Language Competences)	2011 (European Commission, 2012)
ESLC (European Survey on Language Competences)	2011 (European Commission, 2012)
ICILS (International Computer and Information Literacy Study)	2013 (IEA—The International Association for the Evaluation of Educational Achievement, 2014)

Acknowledging the presented survey data is at the time of writing this chapter at least four years old, trends show that Croatian students have around average language competences (in ESLC 2011 just below average in first target language and just above average in second target language; in PISA 2015 slightly below average reading skills; and in PIRLS 2011 well above average in reading skills), below average science and mathematics skills and below average computer and information competence.

ICILS survey is implemented by the International Association for the Evaluation of Educational Achievement (IEA) with the main aim of answering the overarching question: "How well are students prepared for study, work, and life in the digital age?" According to ICILS, students' computer and information literacy (CIL) refers to the "students' ability to use computers to investigate, create and communicate in order to participate effectively at home, at school, in the workplace, and in the community." The 2013 ICILS cycle collects data from student population at their 8th year of formal schooling (usually Grade 8, with the average student age being 13.5 years).

The ICILS 2013 survey in Croatia was performed on a sample of 3533 students from 180 primary schools with the participant response rate of 82.4% and is deemed as the most relevant indicator of the state of education in Croatia by the authors. The survey included four main modules: (1) After School Exercise, (2) Band Competition, (3) Breathing and (4) School trip. All the modules included ICT tasks such as using online spaces, planning a website, collecting and evaluating information or producing information sheets. The ICILS conceptual analysis framework classifies students across the four literacy levels (1–4). Amongst 21 countries included, Croatia is positioned as 14th on the list, just slightly above the average score (which was set to 500). 1% of Croatian students were in the highest literacy level, 21% in the second, 42% in the third and 11% in the fourth literacy level. Similar to the overall ICILS data, socio-economic status and gender impact student achievement in ICT

Table 3.3 Detailed ICILS 2013 data on Croatian student computer use

Have computer at home	98%
Have an internet connection	97%
Use the computer at home at least once per week	95%
Use computers in the school at least once per week	61%
Use computer at least once per month for schoolwork	24%
Use computer for creating presentations	41%
Use computer for group work	33%

literacy, with girls achieving on average 15 points more than boys on the tests. The detailed data on student computer use according to ICILS is given in Table 3.3.

Computers are mostly used by the students for editing documents, communication and social networks and in leisure activities such as playing games. In Croatian schools, one computer is used by 26 students which is much lower than the ratio in most of the participating countries. Computers are most used for the Informatics non-compulsory subject (70%), and only 10% of students using them in science or social subjects. Only 5% of students use computers in language subjects and 6% in mathematics subjects.

3.7 Teachers' Professional Development

Although Croatia has a dedicated agency, the Education and Teacher Training Agency (AZOO[12]), in charge of school teachers' professional development, which is very active in providing various trainings for teachers, there is a dearth of recent evidence and research data for the characterization of teachers' professional development in Croatia. This chapter will, therefore, be based on two main studies: the ICILS 2013 study and an independent study of the use of ICT in primary and secondary school in Croatia (Pović, Veleglavac, Čarapina, Jagušt, & Botički, 2015). The latter study was conducted in 2015 and investigated teachers' attitudes towards the use of ICT in a variety of educational scenarios.

The independent study data shows that teachers have the affinity towards the use of technology solutions in education for administrative purposes. For example, 87% prefer using the electronic attendance and grading system registers (e-Registry) compared to paper-based registers due to practicality, speed, 24/7 availability and a better overview of data. 97% of teachers use desktop computers, tablets or smartphones in their teaching, with 60% using desktop computers almost every day, while tablet-computer and smartphones remain less utilized. The finding is congruent with the figure of 71% of teachers using ICT in education in the ICILS 2013 research (a small increase is most likely due to the two-year gap).

[12] AZOO—www.azoo.hr.

Both the independent study and the ICILS 2013 investigated teachers' use and application of educational tools. Teachers put the lack of adequate equipment, problems with internet connection and the need for sharing basic equipment items such as projectors and computers in schools as the top problems. The issues are further emphasized by the lack of equipment maintenance strategies and technical personnel in schools. Interactive whiteboards are present in 52% of respondent schools, and while almost all teachers agree they would like to use them, they are actually used by only 23% of teachers due to fact that they are usually shared amongst teachers and that there is no education on the ways of use. Furthermore, only 5% of teachers use the interactive touch sensitive feature of the interactive whiteboard.

In terms of digital educational resources, the independent study data shows that 89% of teachers use YouTube video contents, 75% use Wikipedia and 49% use intelligent games to make learning content more interesting for the learners. LMSs are used by 12% of teachers for delivering content and by 5% of teachers for assessing students (Moodle is the most used LMS since access and support is provided to the teachers by CARNet). However, when educational resource usage on a regular basis is examined, ICILS 2013 data shows that less than 10% of teachers use digital learning content, and less than 5% use multimedia, digital games, collaborative or interactive resources on a regular basis (NCVVO, 2014).

ICILS 2013 data shows that teachers are self-confident in searching the web for educational materials, using text editing software or other standard computer software. A smaller proportion of teachers (less than 60%) is able to use ICT to grade students, track their progress (ICILS 2013 quantifies it to less than 10%) or to prepare digital class contents. 93% of teachers produce their own digital learning content in form of slide presentations. Other forms such as tutorials, web pages or e-books are rarely produced by the teachers. 59% of teachers educate students on safety on the internet.

According to the ICILS 2013 data, Croatian teachers' attitudes towards the use of ICT in education are less positive compared to the other teachers from the ICILS participating countries, with only 54% of teachers believing that ICT increases student learning results. What is more, over 60% of teachers believe that ICT negatively impacts writing or social skills, with 51% believing that ICT only stimulates copy-pasting information from other sources.

ICILS 2013 research data gathered from the school principals shows that teachers attend ICT in education courses organized by the school they work in, with the majority of teachers participating in professional development courses on generic software and internet usage, which was seen by the teachers as the key limitation in the intended study. Less than 45% of teachers have participated in a course covering ICT use in education within the period of two years prior to the surveying date. Less than 20% of teachers participated in software or courses on the use of multimedia equipment in their specific course, online discussions or forums on the topics of learning and teaching.

3.8 Outcomes and Achievements

There have been initiatives by the state ministry and CARNet to promote the use of ICT in Croatian classrooms as well as to promote teaching of computer science and increasing children's interest in STEM area in particular. One of the most prominent initiatives is named STEM revolution or Croatian makers, which provide schools with robotics sets or microcomputers and educate teachers on how to work with those new resources.

Additionally, the state-run e-Schools project plays an important role in equipping the schools and promoting the use of digital educational resources, pushing both the users and the market towards the possibility of entirely digital educational resources. It includes a series of activities covering the entire span of the e-School concept and will support primary and secondary schools in the process of growing their institutional digital maturity. As a significant component of e-Schools, several ICT systems are developed in order to supplement or add to the existing solutions in Croatia. One prominent example is the national digital educational content repository that will be used as a central place to store and manage current and future digital resources of many previously mentioned initiatives and projects.[13] The repository will promote both OER and licensed use of published materials. Additionally, it will try to push classrooms towards using digital learning materials to a greater extent. With that goal, through the pilot phase of the project, four STEM subjects for four grades will be covered with high-quality, highly interactive, modular open digital learning materials with a Creative Commons license, in a way that will allow materials to be further developed, remixed or changed by the users.

This, and many other projects and initiatives are increasingly focusing on developing transversal skills of students on all levels, such as problem and critical thinking, interpersonal skills and the most important in this context—digital skills.

3.9 Challenges and Strategies

Although a significant number of initiatives is underway with the goal of ensuring the digital transformation of the Croatian education system, there are also many challenges in the process.

As mentioned previously, one of the key strategical activities is the comprehensive reform of school curricula which started in 2015, but was virtually halted by two changes of government and by its critics. The curricular reform would span all K-12 levels and was seen by the teachers as one of the key elements in the educational system reform. It is based on the use of computers and digital content in teaching and education. This met the opposition of the conservative fraction of the society, fearing that it would diminish the efficiency of learning and lead to the "digital dementia" in students. Furthermore, some textbook publishers expressed concerns over new

[13]Edutorij—The Digital Contents Repository—https://edutorij.e-skole.hr/share/page/home-page.

business models and were at first reluctant to support it. Fortunately, publishers are beginning to perceive publishing of digital content as a new business opportunity.

The reform of school curricula was also criticized by some on a number of accounts: for distancing Croatia from the middle-European school system, for the curricular approach focusing on learning outcomes which was claimed to be abandoned by other forward-thinking educational systems, for disregarding the national identity and STEM content, for insufficient emphasis on the upbringing component etc.

With the Ministry of Education and Science restarting the curricular reform in 2018, these issues and challenges are being dealt with. The political situation in Croatia today is more in favor of the educational reform than before, which has, over the years, became more political than expert issue. Nevertheless, there are some fears that the teachers will not be adequately educated in time, even a complaint at the Constitutional Court has been filed against implementation of mandatory informatics course, on procedural grounds. The ruling of the Constitutional Court is not known yet, but is uncertain.

Simultaneously, Croatia ranks poorly on the DESI measurements, with its Human Capital being below the EU average (European Commission, 2017) and has an acute problem with relatively high proportion of low skill individuals in the population as well as with the relevance of skills acquired through vocational and higher education. The EU also states that “basic skills have declined and are below the EU average. There are differences in performance linked to socioeconomic status, but the quality of curricula and teaching appear to be the main driver of Croatia’s poor performance.” (Publications Office of the European Union, 2017).

3.10 Reflections and Issues

Croatia participates in many cross-border projects with countries in the region, including some Belt and Road countries, mainly through utilizing various EU funds. Projects funded as currently relevant to the EU public policies in the field of education include student and teacher digital competences, digital transformation and transformation of education systems through the introduction of generic competences for the labor market as detected through various international tests and research studies. Croatia naturally gravitates towards collaboration with countries in the CEE region (Slovenia, Poland, Check Republic, Slovakia, Romania, Bosnia and Herzegovina, Serbia etc.), as it has a lot in common with the didactic tradition in these countries, as well as a lot of other common issues including the lack of funding, less stable political landscape with higher influence on education etc.

The Croatian educational arena has been rather conservative in accepting the digital transformation. Some of it is due to the lack of funds, which is being alleviated by the constant increase of the EU funding. Other important factors include a strong conservative strain in Croatian politics and consequently educational policy, opposing quick changes and leaps the young country could make based on the experience of more mature systems. Throughout the last decade and prior to the implementation of the e-Schools project, there have been no major pushes for digitalization of the school system. Similarly, prior to the curricular reform, there have been no major pushes for the modernization of the curricula or teaching methods used in Croatian schools. Both initiatives are now conducted in parallel and are contributing to the schools becoming more experienced in terms of the ICT use for teaching and learning. Nevertheless, printed materials still largely remain the dominant medium and traditional teaching methods still prevail.

It is worth mentioning that the Ministry of Education and Science in Croatia in its latest mandate has been a strong advocate of the digital revolution. It is pushing for the introduction of mandatory informatics in primary and secondary schools, as well as the introduction of a new curricula in alignment with the Strategy of education, science and technology in all other subjects, supported primarily by digital educational resources, rendering them equal to the print and pushing both the public institutions and the market to support more digital educational resources.

One of the pressing issues in the Croatian educational system are digital competences of teachers and professors and their readiness to accept new technologies, not only as tools but as a means of changing the way of teaching. After several decades of unsuccessful attempts of modernization of the education system, teacher motivation and confidence in changes are challenged. Introducing significant changes through new curricula and ICT in teaching at the same time is both an opportunity and a threat since there is a risk that sustained teacher professional development gets neglected. Even if in-service training and life-long learning is focused on digital competences of teachers already in the schools, new teachers that are coming out of the higher educational teacher training institutions would lack these competences. Since changes in the education system are highly dependent on teachers carrying them out, teacher competences and motivation remain the issues Croatia will have to deal with.

In terms of the higher and vocational education, the relevance of skills acquired through the programs offered, especially in terms of preparation for the digital market and economy and timely adaptation to the needs of new and transformed professions due to digital technologies, are the main issues to be addressed.

This chapter discussed the state of the ICT in education in Croatia by dealing with the most relevant and critical issues the educational sector and key stakeholders are dealing with. Croatia is in a transition process with a number of ongoing educational reforms dealing with the issue of teacher professional development and their motivation as the main challenge. Currently the majority of Croatian teachers lack digital skills which is being bridged by the use of technology and specially designed and targeted professional development initiatives. However, the chapter discusses such intermediary solution by emphasizing that teachers should be prepared for the new digital era systematically and much earlier, during their formal teacher training years. Although technology, such as the efforts made in Croatian UNESCO recognized project e-Schools, is a change maker, new challenges of improving the status of teacher profession in the society, the sustained tracking of changes and the resulting outcomes through research and analytics need to be the base for the sustained educational sector development and fine tuning.

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Chapter 4
ICT for Education, Employment and Empowerment in India

Kannan M. Moudgalya

Abbreviations

AICTE	All India Council for Technical Education
ASC	Arts, Science and Commerce
FOSSEE	Free and Open Source Software for Education
FLOSS	Free/Libre and Open Source Software
ICT	Information and Communication Technology
IIT	Indian Institute of Technology
IT	Information Technology
MAKAUT	Maulana Abul Kalam University of Technology
MOOCs	Massive and Open Online Courses
NKN	National Knowledge Network
NMEICT	National Mission on Education through ICT
NPTEL	National Programme on Technology Enhanced Learning
PM^3NMT^2	Pandit Madan Mohan Malaviya National Mission on Teachers and Teaching
T10KT	Train 10,000 teachers
UGC	University Grants Commission

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_4

4.1 Case Overview of India

India's Gross Enrollment Ratio (GER) in 2010 was about 15%. The Indian Government is making an attempt to reach a GER of 30% by 2020. There are indications that this figure will be reached. Unfortunately, because of this sudden growth, the quality has suffered. A McKinsey report says that only 25% of engineering graduates of India are employable (Farrell, Kaka, & Sturze, 2005). A recent report says that most students from top engineering colleges cannot even write computer programs that compile, let alone give the correct answer, and efficiently (PTI, 2018). The government is now trying to improve the quality of education (Moudgalya, 2018a), so that more students will be employable. Many poor quality colleges are also getting closed down (Anand, 2017).

India has been developing and using technology based solutions to solve problems faced by its people. An example of it is the satellite technology developed by the Indian Space Research Organisation, which although appears esoteric, has started helping the common man in a big way (Laxman, 2016). It is also the most economical way (Amos, 2014). Technology based educational methods can also be very effective, if designed and implemented properly. For example, in the Spoken Tutorial based IT training method developed by the author, the cost to provide IT training to one person on one topic is Rs. 50 (Moudgalya, 2017), which is less than $1.

In this report, we give an overview of the ongoing efforts in India to raise the levels of education. We first present the scale and nature of ICT in education on six dimensions. Then we present a sample of outcomes and achievements. The next section is devoted to challenges and different ways of addressing them. The final section is devoted to reflections and to some issues that are intractable.

4.2 Scale and Nature of ICT in Education Based on the 6 Dimensions

4.2.1 Policy Perspectives

The policy makers in different arms of the Government have understood the indispensability of ICT to achieve fast development. This is illustrated by the launch of the $1 billion National Mission on Education through ICT (NMEICT) (Ministry of Human Resource Development, 2018), an initiative of the Ministry of Human Resource Development. The IT Ministry mandated the use of open source software (Govt. of India, 2015). Indian space programmes relied on ICT based methods and other technology inputs to provide effective low cost solutions (Economic Times, 2013). More recently, all school books created by NCERT (NCERT, 2018) have been made available for free access. The earliest ICT initiative in tertiary education came from the National Programme on Technology Enhanced Learning (NPTEL

Team, 2018a), which made available the basic courses required in five fields of engineering. This effort has now evolved into the MOOCs (Massive Open Online Courses) platform, SWAYAM, designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality (Swayam, 2018). Both UGC (University Grants Commission, 2016) and AICTE (All India Council, 2016) have now permitted up to 20% of the courses to be taken through SWAYAM. Because of the ability to accommodate a large number of people simultaneously, now SWAYAM is proposed to be used for massive teacher training.

4.2.2 Infrastructure

Many of the successful ICT based educational initiatives of the Indian Government have been created by NMEICT (Ministry of Human Resource Development, 2018), started with $1 billion allocation in the year 2009. Establishment of 1 GBps bandwidth in each of the then existing 400 universities received 60% of this fund. Most of the remaining amount was devoted for content generation and training. Some of the important projects initiated by this Mission are presented here. We will begin with the content generation.

National Programme on Technology Enhanced Learning, coordinated by IIT Madras, was perhaps the most important activity: it has released 50,000 h of video recording from 1500 complete courses, mostly in the field of engineering and sciences (NPTEL Team, 2018a). Virtual Labs (Bose, 2018), coordinated by IIT Delhi, was started subsequently to cover experiments required in engineering courses. Another important content creation activity was e-Kalpa (Poovaiah, 2018), which created a large educational content in the field of design education. To help support the outcome based education, the Government also initiated the Pedagogy project (Pedagogy Project IIT Kharagpur, 2018; Ray, 2014), coordinated by IIT Kharagpur.

National Digital Library of India (Chakraborty, 2018), coordinated by IIT Kharagpur, is an important initiative to create a framework of virtual repository of learning resources with a single-window search facility.

Train 10,000 teachers (T10KT) (Kannan, 2015; Kannan & Narayanan, 2015a, b), carried out by IIT Bombay and IIT Kharagpur, was a unique programme that trained possibly the largest number of people simultaneously. Through this activity, 180,000 engineering college teachers were trained in five years.

The Government spent considerable amount of resources to promote Free/Libre and Open Source Software (FLOSS). The flagship activity that came out this effort was Spoken Tutorial (Moudgalya, 2017) that was initially started as a documentation project for FLOSS. The Spoken Tutorial project is coordinated by IIT Bombay. Because it was highly successful, Spoken Tutorial became a large scale asynchronous training programme, benefiting more than 5 million students. Another important project to promote FLOSS is Free and Open Source Software for Education (FOSSEE) (FOSSEE Team, 2018; Moudgalya, 2014), carried out by IIT Bombay, to collaboratively use and improve open source software.

We will now present a few hardware based projects. e-Yantra (Krithivasan, Shandilya, Shakya, Arya, & Lala 2016), a robotics based training programme carried out by IIT Bombay, is aimed at the use of hands on approach to teach computer science and electronics. Another hardware project was also started to provide low cost access and computing devices, such as tablets and laptops (Moudgalya, Eranki, Ganguly, & Apte, 2016; Moudgalya, Phatak, Sinha, & Varma, 2013; Patil & Patnaik, 2013).

We will now present the current flagship activity in IT based education: SWAYAM (2018), the MOOCs platform of the Government of India. SWAYAM Prabha (2018) is an attempt to take the educational content to a large number of learners simultaneously. It is a group of 32 DTH channels, devoted to telecasting of high quality educational programmes on 24X7 basis using the GSAT-15 satellite.

Realising the importance of teacher education, Pandit Madan Mohan Malaviya National Mission on Teachers and Teaching (PM^3NMT^2) was started to address comprehensively all issues related to teachers, teaching, teacher preparation and professional development. This Mission is establishing 30 schools of education (SoE) in central and state universities, five centres of excellence in science and mathematics education (CESME), 25 teaching and learning centres (TLC), 20 faculty development centres (FDC), two inter-university centres for teacher education (IUCTE), and five centres of academic leadership and education management (CALEM).

When the IT initiatives started about a decade ago the Internet bandwidth was expensive. The Government attempted to provide 1 GBps bandwidth to each of 400 universities and high speed Internet to affiliating colleges, funded by NMEICT. All the above described projects have been started by the Ministry of Human Resource Development. The National Knowledge Network (NKN) was initiated by the Ministry of Information Technology to establish 1 GBPs bandwidth in 1000 government educational institutions and research centres (NKN, 2018a).

We will conclude this section with a project from a State Government. The it@school is a very large initiative of the Kerala State Government, to train its school teachers on the use of IT using open source software.

4.2.3 Educational Resources

In this section, we present the educational resources that came out of the initiatives reported in the previous section, in the same order.

NPTEL has 1500 courses, consisting of 50,000 video hours, with text transcription done for 30,000 h. There have been 800 million views of the NPTEL website (NPTEL Team, 2018a). Virtual labs has created about 100 labs, with more than 1000 experiments, contributed by 30 top educational institutions in India. The e-Kalpa's courses are based on the fact that designers learn from design studios instead of classrooms. This project emphasises on week long modules instead of hourly classes. Learning is based on Demos, Case studies and Examples. The approach is based on Creative Problem Solving, which happens through Project Based Learning. Active learning is emphasised through experiential Learning—*do it and learn* Design process. This project has created 120 courses through 400 resources in 650 galleries and 220 case studies. There have been about a million informal users of these resources.

Complete curricula for a selected list of 200 one semester long theory courses in engineering were created by the Pedagogy project as Open Educational Resources (OER) on the project website (Pedagogy Project IIT Kharagpur, 2018; Ray, 2014). The curricula include Course Overview, Course Objectives, Module Overview, Module Objectives, Unit Objectives, Self Assessment test items with solutions matched to objectives, Objective-wise Learning Resource reference list and a short summary of each unit. The project aims to train a minimum of 3000 engineering faculty members in the basics of pedagogy and outcome-based learning through a mixture of hands-on workshop and web based tools.

NDLI currently hosts 14 million digital learning resources and more resources are regularly added in the repository. NDLI has 1.4 million active users from more than 9000 institutions geographically spread over India and different levels and groups of users. Several thousand new users are becoming members of NDLI every day. There are about 50,000 daily hits of this portal.

The T10KT project has established about 550 remote centres, each with audio–video facilities for live interaction with the faculty member at IIT Bombay and IIT Kharagpur. These two institutions have together trained about 180,000 teachers, from mainly engineering colleges, through about 30 courses.

The Spoken Tutorial project has created more than 1000 original tutorials in English. These tutorials are dubbed into all 22 languages recognised by the constitution of India. Including dubbing in these languages, there are 10,000 spoken tutorials. Some of Indian languages can be used in neighbouring countries: Urdu, Punjabi and Hindi in Pakistan; Nepali in Nepal, Bengali in Bangladesh, and Tamil in Sri Lanka. There are also samples of dubbing in other international languages: Arabic (11), Khmer (1), Persian (150), Spanish (3), Portuguese (6), and Thai (1), Vietnamese (18). More than 5 million students have been trained through Spoken Tutorials.

One of the main educational resources created by the FOSSEE project is the Textbook Companion (Braatz, 2014; FOSSEE Team, 2018). At present there are about 600 Scilab textbook companions that have code for 75,000 solved examples, and 500 Python textbook companions. In a similar way, more than 25 textbook companions have been created in OpenModelica and about 15 are in progress. In addition, in specialised software, very useful solutions have been created by the FOSSEE team. For example, 135 DWSIM flowsheets have been created, while 50 are in progress. More than 75 eSim circuit simulations have been created. All of them have been contributed collaboratively by students and faculty of colleges across India. All contributions have also been reviewed for accuracy before getting uploaded on to the website. Anyone, from anywhere in the world, can contribute through these projects and get paid a suitable honorarium. This approach has been identified as a possible method to build virtual research groups (Moudgalya, 2018b). The first evidence of this possibility was demonstrated in a National Conference on Chemical Process Simulation (Moudgalya, Naren, & Wagner, 2018), whose proceedings have flowsheets of 100 chemical processes, created by students from various colleges in different parts of India.

The e-Yantra project has established a large number of robotic labs in hundreds of engineering colleges in India. Their robotic competitions are extremely popular amongst college students. The number of students who enroll in their competitions is of the order of 100,000. Students who do well in the competition get a chance to do an internship with the e-Yantra team at IIT Bombay.

As a part of the affordable access devices project, the IIT Bombay team distributed 100,000 tablets to students and teachers of engineering colleges to assess its efficacy. It also trained about 25,000 teachers and students on the use of the tablet, through the T10KT programme, described earlier. A large number of content for this tablet was created collaboratively (Aakash Team, 2018a, b). A critical study of this project has concluded that this was a successful project, with one main achievement being the lowering of the street price of android tablets (Phalkey & Chattopadhyay, 2015). Tablets continue to be important in the government's push to spread ICT literacy and modern teaching methods.

The IIT Bombay team made the low end tablets discussed in the above study to work on Linux, primarily aimed at programmers (Patil & Patnaik, 2013). They then migrated to laptops, as a keyboard is indispensable for programmers, and as the external keyboard attachment to the tablets was not a sturdy solution. This team established the efficacy of a low cost laptop costing about $110 by carrying out rigorous studies through IIT Bombay's first year undergraduate students (Moudgalya et al., 2016). They have now improved the shortcomings of this laptop, with a much better one, costing $140 (Moudgalya, 2018c). More than 1500 students from across India bought this laptop with their personal money, without any subsidy. This laptop runs on Debian Linux software with more than 100 pre-installed software packages.

The Government has now launched the MOOCs platform SWAYAM, through which more than 1500 courses have already been released. All the future educational content created through the government is expected to be released through SWAYAM. The 32 SWAYAM PRABHA DTH channels have just started transmitting courses to students across India. Topics that these channels cover are provided in (SWAYAM Prabha, 2018). One can see from this list that a large number of topics are covered through these channels.

A goal of PM^3NMT^2 is to follow a coordinated approach to address shortcomings related to teachers and teaching at both school and college levels. To empower teachers through training, retraining, refresher and orientation programmes in generic and pedagogic skills and discipline specific content upgradation, using conventional and ICT based methods. This Mission aims to provide an Induction Training Programme to about 100,000 college teachers during the next two years.

NMEICT successfully installed 1 GBps bandwidth in 400 universities and high speed Internet in affiliating colleges. NKN established 1 GBPs bandwidth at more than 1600 governmental educational and research institutions free of cost to users (NKN, 2018b). These have been extensively used for collaborative research, teacher training, etc. These centres are in addition to the 1 GBPs bandwidth established by NMEICT in 400 universities. The payment model and the target audience of NKN and NMEICT are somewhat different. While NKN users get the service free, NMEICT users have to pay 25% of the cost. While the former services only the government sector, the latter includes private universities also. The NMEICT scheme includes connectivity to affiliating colleges as well. Private universities also benefited by the NMEICT's scheme. Now, the NMEICT scheme is also managed by the NKN. As these resources were established circa 2010 when bandwidth was very expensive, academic and research institutions benefited immensely by both schemes.

The it@school of the Kerala government using open source software is possibly the largest training programme undertaken by any governmental agency, anywhere in the world. It has trained more than half a million school teachers on the use of open source software.

4.2.4 ICT Integration into Practices

The policies and the infrastructure thus created and explained previously have helped ICT to be integrated into practice, some instances of which will be explained now.

Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, has permitted its 8th semester computer science and engineering students, those of information technology, and those of electronics and telecommunication to do their 8th semester courses to be done through MOOCs. They have permitted three of their theory courses to be done from three baskets of the well known NPTEL courses that make up a total of 9 courses (Maulana Abdul Kalam Azad University of Technology, 2018).

The same university has permitted Spoken Tutorial based courses to be chosen as MOOCs for their practical course, the Design Lab. They have permitted any three out of a basket of 8 Spoken Tutorial courses to be completed for this purpose. Given that about 200 engineering colleges are affiliated under MAKAUT, it is a recognition of the quality of Spoken Tutorials.

Many more universities have either already announced a similar equivalence or, in the process of implementing it. A list of 40,000 lab courses that use Spoken Tutorials during their course timings, through a one-to-one mapping, is available at (Spoken Tutorial Team, 2018a). In this method, a student listens to tutorials that correspond to the syllabus for that week. This information is made available through the *mapping* process. As there are typically ten turns in a semester long lab, a student completes a software in as many weeks, not in one sitting. This repeated process of learning provides students sufficient time to learn complex topics as well.

Recall that T10KT is a teacher training programme. All two week courses delivered by the faculty of IIT Bombay and IIT Kharagpur through T10KT have been recognised by the Indian Society for Technical Education. This recognition helps college teachers who undergo these courses at the time of their promotion. T10KT, in turn, gives certificates of completion only after a rigorous assessment (Kannan, 2015; Kannan & Narayanan, 2015a, b).

To bring rigour into ICT based educational techniques and to provide sound theoretical support for modern methods, educational institutions in India are in the process of establishing academic programmes in the general area of Educational Technology

(ET). An example of this is the Ph.D. programme in ET at IIT Bombay that started about 8 years ago. There are 25 Ph.D. students and five full time faculty members working in this department (ET Team, 2018). The ET programme is about to launch a Master's (M.Tech) degree. We expect to have many such academic programmes getting started in different institutions of higher learning.

4.2.5 Students' ICT Competence

Only about 10% of students in India have access to a computing device, such as laptops and desktop computers (Sharma, 2015), although a lot more of them have access to mobile phones. While mobile phones and tablets can be used for distribution of content, *complex tasks, like submitting a job application or a homework assignment, are much more difficult to accomplish on a smartphone than on a computer* (Rideout & Katz, 2016).

For students who have enrolled in programming courses in colleges, access to computers is a difficult problem. During college hours, computer access is neither available nor students have free time to practise. Most students have to spend about two hours per day, on an average, in commuting between their homes and colleges, by buses provided by their colleges. If they miss college buses, it could take a lot more time. So, students leave for their homes at 5 pm, when college buses leave. As they don't have personal computers, they cannot use the evening time to practice programming, which they never get to do.

In view of the above, students are asked mainly descriptive questions in programming courses. For example in the 2017 question paper listed in (JNTUK University, 2018), only 20% of the marks are reserved for programming. Even the programming questions are expected to come from a standard set of questions, and if any question is asked outside of it, students have difficulties (Venugopal, 2018).

So, it is not surprising that a study conducted on 36,000 engineering students from IT related branches of over 500 colleges concluded that 95% of engineers in India are unfit for software development jobs (PTI, 2018). This study also finds that about 66% of students cannot even write code that compiles, and the code written by only 5% of them are correct, while only 1.5% can write functionally correct and efficient code.

The state of students of arts, science and commerce (ASC) colleges is a lot worse. They have much less access to computers, compared to IT and engineering students. Many of the ASC colleges don't even have decent computer labs. Computer labs, if at all available, are used mainly for programming, never to learn subjects from their specialisation that require computers. For example, most of the commerce students do not get to use any accounting software—they learn accounting only through the paper and pencil mode.

Various governments have been working hard to address this difficulty of lack of devices. One of the early projects on this front is the Aakash project (Moudgalya et al., 2013). There were some adverse press reports, owing mainly to late deliveries and unreasonable expectations on the quality of the device, which was made available at about 5% of the cost of top end devices. A study undertaken at Kings College, London, has concluded that it was a reasonable success, given the constraints (Phalkey and Chattopadhyay, 2015). One of the main objectives of this project was to demonstrate the feasibility of a useful device at a low cost, keeping in mind that about 300 million students in India had to be reached eventually (Moudgalya et al., 2013). The other objective was to bring down the street prices of tablets. These aims were achieved.

Because of the extraordinary amount of discussion on the feasibility and the logistics of the $35 Aakash tablet, the outstanding educational work done on the device was not noticed by the public. IIT Bombay that coordinated the Aakash project successfully ported Linux on to this frugal device (Patil & Patnaik, 2013). It conducted training programmes for more than 20,000 college teachers and students on Android programming; teamed up with more than 300 colleges and developed many useful Apps (Aakash Team, 2018b).

The educational aspect of a low cost device was pursued with a rigorous study of an affordable laptop (Moudgalya et al., 2016). This study found that 20% of the fresh undergraduate entrants to IIT Bombay who had to enroll in a compulsory programming course, did not have laptops. This group belonged to lower strata of the society, both economically and educationally. This study was interested in the question whether low cost laptops would be useful to these students or it would be a punishment, considering that such devices could have shortcomings compared to more expensive systems.

It was a highly successful experiment. Students who used this laptop wrote a large number of lines of code, even though they previously had only a minimal exposure to such devices. Table 4.1 compares the number of lines of code written during the course and previously. These students produced more code than their counterparts, who had access to more expensive laptops, see Table 4.2. These students seemed to be a lot more motivated than their affluent counterparts, as can be seen from Table 4.3, which has data on students who scored 20% and less marks in the course.

Interestingly, students who used the affordable laptop wanted it to be sleek and powerful. In other words, sleekness could be as important as the capability of the laptop, even when the cost is low. Keeping all these requirements in mind, the IIT Bombay team has come up with a much better, yet affordable, laptop (Moudgalya, 2018c).

Table 4.1 Number of lines written by the experimental group of 90 students who used the low cost laptop

No of lines of code	Before Course (%)	After Course (%)
<10	26	5
11–100	36	7
101–1000	36	31
>1000	2	57

Table 4.2 Number of lines written by students who used expensive laptops and the experimental group that used low cost laptops, both during the course

No. of lines	Expensive Laptop users (%)	Low cost Laptop users (%)
<10	8	5
11–100	20	7
101–1000	49	31
>1000	23	57

Table 4.3 Details of students who scored less than 20% marks in the course

Marks (%)	Expensive Laptop users (%)	Low cost Laptop users (%)
0–10	4	1
10–20	2	1

The situation in most engineering colleges in India is worse than that at IIT Bombay, in the following parameters: access to computers, access to on-campus accommodation, parental income level, parental education level, etc. It is a lot worse in ASC colleges, as mentioned earlier. As a result, the findings of the study discussed above are a lot more relevant.

Training the students to effectively use the available computers, as opposed to providing access to those who don't have, should be attempted first, as it can be done with a lot less resources. As a matter of fact, projects that emphasized the latter, without worrying about the former, have failed miserably (Parashar, 2015). In view of this, the Government is popularising Hackathons to improve the culture of computer programming amongst students (Moudgalya, 2018a).

4.2.6 Teachers' Professional Development

The professional development of Teachers is extremely important. In view of this, the Indian Government has come up with a mission Pandit Madan Mohan Malaviya National Mission on Teachers and Teaching (PM^3NMT^2), as already explained. Improving ICT skills is one of the important objectives of this Mission. Details of ICT training provided by the IIT Bombay's PM^3NMT^2 team are available (PM^3NMT^2 Team, 2018).

This Mission has come up with the concept of an Induction Training Programme for new teachers. It plans to train 100,000 teachers, based on a concept note of a group of secretaries. Many of the 40 institutions funded by this Mission have conducted this training. The PM^3NMT^2 team at IIT Bombay conducted this month long course for 120 teachers in December 2017. The average age of the participants is 25. A preliminary study of the feedback of these participants shows that their efficacy level went up from about 30% to about 80%, indicating a substantial benefit by the course. Such a training programme is expected to be made mandatory for all teachers at the start of their career in higher education.

Train 10,000 teachers (T10KT), possibly the world's biggest technology based teacher training programme, has also been quite effective (Kannan & Narayanan, 2015a). This is a two week training programme, wherein the participants listen to and interact with the instructor through interactive audio-video connection from more than 200 centres. Engineering and Science courses have been delivered through this method. Participants of this two week programme get a certificate on passing assessments. This certificate is useful to the teachers for professional advancement. A total of 180,000 teachers have been trained through this approach (T10KT Team, 2018). Teachers like these courses (Kannan, 2015; Kannan & Narayanan, 2015b). Using the same vehicle, the IIT Bombay team recently conducted a massive Koha training workshop to 2500 librarians, and is following it up with Ask a Question sessions (AAQ Team, 2018).

The above method allows a teacher to attend the course at a remote centre near where they live, which allows them to return to their homes every evening. This particularly helps women, who also have to take care of their families, and hence cannot be away at a distant place for an extended period of time. We have seen the enrollment of women teachers to be in excess of 40%. This is a large number, given that the overall ratio of women faculty in colleges is low. We have found that the women teachers are a lot more active in the classroom, compared to male teachers. This is possibly because the women teachers want to make full use of the limited opportunities available to them.

Conducting a training programme for 10,000 people at a time allows almost every interested teacher to attend the course. This has particularly helped young teachers, who would not have been nominated, had there been a smaller class: they would have waited for their turn. It is the young person who is at the start of their teaching career, who would benefit the most by such courses.

4.3 Outcomes and Achievements

In this section, we summarise the achievements of a few select ICT schemes implemented by the Indian Government.

The Spoken Tutorial team set a target to train 10% of all students enrolled in all bacherlors' degree programmes by the end of 2016. But for a few states, this target was reached. In addition, the 10% figure was reached, overall. The total number of people trained at the end of 2016 was 2.6 million. At the time of writing this article, the total number trained is 5 million. Details of this massive, India wide, ICT training programme are given in (Moudgalya, 2017).

Spoken Tutorials are *officially* accepted to be used in 40,000 labs (Spoken Tutorial Team, 2018a). To be used officially, several checks have to be cleared in each institution: acceptance by college teacher, Head of the department, the curriculum committee, academic council, senate, etc. The ICT training given by the Spoken Tutorial programme is a form of active learning. About 15% of the students who take the training appeared in the test in the past, and it is expected to improve in the near future. The pass rate is about 75%.

We will now briefly summarise the outcome of another project, T10KT. A detailed analysis of the effectiveness of this project has been carried out by Kannan and coworkers (Kannan, 2015; Kannan & Narayanan, 2015a, b). Extensive quantitative and qualitative studies by them indicate that a technology based synchronous training programme can especially be useful to simultaneously train a large number of people, both young and old, from cities to remote corners of India. From the feedback of more than 1000 participants, we can conclude that this approach is successful from the points of technology effectiveness, instructor effectiveness, perceived usefulness, behaviour intention to use, and participants' level of satisfaction.

4.3.1 Feedback from Beneficiaries

The projects discussed above have received a large number of testimonials from students and faculty members. In particular, the courses created by these projects are helping them do well in their college course exams, in competitive exams and to get jobs. To illustrate this, we will focus on the lesser known Spoken Tutorial project.

WIPRO, one of the biggest three IT companies in India, has included Java Spoken Tutorials as one of the permitted learning material for their own internal training. Naturally, any student who applies for a job in WIPRO will benefit, if they are already proficient in Java through Spoken Tutorials.

Dr. S. Malarkkan, Principal, Manakula Vinayagar Institute of Technology, Pondicherry says the following:

> More than 70 of the 88 placed students felt that this Spoken Tutorial training helped them to be well-equipped for the Tata Consultancy Services (TCS) campus recruitment.

Krishnaveni Nair, a B.Sc graduate from SIES, who got employed as a Linux Developer in the leading IT company of India, TCS, has the following to say:

> This exposure (to Spoken Tutorial) seems to be one of the reasons for getting selected in TCS, which various engineers and other graduates would love to. The amazing certificates and creating leadership qualities for organizing several workshops during my college days brought in me the confidence to undertake any task. I have got into TCS as a Linux developer. The first time I learned about Linux was when I conducted a Linux workshop, and also took a test organized by IIT Bombay.

Dr. Chitra Desai, the Head of the MCA department of the Marathwada Institute of Technology has given this feedback. She confirms that the SELF workshops can be organised without an expert and that they are useful for employment.

> Recently, I came across one company which wanted students with sound knowledge in PHP MySQL. As our MCA syllabus does not cover PHP MySQL, I decided to train my students using Spoken tutorial. More than 30 students took up the course, and in a very short time, I could train my students. This helped place six students, by training them to meet the company requirement, without incurring any cost. The Spoken Tutorial courses are effectively designed to train a novice user, without the support of a physical teacher, and have taken care of all possible questions that may arise during a course.

Spoken Tutorial has helped students pass their exams. Here is what Prof. K. V. Nagarjuna of Sree Dattha Inst. of Engg. and Science, says about such a student:

> In my college, one of the students in B.Tech 3rd year 1st semester had to appear in a makeup exam and he wanted guidance to learn Java. We gave the spoken-tutorial CD material on Java, and gave explanation on the contents of the CD. After the exam he came and told that the spoken tutorial CD on java helped him a lot and that he developed confidence in Java by going through all the tutorials and doing the assignments. He also told that the tutorials cleared most of his doubts on java and helped him pass the makeup exam.

This is part of an email, a student Madanraj Chandrasekaran of Saveetha Engineering College, who went to the US for higher studies, wrote to his faculty mentor:

> I am doing my Masters in computer science in the United States of America… As I had no knowledge about Python I just tried the tutorial of IIT Bombay which you gave me. I have to tell you the clarity and detail they explain each topic. We cannot deny that the Internet has many tutorials. But I felt Spoken Tutorial was the best. I shared this tutorial with my other project members. They just loved it. In the course of time you wouldn't believe the whole class is using this tutorial. I am really feeling proud to be an Indian and your student.

Spoken Tutorials are useful to school students as well. Mr. Amit Kumar, Computer Teacher, Jawahar Navodaya Vidyalaya, Theog, Shimla Dt. says the following:

> I am glad to inform you that I have received the prestigious National ICT Award 2015 from the Hon'ble President of India at Vigyan Bhawan New Delhi on 5th Sept 2016 (Teachers' Day). The award was bestowed due to my work in the field of "ICT in Education using FOSS" in association with CIET, NCERT, New Delhi and Spoken Tutorial Project, IIT Bombay.

The fact that this teacher received the coveted award of the highest constitutional head of India demonstrates the usefulness of spoken tutorials to school students as well.

4.3.2 Paid Workshops Establish Usefulness

Although making things free help easily disseminate the educational content to a large number of people, adding a cost to it could help ensure that it is effectively used. Once a person pays for something, they will demand good service. As a corollary, projects that can collect substantial amounts can be taken to be effective and successful. Finally, amounts thus collected from many people would reduce the dependence on government funds.

NPTEL has introduced a scheme of proctored exam, followed by a certificate, at a cost of about Rs. 1000. So far, a total of 200,000 students appeared in such exams, in about 500 courses. Details of students who took these paid exams are available at (NPTEL Team, 2018b).

The Spoken Tutorial team has also gone for a paid model for online tests followed by certificates. But it has chosen a different model for invigilation: It has co-opted faculty members of colleges to do the proctoring for their own students. The proctoring is done free of cost, and in return, the cost of the exam is kept low. A college has to pay Rs. 25,000 ($350) per year, irrespective of the number of students and the number of certificates each will receive. As there could be a total of about 1000 certificates issued in a year per college, the cost of a certificate could be as low as Rs. 25!

The name of the invigilator appears in the certificate that each student receives. This makes the proctoring college responsible for the quality of invigilation. This, combined with a flat fee can possibly help improve the honesty levels amongst students. This mode of proctoring also helps keep the proctoring costs low.

Finally, the payment has increased the seriousness of the training process itself: the fraction of students undergoing training appearing in online tests has increased to about 50%, a lot more than the corresponding number of 15% when the online tests were available free of cost. The Spoken Tutorial team plans to conduct job fairs for students who do well in these tests. This should further motivate the students to take this training seriously.

4.4 Challenges and Strategies

Given that the problems faced in India are of large magnitude, there are many challenges. We list a few, and the strategies used to address these.

One of the problems that India faces is the nonuniform development in every field in general and education in particular. This is the case in IT training as well. An example of how this can possibly be addressed is explained now.

The Spoken Tutorial programme set a target of training 10% of the total number of students enrolled in all undergraduate programmes, for every state (Dept. of Higher Education, 2018). In the largest state of Uttar Pradesh (UP), the target to reach at the end of 2016 was 0.5 million. Unfortunately, it was only 50,000 at the beginning of 2016. Managers from well performing states were shifted to UP. In addition, more people were recruited for work on the ground in UP. The target was reached at the end of 2016, not only in UP, but in almost every state (Moudgalya, 2017).

One of the problems in web based education is that until it becomes very popular, insisting on registration and login is counterproductive: visitors leave, when asked to register and log in. On the other hand, registration and login are the only way to find out who visited the website, its efficacy, etc., which are required from the audit department of the funding agency. In view of this difficulty, all established NMEICT programmes have done away with login and registration, thereby sacrificing statistics for the sake of widespread dissemination. Successful projects, however, have not been affected by this decision. For example, the Spoken Tutorial project has extensive data of actual training statistics (Spoken Tutorial Team, 2018b).

Availability of Internet, although improving, is still a problem in many parts of India. Offline solutions are a way to handle this. Spoken Tutorials, for example, can be downloaded once and copied on to many systems, to run locally (Moudgalya, 2017). In fact, the author conducted a few Spoken Tutorial based workshops in Myanmar in 2016, when the electricity supply itself was erratic. All participants used laptops whose batteries were charged sufficiently. Spoken Tutorials were copied into every system. As only FLOSS systems were taught, they could also be copied ahead of time.

Lack of English fluency is a problem for many in India. One way to handle this is what the Spoken Tutorial project has done: dub the audio into all 22 officially recognised languages of India (Moudgalya, 2017). The video is kept in English, which in addition to making the dubbing easier, retains the employment potential in IT companies that require programming to be done in English.

Providing access to computers is a difficult problem in India. As explained earlier in this article, the Indian Government has been trying to address this problem through projects, such as tablets and low cost laptops. Some projects, such as Spoken Tutorial, have been addressing this difficulty by maximising the use of institutional computer systems through a process called mapping that enables the use of good quality ICT material to be used as approved learning material in labs (Moudgalya, 2017).

It is easier for the government bodies to freely distribute laptops than to ensure that the recipients know how to use them. In addition to causing a lot of burden to the exchequer, this could also result in the depression in market prices, as the students who do not know how to use them could sell them in the market at low prices (Parashar, 2015).

One way to address this problem is to provide training to students and make the laptop useful to them. A large scale IT training, of the type described in (Moudgalya, 2017) is one solution. Another approach that is attempted now is to pre-load the laptops with self learning Spoken Tutorials before distribution (Moudgalya, 2018c).

4.5 Reflections and Issues

ICT based methods allow developing countries to leapfrog and catch up with developed countries. As these help improve the quality of life immensely, they are a godsend (Amos, 2014; Economic Times 2013; Laxman, 2016). India has been making great strides in this direction, despite the large scale problems it faces.

In India, elections are held every four to five years and the governments change often. Maintaining the consistency of policies across governments is an issue at times, although successful programmes are generally continued by new governments as well.

Completion rate of MOOCs courses is a cause for alarm. Unlike in the western countries, all the MOOCs effort in India are mainly supported by government grants. The existing metrics of successful participation or completion will not be accepted by the government audit departments for continued funding. One possible way to address this issue is to go for blended or hybrid MOOCs, in which, marks given by the institution one studies in is included in the overall grade (Phatak, 2014). Another approach is the mapping technique to make spoken tutorials part of curricula (Moudgalya, 2017). The 20% credit transfer approach should also help improve the completion rates (All India Council for Technical Education, 2016).

ICT based training is taken mostly by engineering colleges. We need also to train students of arts, science and commerce, which is a challenging task, the main reasons being the lack of infrastructure. Reaching out to schools is even more challenging, as the schools have in addition, a protective layer of administrative control, given the impressionable age of the target audience.

Automatic evaluation for descriptive and other types of questions is extremely important. At present, it is more or less restricted to multiple choice questions. Establishing proctored examinations is another difficult task. It costs money and can be made available only in select places. For widespread use and evaluation, we need better proctoring methods.

One of the issues that we are grappling with is that of (1) translation and (2) dubbing of educational English videos in Indian languages. It is well known that subtitles of movies help improve the underlying language by a foreigner. We would like to know whether it is beneficial to have the subtitle alone in one's language, with the audio in English. If this is shown to be sufficient, the high cost of dubbing the voice can be saved. Given the research finding that subtitles may add excessive cognitive load in videos that have difficult content (as different from movies) (Kalyuga, Chandler, & Sweller, 1999), it is unclear whether one can escape the high cost of dubbing.

If students belonging to colleges can be given ICT based assessment exams, with invigilation to be done by respective colleges, the high cost of proctoring by a third party can be saved. If the name of the person who invigilates the students at the college, as also the name of the college, are mentioned on the certificate, will the resulting rigour of exams be acceptable?

If the cost of funding a project is borne by the government, the cost to train and certifying a student can be brought less than $1 (Moudgalya, 2017). Should creators of such effective methods be fully funded by the government and be asked to bring down the cost of training further? An alternative is to ask them to raise the required funds and try to be self-sufficient. Should they spend their time in trying to make their methods more efficient so as to bring down the cost of training further or worry about raising funds?

Acknowledgements The author is grateful to the generous financial support provided by PM^3NMT^2 and the National Mission on Education through ICT, initiatives of the Ministry of Human Resource Development, Govt. of India, to carry out Teacher Training, Spoken Tutorial, and FOSSEE projects. The work reported in this article would not have been possible without the excellent work carried out by the staff members of these projects at IIT Bombay.

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Chapter 5
The Process of Developing ICT-Enhanced Education in Korea

Myunghee Ju Kang and Seonghye Yoon

Abstract ICT-enhanced education in Korea has shown remarkable growth over the past 40 years. The process of adopting ICT for use in Korean education began in the 1970s, with computer-literacy education. Gradually, it evolved into ICT-supported education, e-learning, ubiquitous learning (u-learning), and smart education. The current focus on innovative teaching/learning is based on a stabilized physical ICT environment. This chapter reviews various educational informatization projects promoted by the Korean government, summarizing them briefly using a framework consisting of five stages (Development, Takeoff, Expansion, Establishment, and Transformation), as well as seven domains (policy, infrastructure, educational content, standardization, curricula and methods, human resources development, and educational information services). The Korean master plan, *Adopting ICT in Education*, has gone through several versions, taking into consideration current technological development trends. Its policies are designed to consistently strengthen infrastructure, educational content, standardization, curricula and methods, and human resources. Korea has also promoted educational information services to publicize and share the achievements of educational informatization projects. The present study proposes a project-initiative model for ICT-enhanced education, based on the Korean initiatives. The Korean experience presented in this chapter can be used as a reference by future project initiators.

Keywords ICT-enhanced education · Education informatization · Project-initiative model

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_5

5.1 Introduction

The process of adopting ICT (Information and Communication Technology) for use in Korean education began in the 1970s, with computer-literacy education. It gradually evolved into ICT-supported education, e-learning, ubiquitous learning (u-learning), and smart education. The Korean government currently uses the term "smart education" to denote learner-centered education that incorporates up-to-date technologies, such as smart devices. In 2001, Korea promulgated general growth plans to informatize education innovation and develop human resources, after establishing a physical foundation for education informatization. Following a period of rapid advancement, Korea is now making a special effort to stabilize ICT-enhanced education. It aims to accomplish this by transferring government-led projects to private and local communities, based on a plan designed to cultivate talent and achieve a ubiquitous learning society. Since partially stabilizing the physical environment, Korea has focused mainly on using ICTs to promote innovative teaching and learning. Remarkable outcomes have been achieved in various areas of education, including content standardization, the development and expansion of human resources, and the provision of an educational information service that is convenient for users.

Currently, the 5th Master Plan for Adopting ICT in Education (2014–2018) proposes a model that supports and introduces learner-centered digital education and makes a quantum leap toward ICT-enhanced education. Under a long-term national plan to establish a learner-centered digital education system, this customized ICT-enhanced education system will foster creativity and build users' character, critical thinking, and communication and collaboration skills through learner-centered education systems, cyber universities, and lifelong-learning centers (Ministry of Education, 2014).

This chapter includes the findings of research carried out in 2005, 2015, and 2016. It offers an overview of the 40-year history of ICT-enhanced education in Korea (Kang et al., 2005; 2015; 2016). Having carefully reviewed the extensive literature on educational informatization projects, the researchers assessed the continuity, impact, and weight of selected core projects. These were used to derive a framework, consisting of five stages and seven domains. The framework covers continuing efforts to upgrade education and foster educational innovation through ICT in Korea. The five perpendicular stages are Development, Takeoff, Expansion, Establishment, and Transformation, while the seven horizontal domains are policy, infrastructure, educational content, standardization, curricula and methods, human-resources development, and educational information services.

5.1.1 The Five Stages of ICT-Enhanced Education in Korea

The **Development Stage** of ICT-enhanced education in Korea lasted until 1995, when computer-literacy education was integrated into the national school curriculum and computers were supplied to schools across the country. During the **Takeoff Stage** (1996–2000), national-level informatization plans were drawn up and legal and regulatory infrastructures were readied. The **Expansion Stage** (2001–2005) saw ICT use in education spread nationwide, while adoption rates surged to new heights. National projects were transferred to urban and provincial arenas during the **Establishment Stage** (2006–2010) to implement the informatization of education. During the final **Transformation Stage** (2011–2015), Korean education informatization expanded in new directions, using digital and smart devices to establish a lifelong-learning-support system.

5.1.2 The Seven Domains of ICT-Enhanced Education in Korea

Policy-level activities have included the establishment of project visions and goals, as well as the creation of a detailed roadmap for incorporating ICT into education. Policy actions have enabled all other project domains, supplying general project directions by defining goals and priorities, formulating missions, and managing budgets. The educational information **infrastructure**, as a physical means of delivering information, includes information equipment (school computers, ICT equipment for school modernization), network facilities, security systems, and other operational systems that maintain and manage ICT educational environments. **Educational content** refers to all knowledge assets used for educational purposes, ranging from text, images, and photos, to sound and video in analog and digital formats; educational content includes products distributed to individual users or user groups, as well as online content. **Standardization** covers all activities that relate to the development of agreed standards and procedures created to promote or facilitate the dissemination and sharing of educational information, as well as the usability and reusability of information. **Curricula and methods** include all institutional efforts to integrate ICT into the national curriculum or to develop and diffuse ICT-based teaching and learning methods. **Human-resources development** relates to the development of a human infrastructure to advance the adoption of ICT in education or to improve information proficiency among teachers. Lastly, **educational information services** maximize user convenience by supporting teaching and learning, research and training, online learning, community management, and administrative and financial tasks. The educational information services are, therefore, regarded as the ultimate outcome of education informatization in Korea. These services will deliver optimal services to users.

Table 5.1 provides information on the core projects carried out within each stage and domain. The following sections briefly review each stage, focusing on these core projects.

Table 5.1 Core projects by stage and domain

	Development stage (–1995)	Takeoff stage (1996–2000)	Expansion stage (2001–2005)	Settlement stage (2006–2010)	Transformation stage (2011–2015)
Policy	School-computer education-reinforcement plan Framework Act on Informatization Promotion	Adopt ICT in Education Master Plan I Establishment of KERIS	Adopt ICT in Education Master Plan II ICT Adopted Education Promotion Plan Promotional Strategy for National Human-resources development through the invigoration of e-Learning	Adopt ICT in Education Master Plan III	Adopt ICT in Education Master Plans IV and V Strategies for promoting smart education
Infrastructure	Supply IT devices to elementary and secondary schools	Establish school LAN and Internet environment in elementary and secondary schools Internet service-rate support for elementary and secondary schools	Infrastructure upgrade (additional PCs supplied, faster Internet) Basic Plan for protecting the information of educational institutions	Distribute GPKI (government public key infrastructure) certificates	Establish cloud education-service infrastructure Establish prototype platforms for smart education
Educational content	Develop instructional software	Develop online learning materials	Develop instructional software Develop Cyber Home Learning content	Develop digital textbook content model	Develop digital textbook for the amended curriculum Develop pilot mobile interaction content

(continued)

Table 5.1 (continued)

	Development stage (–1995)	Takeoff stage (1996–2000)	Expansion stage (2001–2005)	Settlement stage (2006–2010)	Transformation stage (2011–2015)
Standardization			KEM (Korea Educational Metadata) 1.0 (2001) and KEM 2.0 (2003) development	KEM 3.0 development E-Learning Quality Certification Service ISO 9001 Certification	Development of ICT standardization strategy map Standardization of Learning Analytics
Curricula and methods	Add computer-literacy education to the national curriculum	Operation of pilot schools for research on the use of ICT in education Establishment of operating guidelines for ICT education in elementary and secondary schools	Research on ICT adopted teaching/learning models for each subject	Expand ICT literacy education New Millennium Learners study	Develop model of smart education teaching/learning Strengthen software education
Human-resources development	Regularize computer training for teachers	ICT training for teachers; establish a basic plan to build cyber education and training centers	ICT training for teachers Establishment of the ICT-skills accreditation system for teachers and ISST	Provide customized training information	Reinforce teachers' smart education skills Software education; teacher training
Educational information services		EDUNET launch and initial service development and operation of the School Information Management System (SIMS)	Launch and operation of a Cyber Home-Learning System	Major service reorganization centered on consumers	Expansion of public service

5.2 Development Stage

This stage of the government initiative elicited and affirmed the willingness of stakeholders to undertake educational innovation through ICT; it also took the first steps toward adopting ICT in education.

5.2.1 Policy

While the first research projects and teacher training programs on the introduction of computers into schools began in the 1970s, they were conducted sporadically, at best. Projects designed to fully incorporate ICT into education were launched much later, with the School-computer Education Reinforcement Plan of 1987 (Ministry of Education, 1987). During the 1990s, the Educational Reform Plan assigned greater importance to computer education, prompting the government and local educational authorities to create separate informatization divisions and an organizational structure to guide informatization projects. In 1995, the last year of the development stage, the Framework Act on Informatization Promotion was passed, granting informatization national project status and propelling the Ministry of Education policy to adopt ICT in education to the next stage (National Computerization Agency, 2005).

5.2.2 Infrastructure

Computers were distributed to Korean elementary schools, following the establishment of the School-computer Education Reinforcement Plan of 1987—under an MOU between the Ministry of Information and Communication, Korea Telecom (KT), and the Ministry of Education. This distribution project supplied computers to computer labs (multimedia rooms) and teachers, as well as providing other information equipment for school modernization. School-computer networks were created as part of the national computer-network-building project (KERIS, 1998; Ministry of Education, 1987).

5.2.3 Educational Content

During the development stage, most content-development initiatives provided CAI (Computer-assisted Instruction) software for independent study. The development of multimedia content had to wait until the latter part of the development stage, in the early 1990s. However, most multimedia content produced around this time was DOS-based; for this reason, the adoption rate was very low. During the early years of this development stage, most content was developed through joint projects between municipal and provincial school districts, coordinated by an educational informatization agency (the Multimedia Education Support Center). Other development sources then entered the scene as the government, in an attempt to introduce varied content production, welcomed quality private-sector-published content and encouraged independent district-level projects (Korean Educational Development Institute, 1990).

5.2.4 Curricula and Methods

The integration of ICT into school curricula began in the 1970s, when high schools introduced computer-literacy education for some vocational subjects. During the 1990s, computer-related topics were also added to vocational and home-economics subjects at elementary and regular secondary schools (National Curriculum Information Center, n.d.).

5.2.5 Human-Resources Development

As the computer penetration rate in schools improved, the next task was to ensure that teachers possessed basic computer skills. The training provided during this period taught teachers how to use computers. Introductory to advanced-level courses were offered, along with a special program to train computer instructors (Ministry of Education, 1996b).

5.2.6 Assessment of the Development Stage

The chief objective of the development stage (1970–1995) was to build infrastructure. As this project was centered on computer education and was not guided by a comprehensive policy that covered the full spectrum of related areas, adequate support systems were not put in place. Despite this drawback, informatization was gradually perceived as a consequential tool for educational innovation. This shift in perception prompted the government to devise more meaningful policy measures and to create support systems. It also provided momentum for other projects in the areas of content and human-resources development. However, no initiatives were introduced to develop standardization and no educational information services delivered final project results to teachers, students, or parents.

5.3 Takeoff Stage

During the Takeoff Stage (1996–2000), the infrastructure was finally completed, allowing schools to adopt ICT.

5.3.1 Policy

Efforts to incorporate ICT into education during the Takeoff Stage were guided by the global vision of the *1st Master Plan for Adopting ICT in Education.* They were thus aligned with the overarching goals of the Framework Act for Informatization Promotion enacted in 1995. This plan included 5-year goals for government authorities and municipal and provincial school districts by project domain, along with detailed missions. It also modified the expanding project implementation structure. The Korea Education and Research Information Service (KERIS), a new organization created by the Ministry of Education, was assigned a central role and added to the list of national-level project participants. Toward the end of the Takeoff Stage, the then Korean president, in his 2000 New Year address, presented a new vision of Korea as the world's most computer-proficient nation. His support gave Korea's educational informatization process the momentum it needed to leap forward, both in terms of physical and human infrastructure and regulatory and institutional readiness (KERIS, 2001; Ministry of Education, 1996a).

5.3.2 Infrastructure

The school-computer-distribution project achieved a high computer-penetration rate, as schools were supplied with standard PC units for educational use. The infrastructure for integrating ICT into education was further expanded, as regular schools nationwide received computer labs and vocational high schools were provided with multimedia labs. Modern classroom equipment was supplied to all classrooms, achieving the goal of one PC per teacher. All school-computer networks were connected to the Internet. Through a collaboration between KT and the Ministry of Information and Communication, the government offered drastically discounted rates for school Internet access. By the end of the Takeoff Stage, Korean schools were the first in the world to be fully equipped with a full ICT infrastructure (KERIS, 2001).

5.3.3 Educational Content

During the Takeoff Stage, the initiative focused more on developing and supplying software to schools. The Ministry of Education, municipal and provincial school districts, and KERIS carried out various development projects. To encourage schools to adopt quality educational content developed in the private sector, the government contributed to school software budgets and conducted programs to promote the adoption of private-sector software, such as the Quality Certification Program for Educational Software and the Software Expo (KERIS, 2001).

5.3.4 Curricula and Methods

The new informatization infrastructure enabled pilot schools to begin testing ICT-supported instruction. Teachers in pilot schools and experts in related fields worked together to develop effective technology-assisted instructional methods, adopted within actual learning environments. In 2000, the Operating Guidelines for ICT Education in Elementary and Secondary Schools were published, providing national directives on the use of ICT in education. This accelerated the process of infusing technology into standard school curricula (KERIS & the Ministry of Education and Human Resources Development, 2000; Yoo et al., 2006).

5.3.5 Human Resources Development

ICT-enhanced education training programs for teachers grew in scope and intensity, with 25% of all teachers in accredited schools within the national educational system receiving annual training (Ministry of Education and Human Resources Development, 2003). As course offerings expanded, more technology instructors were trained to cope with the increased demand. Distance learning was introduced, enabling teachers to take courses online. In 2000, a national plan was introduced to operate distance-training centers; the Ministry of Education supplied licensing criteria for these institutions (Ministry of Education and Human Resources Development, 2002).

5.3.6 Educational Information Services

The educational content developed under the informatization initiative was eventually of high-enough quality and sufficient quantity to deliver to end-users. It was then necessary to construct an educational information service to disseminate these materials to schools. EDUNET (https://www.edunet.net), created through a collaboration between the Ministry of Education and Human Resources Development and the Educational Informatization Agency (the Multimedia Education Support Center), enabled the nationwide sharing of learning-related materials and information among educators and students. Educational administrators also benefited from informatization when the School Information Management System was adopted nationwide (Kim & Santiago, 2005; Ministry of Education, 1999).

5.3.7 Assessment of the Takeoff Stage

ICT-enhanced education advanced rapidly during the Takeoff Stage, due to strong government support and commitment. Effective collaboration between the government, municipal and provincial school districts, and schools made it possibly to install a complete physical infrastructure during this period. Although physical infrastructure was the primary focus of the Takeoff Stage, progress was also made in other areas; crucial first steps were taken in most domains, apart from standardization. The single most important achievement was the launch of EDUNET, which allowed schools access both content-project output and resources in different institutions, from the Ministry of Education to related government agencies and municipal and provincial school districts.

5.4 Expansion Stage

During the expansion stage (2001–2005), there was balanced progress in all project domains, including standardization. Individual projects in each domain were implemented with good coordination and links were established between domains. Dramatic quantitative and qualitative improvements were made.

5.4.1 Policy

A national master plan, the *2nd Master Plan for Adopting ICT in Education*, provided a global vision and key missions. Under this plan, the scope of the integration of ICT into education became more comprehensive, covering preschool, higher, and lifelong education, in addition to elementary and secondary education, the original target. In elementary and secondary education, a separate ICT-based *Educational Innovation Plan* offered concrete implementation guidelines. The government also outlined projects to upgrade existing infrastructures, develop additional content, expand human-resources development and prepare to migrate the educational information service system into an e-learning system. The central and regional educational authorities and schools used these outlines to draw up their own detailed execution plans (KERIS, 2001; Ministry of Education and Human Resources Development, 2001).

5.4.2 Infrastructure

At this point, obsolete elements of the existing ICT infrastructure were replaced, repaired, or upgraded, while security features were added to systems. The computer penetration rate, based on units in computer labs, classrooms, and small study-group rooms, rose to 1 unit per 5 students. School network environments were updated to provide a connection speed of 2Mbps or faster. School districts installed information-equipment monitoring systems to monitor the functionality of units and identify those in need of repair; they also explored ways of recycling and reusing obsolete equipment. Development began on a comprehensive information-security system to block hacking attempts and virus attacks. To bridge the digital divide and achieve a more equitable distribution of information-revolution benefits, the government provided additional support to children from low-income families. It also took steps toward building a next-generation education infrastructure by researching wireless Internet technology and introducing related pilot programs (KERIS, 2005).

5.4.3 Educational Content

Efforts increased to supply enough educational material to schools to accelerate the adoption of ICT in classroom instruction. The objective of the expansion stage was to provide enough content in all curricular subjects to fully meet demand. The Ministry of Education and KERIS formed the Joint Project Committee for ICT in Education and collaborated with 16 municipal and provincial school districts to develop content, including multimedia educational materials, instructional and study designs for ICT-supported learning, and classroom software. Tasks were divided among participating bodies and coordinated to prevent duplication of effort. While the initial focus on developing instructional classroom content during the initial expansion period, self-directed learning content became more important during the latter expansion period, as a result of introduction of e-learning. The new self-directed learning content could be adopted within any kind of study, including supplementary and advanced study, and to all student levels (KERIS, 2005).

5.4.4 Standardization

Standardization was one of the project domains in which impressive progress was made during the expansion stage. Educational information standards developed around this time made it dramatically easier to share and distribute content, and also improved reusability. The Korea Educational Metadata (KEM), issued with guidelines and instructions for use in both the development and distribution stages, provided a fast and convenient way of delivering educational content to schools via the nationwide resource sharing system (KERIS, 2005). Educational metadata is data that describes an electronic educational resource; it can be used to manage collections of documents, images, and other information (McClelland, 2003).

5.4.5 Curricula and Methods

During the expansion stage, in which efforts to integrate ICT into education began to produce tangible results in all project areas, a stronger emphasis was placed on methodological innovations in teaching and learning. Initiatives were launched to more closely integrate ICT into the school curricula to realize positive changes in teaching and learning. ICT-supported instructional and learning models were developed and distributed through teacher training programs. Student education in ICT skills was redesigned in accordance with the 2000 Operating Guidelines for ICT Education in Elementary and Secondary Schools and became more systemic. These efforts led to a sharp surge in the ICT adoption rate and countless other positive effects (KERIS & the Ministry of Education and Human Resources Development, 2000).

5.4.6 Human Resources Development

No meaningful improvement in schools' adoption of ICT-supported education unless teachers have an adequate level of information proficiency. The expansion of ICT skills training benefitted 33% of all teachers in the national educational system each year. Distance training was expanded to allow teachers to take relevant courses online. The government established ICT Skills Standards for Teachers (ISST) and a certification system for teacher ICT proficiency. Programs, such as the National ICT-supported Education Conference, were set up to encourage research in ICT-supported education (KERIS, 2005).

5.4.7 Educational Information Services

During the expansion stage, further improvements were made in both academic and administrative information services in the education field. EDUNET, Korea's most important national educational information service, upgraded its search functions, enabling users to search educational materials on all linked networks and databases (KERIS, 2005; Kim & Santiago, 2005). Cyber Home Learning, an e-learning system introduced to prepare for building an e-learning support system in elementary and secondary schools, provided a new learning model, in which schools, society, and homes form one sphere of education (Kang, Kim, Yoon, & Chung, 2017). Meanwhile, school information-management systems became part of the National Educational Information System (NEIS, https://www.neis.go.kr), a centralized school administrative-information system, covering information related to academic administration.

5.4.8 Assessment of the Expansion Stage

Projects grew during the expansion stage, becoming larger, more closely coordinated, and linked. Greater synergy and the continuous introduction of new services helped to distribute the benefits of educational informatization nationwide. Progress was achieved evenly in all project domains, including policy, infrastructure, content, standardization, curricula and methods, human-resources development, and educational information services. With ICT-enhanced education, related laws, policies, and the new implementation structure as basic input factors, work was carried out in all project domains, while maintaining the organic unity among them. Project outputs were offered to schools and homes, and then re-channeled into a user-centered environment.

5.5 Establishment Stage

The establishment stage took place between 2006 and 2010, when the quality of education informatization was upgraded by advancing expansion-stage projects. Customized content and services for users increased; quality-management systems for e-learning and ICT teaching/learning methods were reinforced. Systems were designed to block the adverse effects of education informatization and the national educational information service improved. During the establishment stage, expanded government-led projects were transferred to private and related organizations and school sectors in cities and provinces, enabling them to adopt ICT in education.

5.5.1 Policy

The 3rd Master Plan for Adopting ICT in Education, established in 2006, provided a nationwide master plan for achieving Korea's vision of education informatization and its major projects. Detailed initiatives aimed to create a ubiquitous learning society and a national cultivation of talent. By developing a ubiquitous infrastructure for its learning environment and reinforcing people's knowledge and learning capability, Korea leapt forward as a global leader of education informatization, bridging gaps in knowledge information and reinforcing stability, while implementing key projects. This proposal laid the cornerstone for expanding elementary and secondary education informatization into lifelong education and higher education. Legal protections for privacy and copyright have been regularly supplemented and refined in the field of education informatization. To achieve this, the central government transferred projects to local departments and to urban and provincial communities. These projects thus became more voluntary and rooted efficiently in the field of education (Ministry of Education and Human Resources Development, 2006).

5.5.2 Infrastructure

In the establishment stage, informatization devices developed during the expansion stage to manage the business and communication networks have been regularly updated; old equipment has been replaced, new IT devices distributed, and Internet connection speeds increased. Socially marginalized groups, including children from low income families, people with disabilities, foreign workers, and the children of North Korea defectors and multicultural families have received extra support; the group beneficiaries have also increased. Above all, the information-protection system has been reinforced. To achieve this, the government has developed policies for coping with cyber-attacks; GPKI (government public-key-infrastructure) certificates have been given to all organizations. A comprehensive support system for dealing with educational-institution intrusions, an educational cyber-security center, and the EPKI (Education Public Key Infrastructure) for educational (administration) organizations have been operated (KERIS, 2010).

5.5.3 Educational Content

During the establishment stage, new projects were implemented to further develop and expand e-learning content, bringing innovation to lectures and self-regulated study. Digital textbooks were commercialized, in preparation for ubiquitous education. The Cyber Home Learning system expanded its self-study textbook for learners and developed academic content for customized learning, offering entire subjects at various academic levels. Entire subjects were expanded and developed, providing enhanced content for lectures. The biggest change in the field of educational content, during the establishment stage, was the development and use of digital textbooks. These textbooks support both instructors and learners. As they incorporate multimedia education resources, support bi-directional communication with instructors, allow users to search for resources in real time, and manage the learning process, they are seen as a key medium for establishing ubiquitous learning environments. In Korea, research schools have been tasked with carrying out research into ways of making digital textbooks easier to use and more effective. Analyzing the effectiveness of digital textbooks in particular fields could make them easier to access by clarifying their value and importance (KERIS, 2010).

5.5.4 Standardization

The most astonishing achievements involved the standardization of educational information. During the establishment stage, the national capacity for e-learning quality management was concentrated. The e-learning quality management system was established at the national level, and the human resources for this were fostered. Korea's e-Learning quality certification service was recognized as an international standard in 2007 and acquired ISO 9001 certification. E-learning metadata and content packaging technologies were registered as international standards. Standardization procedures were upgraded to meet international e-learning standards that surpassed national standards; this, in turn, reinforced international cooperation. In all of these ways, the nationwide quality-management system enhanced the quality of ICT-enhanced education in Korea (KERIS, 2010).

5.5.5 Curricula and Methods

The development of ICT education undertaken during the expansion period continued into the establishment period, as Korea strove to integrate ICT into all subjects. Research and regular exhibitions on education informatization spurred innovation in teaching/learning methods, introducing informatization to new fields to extend the availability of ICT. Researchers investigated the key characteristics and educational performance required by new-millennium learners in a u-learning society to design effective learning methods for a ubiquitous era (Kang et al., 2008; 2010). Establishment-stage projects were carried out by focusing on their qualitative improvement in continuation of the projects in the expansion stage. These efforts made it possible to establish informatization successfully in elementary and secondary schools (KERIS, 2010).

5.5.6 Human-Resource Development

Human resources during the establishment stage are characterized by high-quality teacher training, based on knowledge cultivated using reinforced e-learning and advancement strategies systematically provided and managed at a national level. In addition, school managers who received leadership training in informatization made it possible for schools to carry out support and supervision activities through human-resources development. In other words, human-resources development led by the nation was delegated to the field; significant efforts were made to integrate informatization into educational practice. One representative change during this period was the fact that teacher training could be customized to reflect the development and evaluation of individual teachers' abilities using evaluation indices (KERIS, 2010).

5.5.7 Educational Information Service

During the establishment stage, EDUNET, the Cyber Home Learning system, and the Educational Information Sharing system were used in the field of educational administration and information systems, as well as supporting areas of teaching/learning. A local educational administration and finance system (EduFine) was developed to support educational finance. The educational information service grew exponentially, following the establishment and development of a service for solving civil complaints related to education (the Home-Edu service, which issues automated civil complaints related to teaching staff), as well as other services, including a comprehensive support system for creative activities, a teacher-information service, and a school-information notification system. In particular, stand-alone services providing educational administration and financial support were linked to existing educational administration-information systems to enhance user convenience (KERIS, 2010).

There have also been outstanding qualitative improvements to educational information services. The representative teaching/learning supporting services, EDUNET and Cyber Home Learning, used Web 2.0 paradigms to launch, cooperate in using, and share a consumer-based service infrastructure (Kang et al., 2017). Various convenient functions and learning management methods were developed and provided to users. New administrative and financial services and other information-management services were developed to connect government information systems, after programs were modified to accommodate users; efficient operations and services were expanded nationwide. Where the previous educational information service was used only by instructors and students, this system was designed to accessed by parents and other groups. In addition, it is also considered as a realization of the education informatization policy which is to cultivate talents by reinforcing the people's ICT skills (KERIS, 2010).

5.5.8 Assessment of Establishment Stage

As shown above, the activities carried out during the establishment of education informatization in Korea have carried over into the expansion stage, where the focus is more on the qualitative growth of education informatization than on quantitative growth. The flow of education informatization was significantly changed, focusing on the internal characteristics, rather than the quantitative growth, of education informatization. In other words, establishment-stage initiatives focused on building a foundation for deeply imbedding the informatization infrastructure within education and daily life, while internalizing operations. The establishment stage qualitatively improved all areas of ICT education, ranging from policies, infrastructure, educational content, standardization, curricula, and methods, to human resources development and educational information services. Education informatization has been carried out in close connection with comprehensive development plans in each area. The expanded educational information service can be used, not only by schools and homes, but by the entire nation.

5.6 Transformation Stage

The transformation stage lasted from 2011 to 2015, resulting in the blueprint for smart education. The Korean government has used the term, "smart education" since 2011 to refer to a learner-centered form of education that incorporates up-to-date technologies, such as smart devices. SMART is an acronym for Self-directed, Motivated, Adaptive, Resource-enriched, Technology-embedded education. Through these functions, smart education aims to realize a next-generation educational paradigm that supports self-directed learning and exploits technology based on abundant, adaptive resources within a ubiquitous environment (Jang, 2014; The Strategy Council for National Informatization Policies & the Ministry of Education and Science Technology, 2011; Zhu, Yu, & Riezebos, 2016). The present-day educational context in Korea can be seen as an extension of the transformation stage.

During this stage, the law was amended to enable online elementary- and secondary-school classes, based on the Smart Education Promotion Strategy. The mobile and cloud-environment infrastructure were improved to support the ubiquitous environment. The Korean government achieved a range of different goals: developing smart content based on digital textbooks; establishing national standards and ensuring conformance with international standards; training specialists to disseminate smart education; developing and applying smart-education models; and improving and expanding access to the national service (The Strategy Council for National Informatization Policies & the Ministry of Education and Science Technology, 2011).

5.6.1 Policy

During the transformation stage (2011–2015), the Education Science and Technology Information Development Plan, also known as the 4th Master Plan for Adopting ICT in Education fostered creative students, established an educational culture based on ICT, and promoted competency in research and development in order to establish a science and technology-information infrastructure. The 5th Master Plan for Adopting ICT in Education has been in effect since 2014; its policies create educational environments that foster creative students by integrating education and ICT; the current system nurtures student dreams and talents (Ministry of Education, 2014; Ministry of Education and Science Technology, 2010).

During the transformation stage, the policy that had the greatest impact on education informatization was the 2011 Strategy for Promoting Smart Education, which developed student creativity through ICT, within the expanding ubiquitous learning environment. The policy mainly concerns the development and use of digital textbooks and online classes and the establishment of an online evaluation system. It has created an environment that promotes the public use of educational content, strengthening ICT ethics education to minimize side effects, empowering teachers to practice smart education, and establishing the foundations of a cloud-based educational service. It has become a milestone in the informatization strategy underpinning elementary and secondary education in the transformation stage (The Strategy Council for National Informatization Policies & the Ministry of Education and Science Technology, 2011). In addition, to facilitate e-learning, the e-Learning Industry Development Act was amended to create the Law for the Development and Activation of E-learning. The master plan for promoting converging ICT also promotes a policy to strengthen software education in schools. Laws have also been amended to cope with the rapidly changing smart education environment; the Enforcement Ordinance of the Laws for Elementary and Secondary School Education, has, for example, been amended to provide evidence to support the operation of online classrooms (KERIS, 2015).

5.6.2 Infrastructure

The Strategy for Promoting Smart Education strengthened the educational information infrastructure during the transformation stage. Smart devices were supplied to each school; the new Information Strategy Plan to build the Foundations for a Cloud Educational Service created a ubiquitous cloud-based computing environment that stored learning materials and learner-generated records in personal Internet space, to be used and shared when needed. A smart education platform was established on a trial basis to help schools access digital textbooks and to provide user-diversity services. As security became more important, after the establishment stage, the security management system was strengthened; NIES was chosen to provide the main information communication infrastructure, under the jurisdiction of the Ministry of Education. The NEIS main operations center acquired ISMS (Information Security Management System) certification (KERIS, 2015).

5.6.3 Educational Content

During the transformation stage, it was necessary to distribute high-quality educational content suitable for the amended curriculum in a timely manner; textbook status was granted to digital textbooks, establishing their basis for use. The 2011 Strategy for Promoting Smart Education was used to accelerate the development of digital textbooks for the amended curriculum. The digital textbooks incorporated a wide range of learning materials, enabling students to learn everything they needed to know from these textbooks alone. A digital textbook platform was also developed, to be widely used in various environments (KERIS, 2015; The Strategy Council for National Informatization Policies & the Ministry of Education and Science Technology, 2011). Recently, digital textbooks based on the amended national curriculum have included immersive content, which provides a comprehensive and realistic experience, such as Augmented Reality (AR) or Virtual Reality (VR) (Dede, 2009; Kim et al., n.d.). Figure 5.1 presents an example of the AR and VR content used in digital textbooks. The number of schools using digital textbooks increased rapidly from 163 in 2014 to 5013 in 2016 (KERIS, 2017).

As smart devices were widely disseminated, mobile interactive content suitable for "Cyber Learning" (previously Cyber Home Learning, https://cls.edunet.net) was developed on a trial basis (KERIS, 2015).

5.6.4 Standardization

During the transformation stage, standardization was promoted in two main ways: the first reflected international standardization trends, while the second established

Fig. 5.1 AR and VR content in Digital Textbooks (Kim et al., n.d.)

standards to promote smart education. First, the Korea Educational Metadata (KEM), which was established as a national standard in 2003, was reorganized into a horizontal metadata system based on Dublin Core metadata, to reflect international standardization trends (KERIS, 2015). EPUB 3.0, the national standard for producing and distributing electronic publications, was enacted in parallel with the promotion of smart education and the Standardization of Learning Analytics, a reference model for defining educational data as standardized data. The collection, analysis, processing, and visualization of data was also promoted (Jeong, 2016; KERIS, 2015). Following the establishment stage, efforts to conform to international standards continued, resulting in the development of a strategy map for ICT standardization (Telecommunication Technology Association, 2015).

5.6.5 Curricula and Methods

In recent years, educational ICT has been criticized for being associated with unified curricula and methods. The need for selective and customized education has become a hot topic during the transformation stage. ICT use is becoming diversified within the main strategy of promoting smart education. The teaching/learning model can be used in a range of different classes, from general classes, to specialized classes, integrated lectures, creative-experience classes, optional classes, intensive courses, attendance-approval classes, and advanced/supplemental after-school classes (The Strategy Council for National Informatization Policies & the Ministry of Education and Science Technology, 2011). Smart-education and digital-textbook research schools are helping to integrate ICT into various fields. In addition, software has become a future growth engine, strengthening software education. The aim of software education is to help students develop creative thinking, so that they can solve problems by learning how computers work (Leem, 2018). The Korean curriculum aims to develop students' information literacy, computational thinking, and cooperative problem-solving capability (Kim & Kim, 2018). Korea has also strengthened ICT ethics education to prevent the misuse of informatization based on the development of IT technology (Ministry of Education, 2015).

5.6.6 Human Resources Development

In the domain of human resources, the transformation stage boosted teachers' ability to adapt to education informatization. It helped teachers adjust to changes in the educational environment, including the dissemination of smart devices and the characteristics and skills of 21st-century learners. To restructure teacher capacity, it was necessary to develop online teacher- training programs on the use of smart-education-based digital textbooks. As software education has improved, software-education teachers have been trained to deliver it; ICT ethics training has also been strengthened, becoming an essential aspect of the field. The new Teacher Training Information Service enables teachers to find the training information they need at any time. This distance training is accessed by more than 1 million teachers every year (KERIS, 2015).

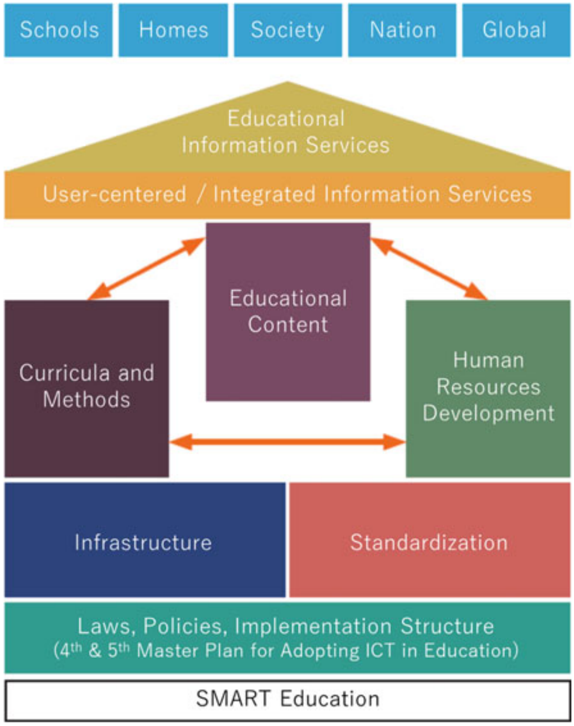
5.6.7 The Educational Information Service

During the transformation stage, the Educational Information Service introduced upgraded services and made them transparently available to the public. Users can access educational information and services whenever they want. A new EDUNET service, based on curriculum use, reinforces the link with digital textbooks, in accordance with the Strategy for Promoting Smart Education. An educational open-market service, created by extending the agreement on donating content with various public institutions and companies, enables various resources to be freely used for educational purposes. Cyber Home Learning has changed its name to Cyber Learning; its philosophy is that the main service domain should be extended beyond “home” to various spaces. It provides a range of supplementary learning content that can be linked to the classroom and used in mobile environments (Kang et al., 2017). Starting with the launch of the next-generation NEIS in 2011, services that support educational administration and finance have aimed to enhance user convenience, linking government information systems and expanding public services. It is particularly noteworthy that a service designed to enhance web accessibility for people with disabilities has begun to narrow the digital divide between privileged and less privileged groups, in accordance with the 5th Master Plan for Adopting ICT in Education. The launch of the Local Educational Finance Disclosure Portal System has enabled members of the public to access information on the use of educational finances. There are continuing efforts to make financial information transparent and to enhance user convenience; one such is the reorganization of the NEIS nationwide service (KERIS, 2015).

5.6.8 Assessment of the Transformation Stage

As detailed above, the Transformation Stage of education informatization in Korea, based on the Strategy for Promoting Smart Education, created infrastructure, developed content, established standardization strategies and teaching/learning methods, trained specialists to work in smart education, and promoted projects to alleviate public concerns about the educational service and user convenience. Smart education does not just mean the use of smart devices in education; it is also a philosophical concept that covers the improvement of students’ self-directed learning abilities, the development of strategies that enhance learning motivation, the use of various

Fig. 5.2 The transformation stage of ICT-enhanced education



learning resources and the development of adaptive learning environments, and the dissemination of technology. It can therefore be said that the educational paradigm shifts, during the Transformation Stage, a provider-centered model to a consumer-centered one. Figure 5.2 proposes a model for implementing Transformation-stage education informatization in all domains, including policies, infrastructure, educational content standardization, curricula and methods, human resources development, and educational information services. These domains can be promoted synthetically using a macro plan, the Strategy for Promoting Smart Education. Compared with the Establishment-stage model, standardization (mainly of content and infrastructure) is extended to include various fields, such as the use of educational information. In this way, the general model of education informatization spreads internationally.

5.7 A Model for ICT-Enhanced Education in Korea

In Korea, education, especially ICT-enhanced education, has been a driving force behind the growth of the national economy for the past several decades (Sánchez, Salinas, & Harris, 2011). During the past 40 years, educational informatization in

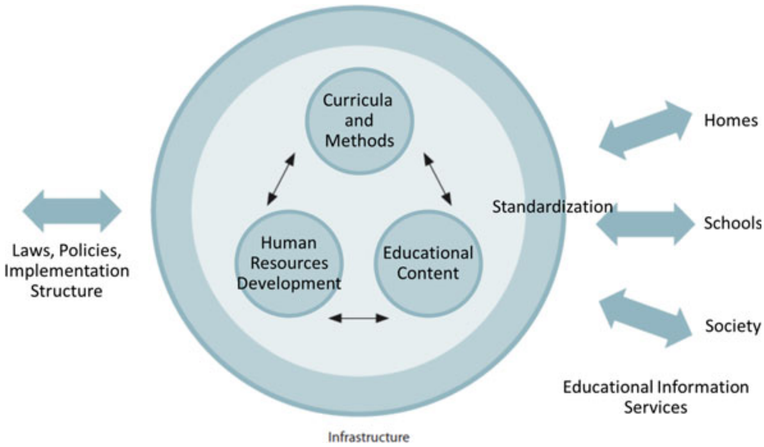


Fig. 5.3 Project initiative model

Korea has progressed through five stages: Development, Takeoff, Expansion, Establishment, and Transformation. This process has resulted in educational improvements and innovations well beyond the development of infrastructure and human resources, or improvements in methods of teaching and learning. Based on Korea's experience in adopting ICT in education, we recommend the project-initiative model shown in Fig. 5.3.

Ideally, efforts to incorporate ICT into education must maintain the unity, integration, and balanced growth of all seven domains, as shown in Fig. 5.3. All sub-projects must be closely interconnected both within a domain and between domains.

A well-organized steering structure is vital for the success of such a project. Once the needed legal frameworks and policy supports are in place, an implementation structure must be created, dividing roles and responsibilities between the national government, local authorities, and schools. Adequate policies and support programs are indispensable enablers, providing the legitimacy, financial means, and administrative assistance needed to launch activities that further the project goals. In Korea, a new Master Plan for Adopting ICT in Education is announced every five years. As of 2018, the 5th Master Plan for Adopting ICT in Education has ceased and the 6th Master Plan is being prepared (KERIS, 2018; Ministry of Education, 2014). This new master plan includes the extensive promotion of educational informatization, alongside educational content, curricula and methods, and human-resources development.

Project output should reach end-users directly. Importantly, necessary measures should be put in place to ensure that output is not used merely in school learning activities, but also at home, and in society at large, and throughout the nation, to create an extended learning environment. Korea has steadily refined its educational information services, which include EDUNET, Cyber Learning, NEIS, and EduFine to ensure that schools, homes, and society can share this educational resource. The new paradigm emphasizes openness, participation, sharing, and cooperation.

Project initiators must accurately assess the state of education informatization in their respective countries and in each smaller domain and sub-domain. Such an assessment is vital to ensure that the benefits of ICT touch all aspects of education. Balanced progress must be achieved in all project domains, with any domains that lag behind raised to the level of the others. To achieve this goal, we recommend using the Korean experience as a reference. The educational level of any country could be measured using the Korean model, which consists of five stages and seven domains; this structure can also help to plan key tasks. We hope that sharing the experience and knowledge of educational informatization in Korea through will provide valuable implications for successful educational informatization worldwide.

Acknowledgements This paper is based on the outcome of the following project, "Knowledge Package 2016: A Korean Model for Using ICT in Education," sponsored by KERIS (Korean Education Research and Information Service).

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Chapter 6
Information and Communication Technologies in Russian Education: Background and Outlook

Diana O. Koroleva

Abstract This chapter takes historical and forward-looking perspectives on the implementation of information and communication technologies (ICT) across the Russian educational landscape. We first discuss how Russian public policy with respect to ICT-supported education has been transforming over time, while briefly addressing the principal phases of this ongoing digital move as reflected in evolving ICT perceptions and development priorities, deployment approaches, as well as key outcomes, challenges and further action plans. Next, we explore how the present-day digital agenda for future-proof education is being conceptualized and implemented in practice by taking insights into the following individual areas: 1. ICT Infrastructure; 2. ICT Learning Resources; 3. ICT in Instructional Practice; 4. Student ICT Competence; 5. Teacher ICT Competence and Upskilling. The final sections give a round-up of findings with respect to the current status and outlook for ICT development in Russian education. This paper is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics, Moscow, Russia.

Keywords ICT in education · Russian case · The third wave of informatization · Digital economy

6.1 The Russian Education System: Brief Overview

The core piece of legislation governing the Russian education system is Federal Law "On Education in the Russian Federation" (2012). According to this law, until May 2018 the executive body in charge of the formulation and implementation of education policies at all levels was the Ministry of Education and Science of the Russian Federation. In 2018 executive the body was split in two: the Ministry of

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_6

Education, responsible for primary and secondary education, and the Ministry for Science and Higher Education.

The Russian system of general education consists of preschool, elementary and secondary stages. It normally takes 11 years to obtain a certificate of complete secondary general education. Vocational education and training in Russia is available at both the secondary (basic vocational training) and post-secondary (specialist college degree) levels. Those seeking to pursue tertiary (higher) education can receive training in Bachelor's and Master's university tracks. According to the Russian Federal State Statistics Service, in the 2015/16 academic year the Russian education system enrolled a total of 14.8 million schoolers and another 4.7 million university students.

In recent years, Russian education policy has primarily emphasized the following as its systems imperatives: enhancing diversity and accessibility in preschooling; improving the quality of educational outcomes at different levels; advancing opportunities for continuing learning and development; and reinforcing the nation's uniform and high-standard educational space.

- Workforce for Advanced-Technology Occupations.
- Universities as Linchpins of Sustainable Innovation Ecosystems.
- Modern Digital Learning Environment in Russia.
- Modern Educational Environment in Schools.
- Accessible Children's Extracurriculars.
- Fostering Russia's Potential for EdTech Exports.

All of the above-listed projects imply, to a greater or lesser extent, further developing and harnessing information and communication technologies (ICT) in education as an important component of their respective agendas. Below we provide a detailed discussion of how ICT-related objectives of Russian educational policy have been transforming over time amidst the changing role and scope of ICT in the economy and society.

6.2 ICT Implementation in Russia: Historical Outline

Since the mid-1980s, Russia has seen a vast number of policy initiatives aimed at fostering various aspects of ICT integration into national learning environments. The first wave of education informatization went underway in 1980s, when Decree No. 13-XI "On the Reform of General and Vocational Education" was passed in April 1984. As a result of this policy step, Russian schools and universities were equipped with the essential computer infrastructure enabling access to basic ICT. In terms of the curriculum, a new course, "Computer Science," was introduced in secondary schools, and some STEM (Science, Technology, Engineering and Mathematics) teachers received special training in IT and computer operation to be able to give appropriate instruction in this new subject. Also, some training in computer basics was organized for teachers in other subject areas as well as for school administrators. At the same time, a number of disincentives and downside factors of various scale and socioeconomic nature dampened this reformative momentum. For one, there was a huge gap between urban and rural schools in Russia; for another, educators themselves would often counter the reform and the ICT transitioning processes it had prompted amidst then meagre awareness of the new role that ICT was soon to obtain as a major competitive driver in technology and human capital. The fall of the Soviet Union embroiled Russia into a situation of persisting socioeconomic disarray where education-related objectives long remained outside the state executives' top-priority agendas. It was not until the late 1990s that education informatization came back to broad public and government attention.

The second wave of education informatization, which spanned a period from the late 1990s and through 2010, was marked by a surge in the number of initiatives to facilitate ICT-supported learning at both federal and various regional levels. These were complemented by a series of non-government endeavours run by international foundations and other organizations, such as World Bank, Intel and Microsoft, among others. For educators, training & development programs were deployed that sought to advance ICT literacy within a broader multidisciplinary cohort of instructors, unlike in the first wave of informatization when only limited teacher corps received such IT-focused professional upskilling. The above-mentioned measures to boost ICT integration into the educational perimeter have yielded noticeable enhancements in the overall ICT infrastructure. Thus, schools have been procured with more comprehensive background hardware, including computers and related IT systems, laptops, e-boards and other multimedia, which has facilitated the creation of mobile classrooms, hybrid libraries and media centers with access to various electronic learning resources, etc. In higher education, a number of massive state-run programs have also been implemented to spur sector digitization and ICT-assisted networking for more effective administrative and academic operation. Taking stock of the said period, as noted in the OECD's "Measuring Innovation in Education" report, Russia has achieved a major progress in transitioning to a digitally supported educational model thanks to the improved availability of computer and internet infrastructure across the country's institutional landscapes (OECD, 2014).

Today, implementing ICT in education remains among the chief imperatives of Russian educational policy. While it is barely possible to identify any predominant focus area or key development program in the field, a host of initiatives aimed at modernizing education through further integrating the use of ICT are currently underway at both the county-wide and local levels.

6.3 Current ICT Policy Framework in Education

It is the Federal State Educational Standard [Federalny Gosudarstvenny Obrazovatelny Standart, FGOS], which is adopted in Russia for each individual level of education, that provides a fundamental framework regulating such facets of schooling as the curriculum requirements, the most appropriate instructional models to be used, as well as the learning outcomes expected at each stage of the educational ladder. Insofar as ICT is concerned, FGOS emphasizes the need to develop the entire range of student ICT competencies as an important part in delivering on such broader aims of EdTech innovation, as spurring student motivation, including to build a sustained capacity for self-propelled learning, to facilitate syllabus progression and knowledge acquisition, and hence to improve the overall quality of education.

According to FGOS, metasubject learning results in elementary school (1st–4th-graders aged 7–10 years) include active use of speech and ICT means for solving communicative and cognitive problems. In lower-secondary schooling (grades 5–9, teens of 11–15 years), FGOS sets out the formation and development of comprehensive basic ICT competency as the expected metasubject outcome. For upper-secondary education (high school grades 10–11, 16–17 year-olds), FGOS envisages the ability to use ICT tools in solving cognitive, communicative and organizational tasks as the key competency to be acquired. According to the educational standard, a high schooler is also expected to become well-versed in a fairly broad range of specific Computer Science areas, including the basics of network architecture and operation, the essentials of information ethics and law, cybersecurity and safe ICT practices, etc.

In higher education, there is no uniform FGOS, as separate standards exist for individual groups of majors. Nevertheless, each such standard has a provision regarding the ICT knowledge and skills students enrolled in a given higher education track are expected to possess. On aggregate, the following is outlined as a generic ICT competency profile of a university graduate: using ICT skills in a variety of social, learning and professional contexts, including necessary hardware, software and network means; using database solutions and other ICT in effectively handling various job tasks; broad software, web technology and digital networking literacy, etc.

An important criticism of the Federal State Educational Standard is its framework nature. Since FGOS lacks any clearly articulated principles or mechanisms whereby the stated metasubject competencies and individual learning results should be best attained, it needs to be complemented by more elaborate and definitive legislation pieces by individual level of schooling to become a more effective regulatory means.

As has been stated above, further developing ICT-supported education at all levels has been among the lasting priorities on the Russian government's social policy agenda, and a series of state-propelled initiatives aimed at effectively addressing these education digitization goals have been underway. Of the entire multiplicity of such innovative endeavors, which are being carried out in both federal and regional educational jurisdictions, several ones where the greatest resource is involved and high-impact payoffs are expected are worth a close-up consideration.

In a national and global setting of drastic societal change, where learning & development is becoming an increasingly lifelong imperative, the first such project, "Modern Digital Learning Environment in Russia," aims to create a uniform and high-standard electronic educational space that would reach to the widest and the most diverse cohorts of Russian population. The project scope involves creating the basic development conditions for this mass-accessible e-learning environment by

2018. In a longer run through 2025, the participation of Russian learners at all levels in various online courses is conjectured to reach 11 million people thanks to this national digital learning space initiative.

Another initiative to be noted is the "Moscow e-School" project, which has been a joint endeavor between the Russian Education and Science Ministry and the Government of Moscow. According to its official web page,[1] this e-schooling platform allows teachers to draft electronic lesson plans and scenarios, to create virtual labs and implement other content formats that can be effectively harnessed in classroom as a variety of ICT-assisted teacher–learner interactions involving such modern e-media as smartboards, personal tablets, smartphones, etc. Upon expert verification, the most practical and expedient developments will be identified within the entire pool of uploads, to be subsequently digitized and made available for e-circulation, further improvement, etc. Overall, this project envisages accumulating and sharing a comprehensive electronic lesson plan and learning aid repository as its bedrock idea. Thus, with time, teachers outside Moscow will be able to access such best-practice developments by their Moscow peers, while regional schoolers will take advantage of a multitude of handy digital resources, including core syllabus materials and extra aids, interim and exam tests, etc. Importantly, "Moscow e-School" will serve to promote innovative, result-driven teacher practices and learning formats, such as instructor networking on foremost ICT-supported pedagogical design models, collaborative learning, etc. Alongside its current focus on generating a pool of adequate academic content, the project also entails massive state-funded infrastructural procurement (modern IT systems, portable equipment, smart interaction devices, etc.), which is already fully underway. In a sense, this systemic implementation approach sets the "Moscow e-School" initiative apart from many similar endeavors (i.e., subsequent to 2010). In comparison with that period when objectives of education digitization have typically seen some blurring and little state-level support has normally been provided for infrastructural upgrades "Moscow e-School" has clear goals and tools to achieve them.

Going forward, it is the newly adopted "The program Digital Economy of the Russian Federation" (2017) that is most likely to lay the essential groundwork for shaping much of Russia's policy with respect to further fostering ICT in education. Seeking to nurture an environment for systemic development and deployment of digital innovation across the realms of social and economic living, the program envisages policy updates addressing the following five key areas: education, human capital, research, IT infrastructure, and cybersecurity. Given how ambitious the program's scope and objectives are, as well as judging by its elaborate implementation roadmap, one can reasonably anticipate a massive turnaround in the national ICT-related educational policy to commence in the near future.

[1] https://www.mos.ru/en/news/item/29343073/.

6.4 ICT Infrastructure

Statistical research on ICT accessibility in Russian schools (Zair-Bek, 2016) suggests there was one computer available on average per seven students in 2014, almost a tenfold improvement on what was recorded in 2001. Similarly, according to this report, 95.8% of Russian schools had stable internet connection in 2014, whereas the respective indicator was zero in 2001.

In recent years, many schools have been carrying out local programs to expand and renew their ICT infrastructure, which involve procuring modern desktop PCs, server and network equipment, as well as portable and tablet devices that have received growing popularity among an ever-expanding population band in today's settings of ubiquitous mobile communication and networking. These modernization initiatives are typically financed on a multilateral basis, including schools' own funds, parental donations and corporate sponsorship. Among the projects implemented on a state-subsidized basis, the "Moscow e-School" digital resource repository project can be noted (see above for a detailed description), where individual Moscow secondary schools have been receiving full-scale ICT infrastructure upgrades (see Table 6.1 for supply breakdown by type of fixed assets).

However, stark variances have been observed across Russian regions in terms of the development level of their ICT-supported educational infrastructure. In rural schools, for example, student coverage by computers with internet connection is still lower than in urban schools. Also, there are many regions where a significant proportion of schools have access to obsolete ICT only, because of highly antiquated computer equipment and allied infrastructure.

At the same time, according to the International Computer and Information Literacy Study (ICILS), the availability of school computers is a major positive factor in students' ICT literacy attainment (ICILS, 2013). Thus, ICILS has found that making active use of ICT means and resources in instructional practice adds an average 8.7 points to the student test score (the average score—516). By contrast, such limitations to ICT use as obsolete equipment, scarce technical support, lack of time spent on ICT-assisted study, etc. can lead to an average 8.5-point decrease in the student test score. Notably, Russia has demonstrated the strongest correlation between ICT availability at school and student ICT literacy gains among all of the ICILS participant nations.

When it comes to higher education, the ICT coverage patterns appear to be similar to what has been reported for secondary schools. Thus, according to the Russian

Table 6.1 "Moscow E-School" project: Planned and actual ICT equipment supplies

	Planned	Supplied (August 2017)
Laptops	38,917	4221
Servers	1840	219
Wi-Fi	59,016	5007
Interactive boards	20,331	2336

Federal State Statistics Service, there was one on-campus computer available on average per four university students in 2014. Barring the stock of PCs without permanent internet access, the average ICT coverage ratio in Russian universities is lower—one computer per five students.

While discussing the latest trends in today's ICT-driven educational environments, it is necessary to note the ever-expanding penetration of modern web, mobile and cloud computing technologies. These have become part and parcel of various learning settings, amidst the ongoing growth in the accessibility of smartphones, wearable communication devices, etc. among broader socioeconomic population groups, as the global mobile technology sector has thriven in recent years to offer an increasingly diverse product mix in different market segments. It is therefore no wonder that the youth, who are unfailingly the most active explorers and typically take a keenest interest in cutting-edge technology and equipment, are the major consumers of foremost ICT. Recent empirical scrutiny on the matter (Koroleva, 2016) provides compelling evidence for this argument. According to the study, 93% of Russian middle schoolers own and actively utilize smartphones for a broad array of communicative purposes. Alongside the out-of-school perimeter, which is traditionally the broadest realm where mobile devices are used by adolescents for peer communication and entertainment, the survey participants have also noted the increasingly prominent role of smartphones as mediators and facilitators in regular school life and learning, including classroom activities, group work, home assignments, etc., as well as in extracurricular and self-study practices. From the regulatory standpoint, however, mobile phones have not yet been officially recognized as an ICT educational technology in Russia, and there has yet to be an appropriate legal framework created that would formalize and govern the educational use of smartphones and other similar digital devices. So far though, whether to encourage or, by contrast, to limit or even completely ban the use of such technologies and devices in a learning & development setting is at the entire discretion of an individual educational entity.

6.5 ICT-Based Educational Resources

As the ever-hastening ICT move has sparked a universal transition to data-driven ecosystems, including digital business and world-spanning social networking, global data volumes have surged dramatically in recent years. According to McKinsey, between 2010 and 2015 international electronic data flows grew at a rate nearly 50 times as high as the average pace posted in the previous decade (McKinsey and Company 2017).

This data boom has also been true of the educational sector, which has seen the continuously expanding supply of both free and paid-subscription digital learning resources. Created by multiple educational stakeholders, e.g., teachers themselves, e-learning vendors, etc., such developments include a diversity of websites and mobile applications featuring educational games and other interactivities, multimedia content, hypertext documents, virtual labs, etc. Today, these resources cover almost all subject areas, and they are typically arranged in a way to offer convenient access to individual repositories organized by a given field of knowledge, level of schooling, skill level, etc.

It should be noted, though, that a major portion of such e-offerings are custom developments mostly reflecting individual teaching experiences and conceptions with respect to modern ICT-supported educational design. Importantly, much of this electronic content has never been subject to any expert validation to assess whether such offerings are actually appropriate and measure up to national and global educational requirements. Apart from these concerns about the academic adequacy of the featured content, the e-learning resources in question have also suffered a lack in technical consistency and the overall quality of implementation (e.g., poor sound and graphics, awkward and unintuitive interface, etc.). These factors have altogether pinpointed the need to address this market fragmentation through suitable law & policy.

To that end, a federal standard on educational ICT and electronic learning resources was adopted in Russia in 2011. While seeking to bring in more consistency by stipulating a set of general classification and organization requirements this educational domain should abide by, the standard has nevertheless failed to offer any well-defined, unambiguous framework conducive to a uniform development space of improved ICT resource quality and compatibility. As a result, the Russian market for ICT learning aids keeps evolving unsystematically amidst an overwhelming supply of arbitrary offerings. Accordingly, this environment of no clear-cut guidelines, when educators are left with the task of evaluating and selecting ICT aids by themselves, as best fit for their personal educational contexts, may be treated as a noticeable downside to the quality of national teaching practices and learning outcomes as a whole. Worth mentioning, however, the large-scale projects those appear on the market. Attention may be drawn to a number of examples:

Schools across the country are adopting United Learning Management Systems (LMS) Dnevnik.ru. It is the largest educational school management system project in Russia, connected to more than 6 million customers and 27,000 schools (more than half of all schools of the Russian Federation). It is significant that Dnevnik.ru represents a commercial product and Government had not participated in its elaboration. However, the Government introduced LMS onto the education market. This particular case could be considered as the effective public–private partnership.

Online learning space Znanika providing necessary tools and algorithms for students' assessment and competition. According to statistic Znanika has 1, 5 million users and 145 thousand registered teachers. It supports and caters to each teacher's unique blend of student-driven learning and teacher-led instruction. The application is used for students competitions (olympiads) mostly math and science and evaluation of the quality of education.

Ten applications of artificial intelligence in education becoming more and more popular. Online chatbots in particular, the most common case. The Russian language chatbot was created to improve communication skills and help foreign students learn Russian language. Mendeley is a chatbot to memorize the periodic table and learn the chemical elements. Both services were presented at the National Education Innovation Competition (KIVO)[2]—a joint project between Institute of education HSE and the Rybakov Fund that aims to support grassroots innovations in learning & development.

When discussing the key processes that have in recent years been framing the Russian learning & development landscape, another important ICT milestone should be stressed, i.e., the advent of Massive Open Online Courses (MOOC). In 2015, following the Council for Open Education was established in late 2014 at the initiative of the Russian Education and Science Ministry, eight leading Russian universities[3] set out to create the National Open Education Platform (NOEP). Along with representatives of these universities, officials with Russia's Federal Service for Education and Science Supervision and Education and Science Ministry joined the Council. For purposes of NOEP development and operation, a Project Association was then established in April 2015 by the above participant institutions.

The NOEP project, which aims to implement a comprehensive, internationally competitive Russia-based e-learning platform, pursues a broad and diversified agenda, where the following essential objectives can be singled out:

- Publishing online courses created by members of the Association.
- Monitoring global best practice and facilitating the adoption of international standards in this educational domain.
- Formulating and advancing quality standards for online courses.
- Collaborating with providers of higher educational programs; pursuing broader multi-stakeholder partnerships.

At the moment, the NOEP Project Association has expanded to comprise a total of 17 member universities, with its collaborative MOOC platform already offering more than 250 certified online courses. Notably, this initiative has also had a series of important policy and practice implications at various educational levels. Thus, for instance, introducing individual MOOCs as part of official coursework has received an increasingly wide following at Russia's institutions of vocational education and training (students can redeem their MOOC pass certificate to earn a credit for respective subject). In terms of ensuring quality training and due recognition of educational outcomes, Russia's NOEP venue has a fully-fledged functionality for building effective and representative individual e-learning paths. This includes, among others, secure student authentication; an advanced academic tracking & monitoring system, which renders a comprehensive snapshot of a learner's attempted and completed credits as well as evaluations and test scores received; opportunities for authorized third parties to engage in the learning process by supplying extra resources and aids, overseeing the evaluation process, etc.

[2]National Education Innovation Competition (KIVO) www.kivo.hse.ru.

[3]National Research University Higher School of Economics; National Research Nuclear University; Ural Federal University; Lomonosov Moscow State University; National University of Science and Technology; National Research University Saint Petersburg State University of Information Technologies, Mechanics and Optics; Saint Petersburg University; and St. Petersburg Polytechnic University.

6.6 ICT in Teaching Practice

According to an international study by OECD, Russia ranks among the world's top five economies that recorded the highest pace of innovation in their national systems of secondary schooling between 1999 and 2011 (OECD, 2014). The list of nine areas of innovative education development the study was focused on includes such ICT aspects as the growth in computer penetration and internet access across school environments. It can therefore be inferred from what the OECD ranking suggests that various policies and measures the Russian state authorities have been implementing to support ICT integration into the educational perimeter since the mid-1980s have fully or partially achieved their objectives.

At the same time, it should be stressed that the latest surge in ICT, spurred by the ever-intensifying streams of transdisciplinary innovation, has fueled a digital transition as grand and ubiquitous as never before. Astounding advances in micro-computing as well as mobile and web technologies have prompted a dramatic expansion in data systems and digital communication infrastructure between 2010 and 2015. The rise of digital networking, where ICT have become central to virtually every facet of doing business and social interaction as a whole, has pushed the upcoming ICT agenda in education far beyond maintaining technical competitiveness proper. If learning environments are poised to succeed in accommodating this digital momentum depends increasingly on how well the human capital at stake is prepared to respond to this universal call for going digital, and namely on whether educators will take a more proactive part in forging learning & development practices better aligned with digitally-driven imperatives of broader socio-economic strategies.

To sum up, if the technical infrastructure available at an educational organization is sufficient and up-to-date, and whether the organization's administrators and teaching staff are positively disposed to modern information and communication technologies are the two pivotal forces determining the extent and pace of transitioning to the new paradigm of ICT-supported learning.

Analyzing the Russian educational space in terms of the above factors of infrastructural adequacy and teacher sentiment toward ICT suggests a situation where the processes of ICT integration into instructional frameworks may be described as still largely arbitrary and fragmented. Notably, this inconsistent and irregular nature of ICT integration patterns, which are basically not matched with any cohesive action plan, has been observed both at the cross-regional, regional and individual institutional levels. These observations have also been confirmed by evidence drawn through a series of interviews[4] with public school principals on how they assessed the achievements, perils and shortcomings in transitioning to ICT-supported educational practices, insofar as the said facets of the available technical infrastructure and teacher ICT motivation are concerned.

[4]The sample included 15 principals (10 women and five men; mean age = 47) from the Russian cities of Moscow, Saint Petersburg, Vladivostok, Chelyabinsk, Yekaterinburg, Samara, Kaliningrad, and Voronezh. The interviews were conducted in October 2016.

Infrastructural downsides consist in the fact that the Russian educational system is still substantially underequipped, or lacks industry-standard equipment, to hold up to modern requirements for ICT. These technical resource gaps have not yet been adequately closed at both the national and individual community levels. Thus, as has already been noted, ICT accessibility ratios in rural schools have lagged way behind what is recorded in urban institutions. Furthermore, major variances in ICT availability have been observed between educational organizations operating in the same region:

> "Our school received some equipment as part of the "Education" national project [wound up in 2006], actually quite a while ago by now. We got the biology, history and geography classrooms reequipped – and that's it. As of today, the PCs in our IT classroom are completely antiquated." Principal at a public school in Samara (city with a population of 0.8 million people).

> "We've got interactive boards, document cameras, a new projector and, of course, computers. But as a leader I feel the need for new technologies and opportunities to be exploited in a more effective manner. So, my dream is to acquire an electronic flip chart, which would enable working with 150 students through mobile devices. It is really important for us to have an interactive wall, as we've got 1500 students and we're lacking space since our building just wasn't designed to house so many children." Principal at a public school in Chelyabinsk (city with a population of 1.2 million people).

Similarly, it should be admitted that strong headwinds have this far been confronting the Russian educational system when it comes to the second facet, i.e., the teacher's motivation and willingness to go digital and to better align their strategies with ICT choices and expectations of modern learners. While the Russian Federal State Educational Standards emphasize the active use of digitally assisted teaching techniques as a key component in nurturing adequate ICT literacy and skills with students at various training levels, the existing institutional landscape is often unresponsive or literally resistant to this important imperative. It turns out that achieving a more sizeable and uniform progress in harnessing ICT-supported instructional best practices is hindered by the operational environment of patchy institutional policies & procedures where decision-making on whether to go digital, and to encourage others to do so, virtually remains at arbitrary discretion of individual administrators and teachers themselves:

> "Things have been pretty fine in terms of equipment, but teachers' willingness and choice of information resources are crucial. It's not about the absence, for example, of a device, it is actually not a problem at all. We can apply for a funding award to get it procured, to ask parents for a financial hand after all, but it all just doesn't work unless the teacher is willing to engage. Just as an example, we've got a mobile classroom equipped with laptops, but they're barely ever used at all. At the same time, there are smart boards up in every room, and using them to add vividness and interactivity to daily classroom activity has become an increasingly widespread practice." Principal at a public school in Yekaterinburg (city with a population of 1.5 million people).

It should be noted that the above description only provides a high-level portrayal of the general state of affairs insofar as adopting modern ICT means in Russian education is concerned, with no distinction drawn, for example, between non-specialist vs. specialist IT curriculum (the latter, which includes various tracks in programming and other specific IT areas, is subject to well-defined and comprehensive ICT requirements).

6.7 Student ICT Competence

According to the ICILS international study of 2013, Russia holds the sixth to eighth place by schoolchildren's ICT literacy together with Germany and Slovakia. With an average ICILS score of 516, Russian schoolers performed substantially below their same-age peers from Czech Republic, Australia, Poland, Norway and South Korea, but were superior to students from Croatia, Slovenia, Lithuania, Chile, Thailand and Turkey.

When the Russian sample is analyzed in terms of individual test results, the following can be observed (see Fig. 6.1). Almost every tenth student (9%) failed to achieve the ICT Level One (i.e., basic literacy) score. The proportion of those scoring at the ICT Level One and ICT Level Two was 27 and 41%, respectively. Finally, a little more than a fifth (21%) of all Russian schoolers who took up the test made it into the ICT Level Three band. Notably, girls have scored on average 13 points higher than boys on the ICILS.

The ICILS framework shows that ICT literacy has a strong correlation with the socio-demographic factor, i.e., whether students come from an urban or rural area and how populous their place of residence is. Thus, in locations with a population of under 3000 people (mostly the countryside), about 60% of Russian eighth graders were, at their best, capable of solving basic ICT Level One tasks only (see Fig. 6.2). In major urban areas with a population of one million people and above, a much higher proportion of eighth-grade students have passed the ICT Level Two and ICT Level Three test assignments. At the same time, it should be noted that the share of

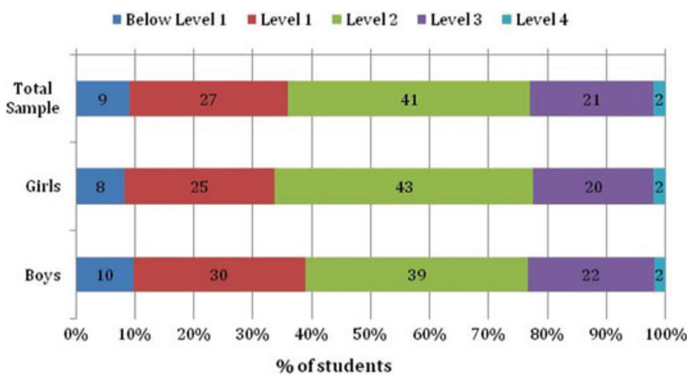

Fig. 6.1 Russian students' scores by ICT literacy level and gender, ICILS 2013

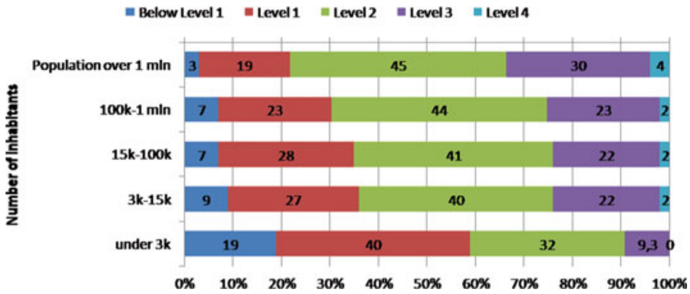

Fig. 6.2 **Russian** students' scores by place of residence, ICILS 2013

those who scored at the ICT Level Four, which is the most complex tasks requiring advanced ICT skills, was universally insignificant for the entire sample.

Another evaluation framework, the Information and Communication Literacy Test, which eighth to tenth graders in various Russian regions took up during 2012–2016, further attests to a situation where stark gaps in ICT literacy between urban and rural schoolers have been observed, with a particularly high share of countryside children who barely have even a basic or elementary level of ICT skills. What is alarming, the study claims, is that no effective remedies have so far been coined in Russia to effectively bridge this gap, so the skill lag between the city and less socioeconomically advantaged rural territories is arguably set to expand further.

It should be noted that there is only limited data available to judge about the ICT literacy of Russian higher education students. Thus, for example, a cohort of young Russian adults between 16 and 24 years of age, who participated in the Program for the International Assessment of Adult Competencies (PIAAC) of [2013], have been reported to earn an average score of 283 on a set of assignments aimed at evaluating the ability to use various ICT for obtaining information and solving practical problems in a technologically saturated environment (Nellemann, Podolskiy, & Levin, 2015). This PIAAC score translates into a Level One information and communication technology competence for adults (for reference, the average OECD score is 295).

Importantly, the same average score (283) was recorded for both a younger cohort of pre-laborers aged 16–19 years as well as a senior group of participants between 20 and 24 years of age. Alongside the fact that the Russian youth are generally inferior to their international peers in terms of ICT competences, this situation may also be suggesting that very little or even no ICT skill addition takes place during the most dynamic and prolific cognitive life stage of young adulthood. Given that educational attainment is generally recognized to progressively taper with age, and considering today's ever-expanding ICT skill requirements in the job market as a reflection of an accelerating transition to digitally assisted non-routine labor, this ICT competence gap may present a considerable challenge to workforce efficiency.

6.8 Teacher ICT Competence and Professional Development

According to the Teaching and Learning International Survey (TALIS), middle-aged people of 30–49 years old made up nearly half (48%) of Russia's total schoolteacher corps in 2013 (Pinskaya et al, 2015). Those falling within the pre-retirement and retirement age group of 50–59 years accounted for another 30%. Finally, about a tenth of all secondary teachers were found to be still in profession while in their sixties.

In the cohort of young teaching professionals, the following important trends can be observed. The proportion of teachers under 30 years of age was reported at 12.3% for Russia, which is close to the survey's all-country average. This indicator remained largely flat over the five-year period since the previous 2009 TALIS survey (11%). Notably, the share of secondary teachers aged under 25 was almost twice as high in Russia as compared to the average value for all the participant nations.

The above statistical outline shows that as far as the workforce age structure is concerned, the Russian educational sector has over the past several years been influenced by the following two counter factors. For one, the average instructor cohort has been getting younger reflecting the growing attractiveness of the teaching profession in Russia. At the same time, this trend toward teacher corps renewal has been moderated by a significant proportion of senior-age staff choosing to continue their service in an economic environment where major gaps between the salary level and the average retirement allowance have not yet been closed.

The 2013 Russian Professional Standard for Teachers has a large number of provisions with respect to the ICT competences and skills that an instructor should possess. According to the Standard, the key competences are as follows:

- General user ICT competence.
- General teaching ICT competence.
- Specialist teaching ICT competence, which is the ICT proficiency in one's individual area or areas of training expertise (based on recommendations of UNESCO ICT Competency Framework for Teachers, 2011).

The Russian education policy in place requires that teachers upgrade their skills and competences on an ongoing basis by enrolling in professional development programs at least once in three years. Modern upskilling tracks for educators involve ICT training as one of the key components on their curriculum, which covers such areas of proficiency as, for example, interactive and multimedia classroom equipment; web technology and mobile devices; e-courseware and digital learning design; etc. Today, teacher development programs offer plenty of educational choice and flexibility in course progression thanks to a diverse mix of delivery formats available in the marketplace, e.g.:

- Courses at specialized learning & development centers.
- Off-job tracks.

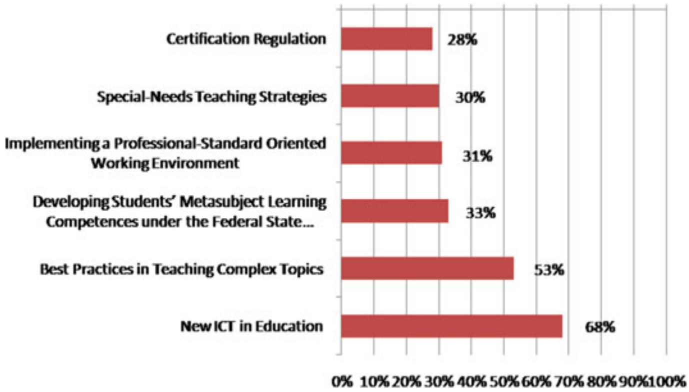

Fig. 6.3 The most sought-after teacher development courses in Russia

- Certificate online courses.
- Hybrid learning offerings.

Statistics published on the "Netologia" educational website[5] suggest there are currently more than a million active schoolteachers in Russia, of whom about 350 thousand annually engage in various professional development opportunities. Among training courses that have in recent years enrolled the largest proportion of Russian teachers are: New ICT in Education (68%); Best Practices in Teaching Complex Topics (53%); Developing Students' Metasubject Learning Competences under the Federal State Educational Standards (33%); Implementing a Professional-Standard Oriented Working Environment (31%); etc. (see Fig. 6.3).

A major downside that can be noted when discussing teacher professional development in Russia consists in the fact that only less than a half (42%) of all educators who sign up for training manage to complete their coursework (20% quit after the first lesson, and 38% do not even reach the middle). Furthermore, 6.5% of those who are allowed to take the final examination ultimately fail scoring substantially below the established passing threshold.

This situation where a substantial mismatch has existed between the amount of continuing learning & development formally attempted by the national teacher corps and the net payoff these endeavors generate may be largely attributed to the employed Russians' overall negative sentiment to professional upskilling and poor intrinsic motivation for lifelong learning as a whole. Thus, according to a 2013 survey by the Public Opinion Foundation, about 40% of working Russians have reported they are unlikely to engage in any professional development opportunities in future. Another 40% of the respondents, who have been found to be more likely to enroll in extra training, have voiced securing a promotion or getting a pay-rise as the key considerations for seeking skill upgrades.

[5] https://netology.ru.

6.9 Outcomes and Achievements

It can be inferred from what has been discussed earlier that ICT have taken a long and largely uneven development course to become part and parcel of the Russian educational landscape. The process of implementing novelty ICT means and instructional practices has seen several major waves where the Russian state at different times pursued different objectives and practical roadmaps for getting the former accomplished. Alongside a broader context of the dramatic and dashing change that Russia underwent as it moved from command administration to the quasi-market and market political and economic paradigm, these policy variations have also reflected, more specifically, how overall conceptions and expectations with respect to ICT, and namely regarding their prospective role in carving out future societal pathways, have been evolving over time. Thus, the following key stages of ICT implementation in Russian education can be revisited in concluding our discussion.

The first phase of the digital move, which spanned a period of the late Soviet era of the mid-1980s and through the turnaround time of the 1990s, was marked by the principal focus placed on establishing the pivotal IT asset base across the national educational perimeter. This period saw the mass-equipping of Russian schools and higher educational institutions with personal computers, which at that time mostly served as a means to tackle a series of standardized, basic computational and modelling STEM tasks, including through mastering and applying the essentials of computer programming. ICT penetration at that very stage was almost entirely limited to the framework of the newly established Computer Science subject. Delivering instruction in Computer Science was primarily entrusted with the math teacher corps, who would typically receive prior basic IT training. It should be noted that, while the ICT scope was concentrated within a single syllabus area, introducing these information technology fundamentals has heralded an important innovative impetus for schooling as students were getting actively engaged in mastering the new cognitive and technical domains of algorithmic thinking, programming and other basic elements of human–machine interaction. (Notably, this subject area then piqued a most pronounced and vivid interest among the youth because the Computer Science classroom long remained virtually the only option left for students to become familiar with the enthralling realm of IT.)

What followed during the era of 1990–2000s has seen information and communication technologies gradually span the whole learning & development domain by penetrating into and transforming both the very substance of education and the entire multiplicity of instructional models and aids. Back into that time, the accelerating processes of ICT-supported learning innovation came to embrace a progressively broad cohort of instructional staff across training areas, whereby the ICT transition gained a robust pace to leap way beyond Computer Science proper. As a brand-new class of electronic learning resources has come on-stream, the computer and information technology as a whole have evolved into an inalienable systemic part of the interdisciplinary curriculum and regular learning practice, which has enabled a host of novelty models of communicative and cognitive interactions facilitating, among others:

- Active self-study and the overall capacity for self-directed learning.
- Changes in the teacher's role toward more learner-centered and personalized strategies.
- Transition to the new, and more collaborative, teacher–learner framework.

As we move on to the contemporary stage of Russian education, we can note that the public policy framework in place almost universally views ensuring the all-round development of global-standard student ICT competences, through effectively harnessing the entire multitude of modern ICT instructional aids, as among its paramount imperatives on the present-day agenda for sustainability and growth. That said, the overall state of affairs that has over the past several years been observed in practice is somewhat not fully matched with what national policies have purported. The extent and pace of how various ICT means have been entering the learning & development landscape can be plausibly described as patchy and inconsistent, with stark disparities well noticeable from both the cross-regional, regional and institutional perspective. The key downside to more streamlined and uniform adoption of modern educational ICT can be analyzed into such components as:

- Inadequate technical infrastructure in individual organizations and localities (slow internet connection, obsolete PCs, scarce availability of portable and multimedia teaching means, etc.)
- Lack of individual teacher motivation to go digital, which, in turn, precludes more appreciable peer effects.
- Arbitrary internal policies & procedures, which fail to provide a cohesive and unambiguous action plan that everyone would abide by.

Insofar as stakeholder expectations for today's uneven ICT implementation curve to be rectified are concerned, a great deal of promise is now attributed to the newly adopted "Program for Development of Digital Economy in the Russian Federation" (2017). The Program's massive scope and ambitious objectives, as well as how scrupulously its deployment roadmap is designed, all suggest we can reasonably anticipate a new large-scale upside effect on educational ICT to occur in the near-to-middle run, once this landmark initiative kicks into a higher gear.

6.10 Challenges and Strategies

As the globe-spanning digital move has been well underway (and is definitely poised to gain further momentum), various domains of social and economic life have seen deep and accelerating changes taking place across their ICT landscapes. The progressive advent of cutting-edge internet and computing technologies has prompted a surge in data volumes and an expanding shift to remote interaction means, such as task-specific free web-based and mobile apps, social media, software-as-a-service (SaaS) solutions, smartphones, tablet PCs, etc. Largely framed by the above global-scale processes, the Russian ICT market has also thriven in recent years to make a growing number of high-impact digital innovations become accessible to an ever-broadening population cohort.

In and of itself, there is no longer anything new about students and educators both progressively switching to mobile technologies as a handy tool to best handle their personal day-to-day tasks of information search, communication, etc. What is new—and most challenging—is to obtain a representative portrayal of how competent modern teachers and learners are in effectively applying frontline ICT means and techniques in the educational context. What makes this assessment task so important is the fact that as borderlines between the school and the out-of-school realms have been rapidly blurring these days, amidst the increasingly pronounced call for ubiquitous, collaborative and life-time learning, ensuring educational settings become truly empowering requires that both instructors and students possess comprehensive ICT awareness and savvy to cooperate in a prolific digital learning environment of shared goals, methods and outcomes. So far though, there has been little reliable evidence available to plausible gauge what the actual state of affairs with ICT-related teacher and learner competences is, namely because most of Russian and international research on the matter has still focused largely on the ICT educational infrastructure and skills existent as far back as the early-to-mid-2000s.

To reiterate, the digital landscapes have since then undergone massive and diverse changes across societal realms, including education. Modern learning & development settings have been increasingly absorbing the entire multitude of daily ICT practices. This expanding trend toward the real and the virtual worlds becoming more mutually penetrating and determinant with respect to one another has driven a turnaround in the substance and process of education, where much of conventional instruction has become obsolete given the new socio-communicative reality (e.g., single-faceted standardized teacher–learner interactions based on the Q&A format, etc.). Furthermore, as the ongoing globalization and digitization have been actively revolutionizing production and consumption models, a drastic reframing has also taken place in the job market, with the key emphasis now put on ICT-assisted non-routine labor. Accordingly, information technology and advanced communication literacies have come to top the entire 21st-century skills agenda, as being among the pivotal learnability and productivity attributers of future-proof talent.

It turns out that the Russian education systems is now confronted with a series of challenges and high-scope questions as to how the country's further ICT and educational development strategies can be best aligned to produce sustainable synergistic effects on social cohesion and economic growth. When addressing this top-priority task, it is first of all important to clearly assess (1) the overall framework and potential of harnessing modern ICT in facilitating the effective achievement of immediate and prospective educational objectives; and (2) the conditions under which this ICT potential can be unleashed at its fullest.

A series of practical steps that may be reasonably considered to be taken as implementing the above-described latest agenda in ICT-supported learning innovation gets underway include:

- Broadening the range of ICT means harnessed in the educational perimeter.
- Transitioning from mastering standard, basic-skill office apps to learning systemically about modern advanced ICT architecture.
- Further expanding and deepening the use of various ICT means and techniques within individual training areas.

We are confident that carrying out these measures will form important groundwork in securing a turnaround toward streamlined advancement into the third wave of digital transition.

Acknowledgements I want to express my gratitude to Igor Manokhin (HSE) whose proofreading and editing greatly helped the readability of my work. This work/article is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE University).

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Chapter 7
ICT Integration in Malaysian Education Scenario

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Abstract ICT has the potential to increase access and quality of education. For a developing country like Malaysia, it offers opportunities to extend and enhance its educational system, and provides access to skills and knowledge which would otherwise be rather difficult. New ways of teaching and learning and a shift towards a more learner-centered approach is achievable through ICT. We want the future generation to be able to use ICT effectively and efficiently where it will give them that competitive edge in a globalised job market. However, the introduction and integration of ICT in the education is not without its complex trials and tribulations. Failure in meeting the challenges would result in Malaysians falling far behind the other nations. This report brings together aspects of ICT implementation in Malaysia. Overview of current scenarios are described from the Malaysian point of view.

Keywords ICT integration · Policy perspectives · Malaysia · ICT infrastructure · Student competency

7.1 Introduction

This chapter examines ICT initiatives in education in Malaysia. It will give an overview of the initiatives in terms of the policy perspectives, ICT infrastructure, educational resources, ICT integration in teaching and learning, students' ICT competencies, and teachers' professional development in Malaysia.

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_7

The growth and capabilities of ICT has become an important topic of discussion among the scholars around the world. As ICT has changed the way people think, work and live, schools and educational institutions are also required to change the way they teach. ICT integration in education is believed to help educators to optimise their teaching and learning processes, thus increasing their competitiveness and effectiveness. It would also help support and improve students' learning performance. Over the years, Malaysia has introduced a number of ICT initiatives to facilitate greater adoption and diffusion of ICT in every educational aspect. These initiatives include continuous policy and financial support, scalability of education and training programmes, and providing an environment which supports a systemic development of ICT in all its schools and tertiary institutions.

7.2 Policy Perspectives

A policy is a document which provides general guidelines for an institution or organisation to achieve certain results, goals or objectives. It provides a rationale, goals and guidelines as to how the education will or can be through ICT. The policies are supposed to motivate, change and channel the nation's efforts in achieving its overall educational goals. Policies, norms and guidelines will have to be established in order to promote the use of ICT in schools.

In the Malaysian context, one of the key aims of the Ministry of Education (MOE) in today's ICT enabled classrooms is to make students more active in the learning process. In 1997, the MOE launched the Smart School Flagship where it was one of the seven Flagships that were launched by the government to facilitate the adoption of ICT in the nation (Lee & Soon, 2016). The Smart School programme was to promote the use of ICT as a critical enabler in enhancing creativity, collaborative learning, critical thinking and problem-solving in the teaching and learning processes. A star-ranking system known as the Smart School Qualification Standards (SSQS) was also created. At present, the SSQS is still in use to appraise schools in terms of ICT utilisation, human capital, applications and technology infrastructure.

The Smart School project completed in 2010 where the country then moved to a more general grander scheme. Based on some studies carried out by the MOE, they found a need for the next ICT initiative to be aligned with changes coming from both the internal and external needs. In meeting the gap between the desired and actual level of ICT integration in the classroom, the ICT in Education encompasses all ICT initiatives in the country. It also seeks to standardise and enhance the implementation moves. Greater commitment and cooperation from various stakeholders are also expected. Concentrated efforts from the MOE and various institution, right down to teachers, parents and students are required in order to strengthen the policy on ICT in education and maximise its impact on students.

In 2011, the MOE had launched a comprehensive review of the education system in Malaysia. Amongst others, the review found shortcomings of previous policies regarding ICT in education. Over the last 20 years, many efforts have been carried out by the MOE whereby a huge amount of money have been spent for the advancement of ICT use in schools and other educational institutions (Ali & Nor, 2010). However, the review found that despite the massive expenditure on the SmartSchools initiative, 80% of the teachers were found to use ICT less than an hour per week (as cited in Ministry of Education Malaysia, 2012. Even if ICT was used, it was limited to word processing applications.

As such in 2013, the Malaysian Education Blueprint (MEB) which is a detailed plan of action that maps out the education landscape for the next 13 years (2013–2025) was launched (Cheok & Wong, 2016). Of the eleven policy shifts identified in the MEB, one was to leverage ICT. Shift 7 of the MEB hopes to transform education in the country by leveraging the Internet and technology use in order to improve teaching and learning, and bridge the digital divide between the rural and the urban schools. In order to achieve this, the 1BestariNet project was initiated (Cheok & Wong, 2014). A single learning platform and a high-speed 4G connectivity will be provided to all the schools in Malaysia. The project aims at linking six million school children from 10,000 schools in the area of 329, 847 km with 4.5 million parents and teachers via the high-speed 4G FROG VLE (Hew & Kadir, 2016). As the education transformation journey through the MEB is complex and extensive, the ministry has sequenced the transformation into three waves. Wave 1 (2013–2015) is to turn around the system by supporting teachers and to focus on core skills before moving on to Wave 2 (2016–2020) whereby here the education system improvement would be accelerated through structural changes. Wave 3 (2021–2025) would then see an increase in operational flexibility (MOE, 2016).

ASEAN countries to varying degrees have made significant efforts in embracing ICT revolution for development. Our ICT use readiness index at 4.6 is comparably higher than that of the other southeast ASEAN countries except for Singapore (Vu, 2017). This seems to show that the effort made to revolutionise ICT in education or for the country's development in general has met with some success. However, there are challenges faced which need concentrated efforts in order for us to enhance the ICT policy design and implementation.

The MOE also acknowledges the role of private sectors in helping the education sector especially in the ICT aspect since 2000. The Malaysian government encourages collaboration from the private sectors in helping them to establish a pool of working force that is highly skilled in ICT. The private sectors have contributed millions of ringgit since then. Their involvement includes infrastructure, resources, training, application and management aspects. This has resulted in reduced ICT system cost, upgraded government agencies performance on the whole, made the sharing of data and resources easier and flexible, reduced the gap between different governmental agencies in terms of ICT capabilities, and provided a better standardised approach across the governmental agencies. Some of the more prominent and established projects that have come out from this collaboration include the SchoolNet project, GSB Technology Learning in School, School Adoption Programme with Samsung Digital Classroom, K-Perak E-Learning Cluster No.1 (KPEC), Cyberkids Camp, E-Learning for Life2 Apple Company and the "Value Add Microsoft" project.

7.3 Infrastructure

Several ICT initiatives in schools over the years like the Smart School Project and the School Computerisation Project, had introduced ICT facilities in schools while the SchoolNet project had provided all schools with Internet access. In addition, the policy of teaching Mathematics and Science in English had also helped in equipping the infrastructure in schools with laptops and LCD projectors with courseware for teaching Mathematics, Science and English Language.

To further increase the use of technology across the 10,000 classrooms, the 1BestariNet project and software for schools have been initiated. 1BestariNet is a project led by the Ministry of Education (MOE), which is to provide access to a cloud-based Virtual Learning Environment (VLE) known as the FROG VLE (adopted from United Kingdom) and a high-speed 4G connectivity by June 2014 to all the 10,000 fully-aided government schools (Ministry of Education Malaysia, 2012).

The implementation of the 1BestariNet initiative is expected to run over 13 years. 1BestariNet IDs have been made available to all students, parents and teachers in all the schools nationwide, which enable them to access the FROG VLE, Google Apps for Education and the FrogStore. Through the FROG VLE's simple site creation tools, teachers are able to digitise their teaching content and explore new ways of bringing the best resources and teaching methods to be shared across the 10,000 government-aided schools (Cheok & Wong, 2014). Learning anytime, anywhere is now possible with free Internet access available to all 10 million teachers, and students in Malaysian schools.

The 1BestariNet project which is led by the MOE provides access to a single learning platform and a high-speed 4G connectivity to all its schools. Schools across the country have access to a cloud-based virtual learning platform and a high-speed connectivity since June 2014. The project was launched in March 2012 and the implementation is being carried out in stages and all schools will be connected to the Frog VLE (Cheok & Wong, 2016). To date, 6695 schools are connected to high-speed Internet access while 2245 are connected using the Asymmetric Digital Subscriber Line (ADSL) or the Very Small Aperture Terminal (VSAT) technology (Ministry of Education Malaysia, 2016). However, the MOE is consistently conducting connectivity-mapping activities to identify potential upgrades from ADSL and VSAT to 4G technology. It has adopted FROG VLE, a United Kingdom's designed application which would help to ease lesson plan development, facilitate administrative tasks, and allow students access to a vast learning resources (Cheok & Wong, 2016).

Despite the amount of money and the number of years the Malaysian government had spent in making ICT an important element in the classroom teachings, teachers' high uptake are mostly found in schools that have high quality ICT resources. An enormous disparity also exists between the rural and urban areas. The lack of Internet connectivity seems to be an all time high issue especially since the FROG VLE was introduced. Schools in certain states in Malaysia are still showing low usage and the blame will always be on the issue of connectivity. It is believed that schools which are well resourced in ICT tend to have better achievements than schools which do not. The best part about this is, the former does not have better social-economic circumstances but most of the time, yes, they do have better quality leadership.

7.4 Resources

The digital learning resources according to the MOE's educational policy need to have tangible outcomes. Quality and relevance of the resources will ensure increased and continuous usage. Digital resources' main strength is in its ability in presenting complex topics and concepts.

The Virtual Learning Environment (VLE) which is also sometimes referred to as the Learning Management System (LMS), Digital Learning Environments, Course Management Systems and Electronic Learning Environment (De Smet, Bourgonjon, Wever, Schellens & Valcke, 2012). It is a web-based application which runs on a server and is accessible with a web browser from any place that has an Internet connection. It is a single, centrally hosted and supported environment (Weller, 2012) and it allows teachers to create online course websites with learning materials by providing a number of functionalities and tools like the navigation, document publishing, announcements, student tracking, assessment modules and forum. The system also provides online resources, teaching sites, assignment modules, forums, quizzes, email, etc., with a media-rich environment where there are lots of video, sound, animation, graphics and other multimedia elements (Hew & Kadir, 2016).

FROG VLE is a web-based learning platform which provides virtual equivalents of real-world learning. It is an equipped integrated solution which allows for teaching, learning, collaboration and administrative functions (Cheok & Wong, 2016). Here, teachers can assign lessons, tests and marks while students can submit their homework, view their notes and important documents (Cheok, Wong, Mahmud, & Mohd Ayub, 2017). This system allows teachers and students to search for almost anything on the Internet, and build it onto the site as their educational materials and resources. School administrators can organise their calendars and disseminate notices via the FROG VLE. Some of the tools are also available to parents. They can view their children's work which were uploaded onto via the VLE. This is one of the links where teachers or interested parties could go to in order to know and learn more about the FROG VLE in Malaysia; https://frogasia.com/learncentre/. It is a website where there are modules available for teachers to understand and learn more about the usage of FROG VLE. The VLE system provides a plethora of educational resources and apps from the web and makes it easily accessible during teaching and learning sessions (Cheok et al., 2017).

This technology-enabled learning allows our students to tap resources and expertise anywhere in the world. However, despite, the many advantages of using the FROG VLE, its level of use in schools has been found to be worrying (Kaur & Hussein, 2014). The nation's hope to weave twenty-first century competencies and expertise in the teaching and learning that takes place within the walls of the schools seem doubtful.

Being one of Malaysia's most ambitious technology-in-education projects, approximately RM663 million has been spent, which includes 5 million students, 4.5 million parents and 500,000 teachers which is expected to run over 13 years (Campbell, Al Harthi & Karimi, 2015). Through the FROG VLE, teachers are able to digitise their teaching content and explore new ways of bringing the best resources and teaching methods to be shared across the 10,000 schools. In 2015, more than 30,000 content materials have been uploaded onto the VLE. Teachers are able to build engaging lessons, download and share materials. Students will have easier access to their learning materials while parents can help to enhance their children's learning and be kept updated with news from the schools concerning their children.

Gümüs' study (2013) showed that students' ICT usage has strong relationship with the availability of ICT facilities at home. For this reason, it would make sense that initiatives to increase ICT programmes in Malaysian schools will increase opportunities for students to be involved in ICT-related tasks. Gümüs (2013), however, warned that increasing the ICT related hardware will not contribute to the students' usage of ICT. What matters most, is the development of human capacity for both teachers and students.

In a study on ICT coordinators in Malaysia, Umar and Hussin (2014) identified limited budget constraints, lack of interest, time constraints, limited computers in classrooms, and obsolete technology as the main challenges of integrating ICT in the teaching –learning process. These coordinators shoulder the big responsibility of managing ICT related matters and monitoring ICT activities in schools. They plan and conduct training programmes for teachers and students in their respective schools. Within the context of Malaysia, ICT coordinators play a pertinent role in enhancing the integration of ICT in the teaching–learning environment.

Besides the FROG VLE, there are also the Open Educational Resources (OER) created in Malaysia for the benefits of providing access to high quality digital educational materials. It helps make education more accessible, affordable, shareable and reusable. As to have an open access to educational opportunity is a basic human right, educational materials should be made easily electronically copied and transferred. Seventy four percent of respondents in Malaysia, in a study on OER carried out by Abeywardena, Dhanarajan and Lim (2013) commented that respondents claimed they have used open content and open source software which include digital readers, online class discussions, images or visual materials, and news or other media sources were the most widely used types of digital resources. Search engines like Google and Yahoo, personal collections of resources, online journals were also found to be popular amongst educators in Malaysia. The study also found 70% of the respondents had used OER in their teaching which were mainly produced within the institution, Internet or co-operation with other institutions. Repositories from other countries were not widely used and this were attributed to reasons like lack of awareness, lack of skills, lack of time, and lack of knowledge to locate suitable OER. As such, further support is needed especially in terms of building and raising Malaysian educators' awareness towards promoting a wider use and reuse of open content. So at present this is still an area where more concentrated efforts are needed to curb educational poverty and this can easily be managed through more sharing of quality educational materials and resources. Though there is a growing momentum to participate by some universities; particularly so by three private universities in Malaysia; Wawasan Open University, Open University of Malaysia and Asia e-University, there has yet to be a widespread understanding about OER due to lack of guidelines. Perhaps a more evidence-based guidelines by the MOE in the future would encourage a stronger uptake of the OER. The nature of it being participatory and sharing, would surely bring an impact towards teachers' instructional and pedagogical practices.

7.5 ICT Integration in Teaching and Learning

Computational Thinking has been introduced in primary schools starting from 2017. Coding was officially added to the syllabus of the national primary schools in 2017, starting with the Year Six students through the Module on Programming within the subject of ICT. Students learn to use their logical and computational thinking to solve problems by using a programming application, Scratch. Students are exposed to the fundamentals of creating algorithms (pseudocode and flow chart) and developing simple programmes. This new initiative involves coding skill which is meant to help students to be more apt at problem-solving, algorithms, creative and logical thinking. The focus here is to get students to think more effectively and ICT skills to act as helping tools. Coding will also be taught from 2020 onwards through the Design and Technology subject for Primary 4, 5 and 6 students. These primary school students will be exposed to the basics of algorithms and introduction of Robotics and Artificial Intelligence.

As for students in the secondary schools, the subject, Basics in Computer Science has been offered to lower secondary school students since 2017 while the upper secondary school students are offered a more advanced Computer Science subject. Students at the lower secondary levels learn coding languages, including Scratch, Java and Python while those at the upper secondary levels learn to use application software such as Microsoft Visual Basic, JAVA, HTML, Javascript, Microsoft Access, MySQL, XAMPP, and Notepad.

From mere digital users, the MOE is hoping to transform the new generation into producers of digital products and services. A total of 9200 teachers nationwide are currently being trained since 2017 to teach these programming related subjects. The syllabus in the prepared modules for teachers to teach was benchmarked against courses offered by Britain's Computing Schools (Aizyl, 2016). Coding knowledge here is imparted via logic-based games, where students are given a solid foundation in preparation for future digital economy jobs. To date within a short span of time, students exposed to the course, were able to create their own games, and presentations (Chan, 2017). An extension of this coding knowledge will see the introduction of Digital Maker Clubs in schools and Digital Maker Hubs in the communities. Private sectors and academia will help manage these clubs which is to further cater to students whom are passionate in digital technologies and would like to further develop their knowledge and skills to a higher level.

As for the Teacher Training Institutes, selected lecturers from the institutes were sent for a two weeks training programme and they then helped train their colleagues. In Malaysia, the Teacher Institutes are preparing and supplying primary school teachers to government-aided schools while the universities are responsible for the provision of secondary school teachers. Every institute has their own Learning Management System (LMS), and all have only adopted LMS which are free like Moodle, Edmodo, and Schoology. This in part is preparing the trainee teachers to be more prepared in handling online courses or blended learning in the future. However, in 2017, FROG VLE has also made its way into the Teacher Training Institute. All the institutes were required to run trainings for all their teaching staff and they in turn will use the FROG VLE in their courses. This will better prepare the trainees when they are posted to schools. In other words, it is pertinent for teacher trainees to use ICT throughout their trainings so that they will be comfortable with ICTs in schools.

The adoption of technologies to enhance teaching and learning has been gaining momentum among Malaysian universities (Lee et al., 2014). For example, 69.7% of courses (undergraduate and postgraduate) offered at a top research university in Malaysia—Universiti Putra Malaysia (UPM) have been identified to have adopted the blended approach to teaching and learning for 2018. This has surpassed the 40% target of blended learning courses at UPM.

The MOE has played its role in providing a comprehensive guideline on the formulation of the national e-Learning policy which involved all stakeholders, especially in guiding those whom have yet to formulate their policies (Ministry of Education Malaysia, 2014). Components included in the policies are comprehensive and cover areas such as strategic planning, principles for effective e-learning pedagogy, implementation of blended learning, copyright issues, training and others. This clearly shows that with the presence of such policies, e-Learning can be implemented effectively. University lecturers are more aware of the existence of the e-Learning policy and a high percentage of them are in compliance with the policies. This seems to suggest that having an e-Learning policy which is transparent and known to the entire campus community and stakeholders is pertinent in order to ensure a successful implementation of their e-Learning agenda.

7.6 Students' ICT Competencies

Generally the levels of ICT competencies among the Malaysian students are still very low (Teck & Lai, 2011). Measures and efforts must be undertaken to further improve the levels of ICT competencies among the students in schools. However, in another study on postgraduate students in a local university, showed positive attitudes toward computer and Internet usage (Abedalaziz, Jamaluddin, & Chin, 2013). These could be attributed to the availability and accessibility to computers and Internet given to postgraduate students at the universities as compared to schools. Moreover, the reason for these positive attitudes toward computer usage can be attributed to high usage of computers and its various applications in instruction and being assigned homework and various tasks requiring computer usage.

Since not every student can afford to have computer access at home, school plays an imperative role in providing opportunities for students to use computers as frequently as possible. Frog VLE's initiative will be able to create more interactivity between students and teachers during the teaching and learning process and accessibility to quality learning resources (Ministry of Education Malaysia, 2012). However, the MOE has also advocated parents to play a more important role in providing the necessary facilities like computer and Internet access at home whenever possible in order to encourage and motivate their children to adopt ICT in their daily lives. The MOE has also provided ICT classes in all the primary and secondary schools. At present, there is no ICT Competency Standards being used in schools. A general description of the core skills that teachers need to possess an ICT literacy was merely mentioned without a detailed description as to what it constitutes. Perhaps this is an area where the MOE needs to consider seriously in order to improve and increase the use of ICT among both, the teachers and students in schools.

In the context of Malaysian universities, digital literacy skills have been introduced as one of the core learning outcomes in the higher education curriculum by the Malaysian Qualifications Agency (Malaysian Qualifications Framework, 2018). Malaysian universities are expected to produce knowledge workers who are fluent in information technology; and able to access, use, synthesise and construct knowledge (Karim, Din, & Razak, 2011). The Framework identified digital literacy skills as desirable learning outcomes for higher education students who are able to "use information/digital technologies to support work and studies. The skills include sourcing and storing information, processing data, using applications for problem solving and communication, as well as ethics in applying digital skills" (Malaysian Qualifications Framework, 2018; p. 17).

7.7 Teachers Professional Development

Professional development involves planning learning experiences and activities that would benefit an individual, group or school. To ensure the success of the number of ICT reforms, teachers, school heads and other educational personnel in Malaysia have been provided with on-going training and courses by the MOE. Malaysian teachers have been found to have a high level of ICT competency (Tasir, Abour, Halim, & Harun, 2012). This means that these teachers are able to use most ICT tools such as using computers, preparing slides to present their lessons, using the Internet to search for updated information, and designing simple web sites.

Massive open online courses or otherwise known as MOOC is a new emergence in the educational field in Malaysia. It started in 2013 and by 2014, all the public universities have began offering MOOCs. Its adoption in Malaysia stems from several important national plans which have included MOOC as a national agenda. In the

Malaysian Education Blueprint (2013–2025), it has declared its intention to leverage on MOOC as one of the strategies to widen access to education. The MOE has also produced a document, Malaysia MOOC Quality Practices (2018) in order to guide MOOC developers whom are mostly from tertiary institutions in developing their courses. The website https://www.openlearning.com/malaysiamoocs currently offers 739 courses with 510,761 students from 20 public universities (data last update: 1st August 2018). The massive number of students include those full time students whom will have to take up MOOC as a compulsory subject. However, as these MOOC courses are free and available online 24/7, teachers do have plenty of opportunities to take them up and make them as part of their professional and ongoing lifelong learning. However, how widespread is the awareness among the teachers towards the availability of MOOC is a question mark.

MOOC is still at its introductory and exploratory in nature, a rather new phenomena in the Malaysian education landscape, and is still not common and widely known among the public in Malaysia. However, the government's target is to have 30% of the courses offered by public universities to be delivered online by 2020. Needless to say, Malaysia still has many issues and challenges to overcome before we can leverage on this innovation.

With the recent implementation of the new ICT initiative in all schools, Frog VLE, a new set of knowledge and skills are needed by the teachers. Advocating teaching and learning through the FROG VLE requires a holistic attention to many aspects. Besides the provision of the system, we need to know how teachers are going to be equipped in running their lessons through it. User training will no doubt raise the computer self-efficacy of users. The MOE or the Teacher Training Institutes should offer training courses for teachers in order to support them in making sense of the FROG VLE in their teaching and learning processes. These would further develop their belief in their own self-efficacy in surfing the Internet while using the FROG VLE. With the confidence after being trained, teachers would then use the system to realise the many benefits that the online learning system can offer.

A total of 351 schools were classified as the Champion Frog VLE Schools while the rest in the nation were classified as the non-Champion Schools (Ministry of Education Malaysia, 2012). The teachers from the Champion Schools have the advantage of acquiring training, delivered direct by Frogasia in their respective schools. On the other hand, limited training was offered to the non-Champion Schools. Upon completion of any training, the participants were expected to deliver the elements in their training to the other teachers in their respective schools. In a study on teachers' competencies in teaching through the Frog VLE, they found that only a small number of teachers have a positive perception on their capabilities (Kaur & Hussein, 2014).

A few studies carried out had shown that Malaysian teachers ICT usage are not up to the required level. It may be due to the lack of training. Most of the training carried out are one-off due to limited budget. Juanna, Wong and Samsilah (2005) found teachers in the state of Melaka possess only moderate level of ICT competence. Melor (2007) in her study found 98% of the English teachers studied, had shown minimal use of ICT in their classrooms. Shahril (2007) also reported similar findings among the Science teachers. In a newer study, Umar and Yusoff (2014) revealed that teachers are skillful in surfing the Internet and also in basic ICT skills but when it comes to more advance ones like producing graphics and animations, many were not able to do so.

Generally, these older and newer studies reported lack of training and knowledge as the main culprits that had hindered them in maximising their ICT usage in their teaching and learning processes. In a study by Rahmat and Au (2012), they found that in order to get the Visual Arts teachers to continue using a system or application, it has to be easy to use. Thus, the MOE needs to ensure that whatever innovation they are adopting is relatively easy to use or user-friendly. Teachers' perceptions and opinions need to be sought before enforcement can be made. Teachers' abilities and potential must be considered by curriculum developers and courseware designers.

For more effective use of technologies in schools, teachers need to appreciate its relevance, usefulness and usability. At the same time, they need to be computer literate, possess sufficient self-efficacy in integrating ICT in their lessons. Having said these, they need help when things go wrong. Adequate technical maintenance and support is essential. In a local study by Lau and Sim (2008), 80% of the secondary school teachers indicated a need for a more school-based ICT training. As schools in Malaysia are centrally managed, school leaders have the tendency to play a passive role by waiting for the top-down instruction. Instead, a more pro-active role should be played whereby they could perhaps initiate and seek for help through smart partnership from relevant industries and institutions of higher learning. More than ever before, teachers in Malaysia are in a dire need of a whole new competencies. Allocation of budget for new ICT innovations, must consider placing teachers' training above the other factors.

In the newly integrated ICT classroom, teachers now need a number of competencies. According to Tinio (2003) teachers' professional development should have five focuses which include provision of skills of the application to be introduced, how it can be integrated in the curriculum, raise awareness of the changes in the curriculum, in the teachers' role and finally the theory underpinning that application usage. Equally important is for the teachers to know why and how they should use ICT to help them teach better. They need to acknowledge their changing role and appreciate that fact.

7.8 Conclusion

Attempt to enhance and reform education requires clear and specific objectives, guidelines, implementation time frame, resources, and political commitments from all levels. There is no one single formula to be followed when planning for ICT penetration into the education system, only lessons to be learnt. We may adopt best practices from around the world and replicate them in our nation and know that whatever challenges and success that emanates from that replication will be uniquely ours. Within our constraints, we will continue to strive as the future generation's success at the global front, lies within the makings of the teaching and learning processes in their classrooms. The MOE will continuously need to increase their commitment, work momentum and to adopt a working style that is more systematic and structured in order to be able to provide better support to teachers and schools to improve their performance and students' outcomes. In addition, strong support from parents, the community and private sectors are equally needed to successfully increase students' achievements in schools.

Phase Two of the 1BestariNet is in its second wave of implementation. Schools are now equipped with better broadband facilities in order to better facilitate the teaching and learning processes including the administrative and management matters (Ministry of Education Malaysia, 2017). The MOE is doing all that they can to improve the efficiency and effectiveness of ICT as an enabler, and this has resulted in a sizeable budget annually to implement ICT based initiatives. However, the huge organisational structure which comprises 36 divisions, 16 state education departments, 142 district education departments, 27 teacher training institutes, 15 matriculation colleges, 5 *Institute Aminuddin Baki* (centres for upskilling of government officers), 10, 196 schools, have made ICT in education an on-going and never-ending challenging endeavour to the Malaysian government.

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Chapter 8
New Zealand's ICT-In-Education Development (1990–2018)

Garry Falloon

Abstract New Zealand's development of ICT-in-education has been something of a haphazard affair, following the ebbs and flows of political ideology and whim since digital devices first appeared *en masse* in schools and other educational institutions in the late 1980s. This chapter discusses how government policy from 1990–2018 has affected the attempts of New Zealand's education institutions to effectively integrate digital technologies into curriculum, focusing on the major themes of this book, namely ICT infrastructure and resourcing, teacher professional learning and development, classroom practices and student outcomes. The chapter maps key initiatives in these areas across three distinct phases in New Zealand's ICT-in Education development: 1990–1999, 2000–2008 and 2009–2018. Acknowledging the uniqueness of New Zealand's education context, along with statistical information, the chapter presents illustrations of projects that detail implementation and impacts at an institution and classroom level. While generally New Zealand educational institutions are making reasonable progress in their ICT integration efforts, the effects of a past legacy of poor support, direction and decision-making lingers, with many issues and barriers to effective ICT integration in New Zealand classrooms identified nearly 30 years ago, still being present today.

Keywords Policy · ICT integration · Digital technologies · Infrastructure · New Zealand · Teaching · Learning

8.1 Introduction

This chapter explores New Zealand's ICT-in-education development, detailing major initiatives and programs across the themes of policy, infrastructure, digital content and resourcing, teacher professional learning (PLD), classroom practices, and student outcomes. While these sections are organised separately, efforts have been made to demonstrate their integrated nature by presenting short examples, illustrating how

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_8

government policy decisions have impacted in areas such as infrastructure and teacher professional learning opportunities, and as a result, classroom practices and resultant student outcomes. To fully understand how New Zealand has arrived at its present position in terms of ICT use in education, it is necessary to briefly overview historical developments and detail how ICT-related policy has affected progress in the other areas. For the purpose of systematic review, the chapter is structured around three main phases in New Zealand's ICT-in-education development: 1990–1999; 2000–2008, and from 2008 to present. The stages mirror significant political and social change that greatly affected the landscape upon which New Zealand's education institutions functioned, and in doing so, their planning, decision making and provisioning of digital technologies in curriculum. Most profoundly affected by these changes was the compulsory school sector, and for this reason, the chapter concentrates mainly on primary and secondary education. While universities and other tertiary education providers were subject to periodic reviews and reports on their digital initiatives and practices, they remained largely immune to the sea-change happening around them—instead plotting their own, separate pathways through the evolving digital minefield. Institutional response to government educational ICT policy (or lack thereof) has been fundamental in shaping the current state of ICT in New Zealand education, where, despite periodic financial and infrastructural investment resulting in some gains, overall practices are yet to reflect the educational transformational potential often touted in literature (e.g., Fluck and Dowdon, 2011; Garrison and Akyol, 2009). The chapter begins by briefly profiling New Zealand's education system and levels of student achievement, before taking a look at the formative 1990–1999 period when ICT was really beginning to make its impact felt in New Zealand schools.

8.2 New Zealand Education Profile

New Zealand is a small nation of just over 4.6 m people, with an increasingly multicultural demographic profile. As at the end of 2017, New Zealand had 2,550 schools, comprising approximately 420 secondary and 2,130 primary and intermediate (year 7 and 8) schools. While the majority of New Zealand students attend urban schools in larger metropolitan areas such as Auckland, Wellington and Christchurch, significant numbers of smaller, mainly primary schools exist in rural areas, many of which have less than 100 students. The country's difficult terrain and remoteness presents significant challenges for internet access and ICT infrastructure provision to many rural schools, meaning that hybrid systems comprising a combination of wireless, satellite and cable solutions are needed.

Data from the OECD's 2015 international comparative PISA study (OECD 2018) indicate New Zealand students score above the OECD average in science, reading and mathematics, and that results have remained reasonably stable over time—although relative to other countries, have improved. Additionally, a relatively higher percentage of New Zealand students (20%) are ranked as 'top performers' in at least one subject area, and 6% in all three assessed subjects. Both of these scores are above the OECD average. Significant challenges exist, however, in narrowing an achievement gap between students attending schools in advantaged vs disadvantaged regions. PISA data shows substantial differences in achievement between indigenous Maori and students from Pasifika backgrounds, and their European and Asian counterparts. This long underachievement 'tail' has, and continues to be, an enduring issue in New Zealand education.

8.3 ICT in School Education Phase 1: (1990–1999)

8.3.1 The ICT Policy Landscape

In 1988, the New Zealand government released the Picot Report—*Administering for Excellence* (Report of the Taskforce to Review Education, 1988), and soon thereafter, the education policy statement, *Tomorrow's Schools: The reform of education administration in New Zealand* (Minister of Education, 1988). These documents laid the foundation for the most significant reform of New Zealand schools for more than 100 years, impacting significantly upon how they were governed and managed, and substantially influencing ICT decision-making and resource prioritisation. Tomorrow's Schools decentralised the administration and management of schools from regional Education Boards to local school Boards of Trustees. Boards of Trustees separately govern each school, while the principal holds management responsibility for its day to day operation. Schools are bulk-funded via an operational grant for everything except teachers' salaries. Each school's grant is determined by a range of surrounding community socio-economic indicators that categorise schools into 10 deciles, the lowest decile (1) generally attracting substantially more funding per student than those in the highest decile (10).[1] While generally principals, teachers and school communities welcomed these changes, the move to a situation where schools were free to make their own choices has proven challenging—especially when it comes to ICT provisioning and implementation. These policy changes transitioned New Zealand to be one of the most deregulated and autonomous education systems in the world (OECD 2013).

8.3.2 ICT Infrastructure and Resources

In terms of ICT infrastructure and resource development, the move to localised decision-making left a vacuum in which schools floundered for nearly a decade. Two seminal reports produced by the Consultative Committee on Information Technology in the School Curriculum (Sallis et al., 1990) and Nightingale and Chamberlain's

[1]For a full discussion of the NZ decile system, refer to https://www.education.govt.nz/school/running-a-school/resourcing/operational-funding/school-decile-ratings/.

'A Study of Computers in New Zealand Schools' (1991), calling for government to play a far more active role in leading and directing the implementation of ICT in schools were ignored, with none of the recommendations they contained being implemented. Calls in these reports for greater government engagement in schools' ICT decision-making and direction-setting ran directly contrary to the prevailing neoliberal agenda of the time, and there was also awareness by government that developing and implementing a national policy on ICT in schools would be a very costly exercise—especially in terms of providing infrastructure, resources and equipment. The compounding effect of these ideologically-driven moves and the reluctance of government to engage directly in schools' ICT infrastructure and resourcing, was profound. In this absence, to fill the vacuum a burgeoning industry developed made up of hardware and software vendors, self-proclaimed experts and ICT gurus, and private, ICT-in-education consulting companies. These vendors aggressively marketed their products and services to naïve school boards and principals, frequently pitching their solutions as the 'latest and greatest' or preying on schools' fears of falling behind others in what was becoming an increasingly competitive environment for students, and the funding they attracted. By the end of the decade, the result was uncoordinated, adhoc and unreliable school ICT infrastructure, with digital resources limited to those that would run on the technology supplied by hardware vendors.

8.3.3 Teacher Professional Learning, Classroom Practices and Student Capability Development

During this period, few direct references to ICT playing any major role in curriculum could be found in official documents. The 1993 New Zealand Curriculum Framework (Ministry of Education, 1993), contained only one sentence on page 18 relating to any specific role for ICT in curriculum. While reference to ICT as a *Technological Area* was included in the later Technology Curriculum statement (Ministry of Education, 1995), the document shied away from detailing the mandatory development of students' ICT skills, and the need for teachers to upskill to deliver these. Such decisions were left to schools, which were often influenced by vendors pushing their own products and programs of teacher PLD aligned with these. Like infrastructure and resourcing, no centrally-coordinated programs of teacher PLD were provided during this period. This resulted in significant regional differences in teacher capability, with a corresponding impact on student digital competency development. Typical classroom practice during this period, at best, reflected 'digital substitution' or augmentation of traditional paper-based tasks—such as using a word-processing application to 'publish' stories that had already been hand-drafted, completing digital versions of mathematics worksheets, or playing 'drill-and-kill' games to learn basic multiplication or addition facts.

The end of the decade saw the publication of 'Interactive Education' (Ministry of Education, 1998) and its partner 'ICT Planning Guide for Schools', which was the first government attempt to provide any unifying framework for teacher PLD. Unfortunately, this attempt to 'turn the ship around' was a case of too little, too late. Schools were in a confused state of paralysis, and questions were beginning to be asked by principals and boards about the worth of pouring more of their scare operational grants into an area that was presented to them in policy and by government, as being only peripherally relevant.

8.4 ICT in School Education Phase 2: (2000–2008)

8.4.1 The ICT Policy Landscape

The new government elected in 1999 quickly became aware of the shortcomings of the 'hands off' approach to ICT-in-education of its predecessor, and immediately set about building a coordinated policy and series of supporting initiatives to provide more direction and resourcing for schools, through adopting a centralised approach to building infrastructure, providing teacher PLD, and provisioning equipment. On the policy front, the 2002 release of 'Digital Horizons—Learning through ICT' (Ministry of Education, 2002) and its 2003 revision, set out the government's strategy, priorities and initiatives for a coordinated, nationwide approach to schools' ICT development. 'Digital Horizons' represented an important milestone in New Zealand's ICT-in-education progress, as for the first time it signalled a central role for government in guiding and resourcing digital capacity-building in teachers and students:

> This government has been quick to seize on the importance and practical benefits of digital technology as a key tool for twenty-first century teaching and learning. That's why we have invested in national initiatives to boost capacity and provide digital resources of the highest quality. We have placed a premium on supporting the ICT activities of schools and their communities…
>
> (Mallard, 2003, p. 2).

Digital Horizons was replaced in 2006 with a second strategy, 'Enabling the Twenty-first Century Learner' (Ministry of Education, 2006). This continued the existing infrastructure and resourcing work started under 'Digital Horizons', but extended it to focus more strongly on building teacher capability and using ICT more effectively to enhance student learning outcomes.

8.4.2 ICT Infrastructure, Digital Content and Resources

Under 'Digital Horizons' (2002–2006) and 'Enabling the Twenty-first Century Learner' (2006–2008), the government rolled out a series of measures to support ICT infrastructure development, and provide schools with the necessary resources and teacher PLD opportunities to make best use of it in their classrooms. Key infrastructure and resource initiatives during this period were:

- Providing broadband connectivity to all New Zealand schools. Recognition of an emerging 'rural vs urban' access divide prompted government to upgrade remote school and community network infrastructure in an attempt to bridge an emerging access divide. In remote areas, this was generally attempted using variably-effective wireless and satellite technologies;
- Project SNUP (School Network Upgrade Project). The government embarked on a program to upgrade all schools' internal network infrastructure to a minimum of Category 5 cabling. This was needed to support associated moves to provide faster broadband, following the earlier well-intentioned, but technically inadequate, community NetDay initiatives;
- Establishing SchoolZone, a managed internet portal for schools. SchoolZone was a filtering and network management portal, designed to provide safe and secure school broadband internet access;
- Expansion of Te Kete Ipurangi (TKI). TKI is a continuing initiative that commenced in early 1999. Translated, Te Kete Ipurangi means *Internet Knowledge Basket*. TKI is a diverse online repository of teaching and learning resources, and over the years has become the 'one stop shop' for teachers looking for advice and ideas to support their classroom programs (see: www.tki.org.nz);
- Implementing a subsidised laptops for teachers scheme (the TELA project), and a free 'laptops for principals' program. All New Zealand principals were provided with a laptop computer, while schools were able to subsidise the purchase of laptops for teachers, through a range of lease-to-own programs. At the end of the lease period, if they wished, schools were able to purchase the laptops at residual value, increasing the pool of digital resources for use in classrooms;
- Developing a repository of digital learning resources in conjunction with Australia's Learning Federation. A series of digital learning objects (DLOs) supporting the objectives of New Zealand and Australian curricula were developed and made freely available to teachers (see: https://www.scootle.edu.au/ec/p/creativeCommons);
- Establishing 'Leadspace'—an online network for principals focused on building ICT leadership capability. Leadspace served as a conduit for principals to share ideas and strategies supporting ICT integration;
- Free access to the Microsoft suite of applications for students and teachers. The government secured a bulk licence agreement with Microsoft allowing teachers and students full access to the suite of Microsoft applications. Teachers could also install these on personally-owned machines;
- A free-call ICT Helpdesk providing advice to teachers and principals on equipment purchasing and technical matters, was established;
- The Virtual School Learning Network (VLN) was established. This innovation linked a number of remote and regional high schools in a series of learning hubs, that used videoconferencing to 'share' teachers to deliver subjects and courses that students wouldn't normally be able to access.

8.4.3 Teacher Professional Learning, Classroom Practices and Student Capability Development

A cornerstone initiative of both 'Digital Horizons' and 'Enabling the Twenty-first Century Learner', was a program known as ICTPD (ICT Professional Development for Teachers). Under ICTPD, government funding was made available to help schools build professional learning communities or clusters, often facilitated by a lead ICT teacher from one of the schools who had been recognised as displaying exemplary practice, or an ICT consultant from a private sector organisation. The greater emphasis and financial support for ICT teacher PLD from government during this period, spawned a whole raft of private ICT consultants, companies and organisations, keen to get their slice of the action. While some of these individuals and enterprises were credible and genuinely concerned with helping schools by providing sound and unbiased advice, many were not, instead covertly aligning themselves with particular ICT equipment or resource brands or providers. While the ICTPD program was well-intentioned and reasonably effective for clusters that secured competent and unbiased facilitation, for others where this was not the and its impact and any ensuing benefit, was questionable.

Although the ICTPD program wasn't perfect, it was an enduring initiative which probably has had the most significant and generally positive affect to date, on ICT practice at the 'chalkface'. It was also a far more coordinated effort than anything that had come before. Its Community of Practice (CoP) model for the first time encouraged teachers to learn from other teachers *within the reality of the classroom,* instead of relying principally on 'one-off' short courses often delivered off-site by so-called experts, in artificial environments such as computer rooms or labs. However, while ICTPD presented teachers with the opportunity to learn practical knowledge and skills directly relevant to their day-to-day teaching, it was limited in its effectiveness for building deeper knowledge of more significant potentials from ICT use. The pragmatic focus of many clusters on propagating existing practice frequently led to a surface-level interpretation of ICT integration, and the possibilities ICT presented for more fundamental changes to teaching, learning and curriculum, were largely bypassed. The ICTPD program was generally well-received by teachers, as its approach provided them with a battery of ICT activities they could use directly in their classrooms. However, it failed to address the need for deeper theoretical understandings responding to the *whys* of meaningful and sustainable ICT integration—and implications this held for learning design and pedagogy, and it did little to acknowledge contextual differences between schools. While the 'cookie cutter' approach of ICTPD worked for some, for others, it made little impact.

The other main ICT PLD initiative of this period were the Digital Opportunities projects or *DigiOps.* These comprised a series of 12 public–private partnership projects, where major ICT hardware and software companies were invited to partner with schools or school clusters, effectively to trial their products in different educational contexts. Project proposals were invited from schools, and the resources and expertise of companies including Microsoft, Hewlett Packard, IBM and Telecom were matched to qualifying proposals, with project plans being collaboratively developed and implemented. The ‘bottom up’ approach of DigiOps, where partnerships were designed around authentic ICT-related needs or opportunities existing in schools, proved highly successful in delivering both targeted and purposeful PL to teachers, and also equipping schools with an array of the latest learning technology (Fig. 8.1).

While the two policy strategies implemented during this period saw significant progress made in content provision, connectivity, capability and pedagogy, both failed to addressed the issue of student access—that is, lowering the student-to-device ratio. This fundamental issue was identified by most schools at this time as being a major impediment to leveraging the full potential of ICT in teaching and learning. Clearly, government was aware of the considerable ongoing cost involved in providing hardware to schools and was keen to avoid this scenario, but there is little doubt that this decision presented a major headwind to schools’ ICT integration efforts.

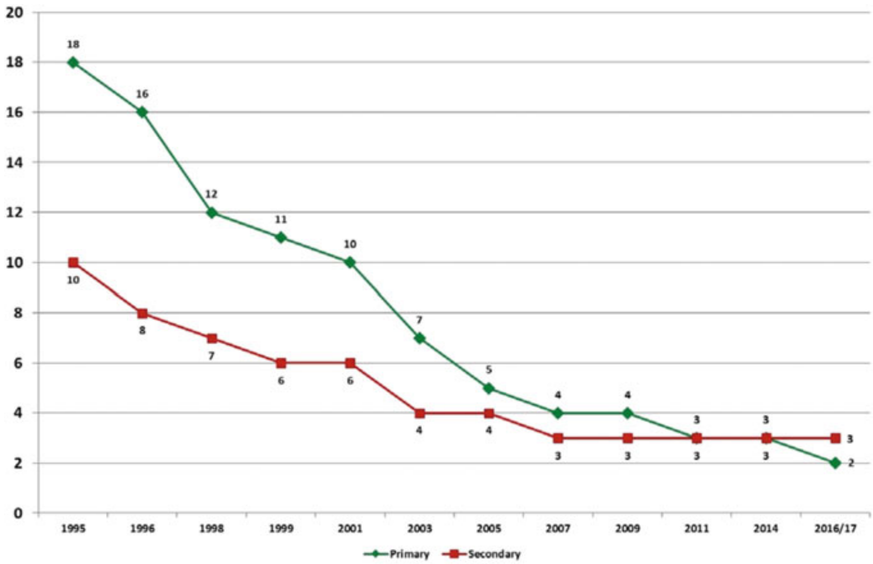

Fig. 8.1 The Hon. Helen Clark, New Zealand Prime Minister (1999–2008) opens the Digital Opportunities Projects (March 2005)

8.5 ICT in the Tertiary Sector

8.5.1 The ICT Policy Landscape (2000–2008)

In 2004, the government published the Tertiary e-Learning Framework (TEF) and its partner action plan (Ministry of Education, 2004). This was the first time any attempt had been made to provide strategic direction for ICT development in the tertiary sector. However, unlike the school sector strategies, the tertiary framework was long on vision but short on specifics. It proposed a view of tertiary education as "a networked, flexible education system, offering accessible, relevant, high quality learning opportunities for all New Zealanders" (MoE, 2004, p. 2), but did not detail any initiatives related to how this would be achieved. The strategy communicated a strong focus on ICT as an *enabler* of education—particularly online learning as a means of addressing social equity goals by providing educational opportunities to marginalised populations, and others seeking greater choice in where and when they learn (p. 7).

The tertiary framework was built around five principles:

- taking a learner-centred approach;
- following and sharing good practice;
- exploiting opportunities for collaboration;
- being innovative;
- developing models for financial affordability/sustainability.

(Ministry of Education, 2004, p. 2)

The TEF loosely identified ICT priorities for the tertiary sector, including the formation of communities of practice through which academics could "share e-learning information and experiences in a collegial manner" (p. 2), professional development for university staff, development of universal design standards for e-learning environments (online learning), and developing credential frameworks that provide flexible learning pathways (including marketable online options for international students). It argued the TEF would "help ensure that the development of our tertiary sector e-learning capability takes place efficiently and effectively. Taking a co-ordinated, national approach will reduce duplication of effort, and leverage maximum benefits from New Zealand's investment in e-learning" (MoE, 2004, p. 4).

While the tertiary framework was laudable for its vision and its call for institutional collaboration and a standardised approach, ultimately it had little impact on what actually happened in tertiary institutions. Decisions about ICT investment, online course development and associated infrastructure, lecturer PLD and other ICT innovations, were solely determined at individual institution level. The main driver for ICT innovation during this period was not government policy, but competition between institutions for students, and online learning was seen as a cost-effective means of attracting more students, and hence, more funding.

8.5.2 Tertiary Sector ICT Infrastructure, Digital Content and Resources

As no official data is collected by the New Zealand government relating to tertiary ICT development—and as individual institutions do not readily disclose this, it is difficult to develop a complete picture of infrastructure and resource initiatives over this period. Notwithstanding this, my personal experience working in educational technology in the sector at this time suggests each institution 'did its own thing', but with a common goal of building their online presence to recruit more students. Technically, online learning management systems including WebCT, early iterations of Blackboard and institution-developed bespoke systems such as CECIL (Auckland University) and Classforum (Waikato University), were used to deliver an increasing array of units and courses to both urban and rural areas. These were supported by national network infrastructure improvements, including commencement of the Ultrafast Broadband (UFB) project in 2009, which aimed to provide fibre internet connectively to all New Zealand homes, schools and communities, by 2025.

While infrastructurally tertiary sector ICT development during this period made significant progress, this was generally not the case for the online educational content delivered through it. A lack of academic staff PLD focused on online learning design and pedagogy that acknowledged the unique challenges faced by online distance learners, resulted in units and courses that reflected a duplication of face-to-face designs, delivered online. In most institutions, online learning systems were used to deliver course information and passive, text-based content to students, rather than as a conduit for facilitating learner-learner and teacher-learner interaction with each other and course content, supporting collaborative knowledge development. One notable exception to this was the work of the late Nola Campbell at Waikato University, who led the Flexible Learning Leaders in New Zealand (FLLinNZ) project. Campbell's pioneering work delivering postgraduate qualifications in eLearning leadership and design based on sociocultural principles, resulted in the formation of an extended eLeadership community of practice, the members of which have been instrumental in shaping present online learning design and practice. A team led by Campbell was also responsible for the development of New Zealand's first blended teacher education qualification—the Mixed Media Presentation (MMP) Bachelor of Teaching degree, that commenced in 1997. The MMP option meant students could complete their qualification while based in their local community, and it has continued to be a popular choice for those living in remote and rural areas.

8.5.3 Tertiary Sector Professional Learning, Classroom Practice, and Student Capability Development

As for infrastructure, no national data are collected relating to tertiary staff professional learning opportunities, classroom practices or student ICT-related outcomes.

Although government had earlier published the Tertiary eLearning Framework (2004) there was no requirement for institutions to implement it, or if they chose to, report progress against any of its goals. Professional learning opportunities were at the discretion of each institution and varied considerably between institutions—but were usually based on upskilling academic staff in the technical skills to migrate existing course content to online systems. Unfortunately, few PLD opportunities were made available during this time that dealt with the unique challenges faced by online learners—particularly learning design and pedagogical considerations. Providing PLD support to tertiary teachers to help them address these issues was not seen as a priority for most institutions. Generally, leadership didn't understand—or chose to ignore, the fundamental differences between conventional and online learning, perceiving the latter as merely a cost-effective way of enrolling more students. Unfortunately, failure to acknowledge these differences and resource PLD and staff time to appropriately redesign courses, resulted in very high student attrition rates of up to 70% in some online offerings.

8.6 ICT in School Education Phase 3: (2009–Present)

8.6.1 The ICT Policy Landscape

A further change of government at the end of 2008 meant a return to the earlier 'hands off' approach to ICT in school education, and a reluctance of government to engage in any form of centralised or direct support for schools' ICT integration efforts. Since the 2006 strategy, 'Enabling the Twenty-first Century Learner' (Ministry of Education, 2006), no further ICT strategy for schools has been developed by government. Instead, in 2011 the Ministry of Education produced a document called the eLearning Planning Framework (eLPF), that was subsequently updated in 2014. The eLPF contained none of the forward-thinking vision of the earlier strategies, but was more a cyclic checklist of stages of ICT implementation, each stage having markers or aim points for schools to evaluate their progress towards the ultimate goal of ICT "empowering education" (Ministry of Education, 2014, p. 3). This was seen as the utopian position insofar as ICT integration was concerned, being described as:

> … your whole school, community and networks work in partnerships to reflect and plan. Technology use is ubiquitous, virtual, accessible and equitable, enhancing authentic, co-constructed learning within and beyond the school community. Teachers work collaboratively alongside students to create personalised, higher-order, real world learning…
>
> (Ministry of Education, 2014, p. 2).

While aspirational in the level of challenge it presented to schools, the eLPF, unlike previous strategies, contained no indication of how schools were supposed to progress between its levels, nor provided any new support or resources that would

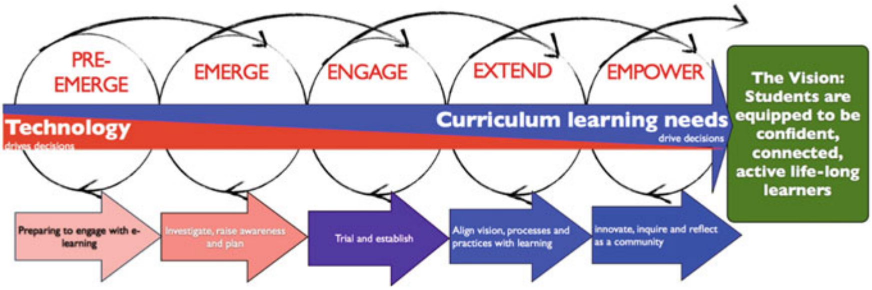

Fig. 8.2 The cyclic model of New Zealand's schools' eLearning Planning Framework (eLPF). *Source* NZ Ministry of Education

enable them to do so. Schools were left on their own to progress their ICT integration, using the eLPF as a 'step to' guide (Fig. 8.2).

8.6.2 ICT Infrastructure, Digital Content and Resources

During this period government concentrated on providing 'big ticket' infrastructure for schools, focusing on the Ultrafast Broadband (UFB) project, the development of a national Network for Learning (N4L), and N4L's education bolt-on, the POND portal. The UFB project was announced in 2009, with the aim of providing fibre-based ultra-high speed internet connectivity to 99% of New Zealanders by 2025, and to all schools by 2020. For schools, this meant having access to unlimited data at download speeds of up to 1Gbps, and as at mid 2018, 97% of schools have been connected to the network, with the remaining to be served by UFB's partner project, the Rural Broadband Initiative (RBI). Paralleling the UFB infrastructure initiative came a ramping up of the earlier SNUP project (School Network Upgrade Project), that focused on schools' internal network infrastructure. Technical infrastructure provided under the later SNUP generally comprised a hybrid combination of Category 6 ethernet and wireless network access, with the architecture for each school differing according to its geography and physical layout. While SNUP is ongoing, as at the end of 2017, over three quarters of all eligible schools have completed SNUP upgrades.

Aligned with SNUP and the UFB project, in 2013 a government-owned company, Network for Learning (N4L) was established. N4L had as its mission to:

> …connect more than 2400 schools across New Zealand to fast, reliable, safe, uncapped internet via our Managed Network. The service is fully funded and managed for schools, allowing every student and teacher seamless access to the internet, regardless of where they go to school.
>
> *Source* Network for Learning; https://www.n4l.co.nz/about-us/

In addition to providing managed network services, N4L established the POND portal (https://www.n4l.co.nz/pond/), which is "a free online community connecting and empowering educators" (N4L, 2016, NP). POND is described as the place for New Zealand educators to "discover and share resources, knowledge and experiences, all within a supportive and generous environment solely focussed on teaching and learning" (N4L, 2016, NP). POND is both a searchable resource repository and a forum for teachers to collaborate and extend their professional networks. It was established to allow teachers to engage collaboratively and share resources online using the UFB network, but to date its use by teachers has been limited. According to a 2017 Research New Zealand (RNZ) survey, New Zealand principals reported less than one-third of teachers in their schools use POND on a regular basis. While reasons for the low uptake of POND are unclear, a study carried out by the New Zealand Council for Educational Research (NZCER, 2016) indicated that only 11% of teachers found POND/N4L useful, compared with 75% for the much earlier-established TKI (see Phase 2 above). While still a relatively recent addition to teachers' digital resource options, indications are that POND may be competing in the same resource space as TKI, which already has a well-established reputation as a valuable resource portal.

In terms of access to school-supplied digital equipment and resources, the RNZ report suggests New Zealand schools have made little progress in improving the student-device ratio since 2011 (see Fig. 8.3). However, the advent of mobile,

Fig. 8.3 The school-supplied device-to-student ratio (primary and secondary schools), 2014–17. *Source* Research New Zealand

personally-owned devices and their increased availability for classroom learning through programs such as Bring Your Own Device (BYOD), signals a wider trend in New Zealand schools away from fixed hardware, towards mobile and portable technologies. Again, the 2017 RNZ survey indicates the extent of this transition, with principals indicating nearly 80% of students in their school were able to access personal or school-owned mobile devices for learning purposes, when required. Interestingly, and particularly in secondary schools, the number of school-owned devices per student is *lower* in schools located in high socio-economic areas. This may suggest schools are ‘off-loading’ the cost of technology provision to parents, who they may perceive to be financially able to afford it.

8.6.3 Teacher Professional Learning, Classroom Practice, and Student Capability Development

The beginning of 2013 saw the wind down of the cluster-based ICTPD program, that had proven to be reasonably effectively for upskilling teachers in the basics of ICT use in the classroom. The ending of ICTPD came at the same time as the emergence of mobile devices and BYOD initiatives, and the transition to this new ICT environment without the support of a program like ICTPD, proved challenging for many teachers. The RNZ report supports this conclusion, suggesting the impact of mobile devices in the classroom is not well-understood by teachers, with less than 20% of principals considering their teachers have sufficient skills to utilise them effectively for teaching and learning. Disturbingly, the report also found that while 75% of surveyed schools indicated they had an ICT strategic plan, considerably less than half of these accounted for use of personal mobile devices, and “notably, there has been little change in relation to schools having strategic plans for the use of digital technologies for learning, or what those plans cover, since 2014” (RNZ, 2017, p. 5). Despite the lack of coordinated PLD, the study indicates greater use of online resources such as Google online collaborative tools or Google Classroom and Microsoft Office 365, with principals reporting nearly 65% of staff use either system on a regular basis, with their students. Interestingly, despite the government’s purchase of Microsoft 365 licences for all teachers and students, only 14% of teachers indicated they used the Microsoft suite for teaching and learning purposes.

In the absence of any nationally-coordinated ICTPLD program, during this time schools and school clusters evolved their own professional learning programs, frequently responding to how they saw ICT supporting the learning needs of their students, and for some, engaging their communities. An example of one of these initiatives is the Manaiakalani (‘The Chief’s Hookline’) cluster, located in the low socio-economic region of South Auckland. Manaiakalani comprises 13 primary and secondary schools, and it began as part of the government’s ICTPD programme. Since that time it has evolved into a charitable trust, managed by a trustee board comprising prominent business, community and corporate sector leaders. Over the years, the trust board has secured funding from government and the private sector (including sponsorship from leading technology and telecommunications companies), enabling the development of a wide area network accessible by all cluster schools and their families, the provision of sufficient hardware for all students (on a subsidised lease basis), and the installation of robust wifi network infrastructure in each school. It has also supported teacher professional learning focused on Manaiakalani's 'Retooling School' model,[2] that emphasises the importance of cultural identify, student agency, high expectations and family partnership, in raising student achievement. Technology is viewed as an essential conduit in their 'Retool' model, enabling parents and whanau (families) to be more actively engaged in supporting the learning of their children. Since its inception in 2007, the initiative has been credited with making significant inroads into addressing historical patterns of student underachievement in numeracy and literacy in the cluster schools (Jesson & McNaughton, 2014).

The Manaiakalani model has proven to be very successful in delivering significant improvement in student outcomes through ICT-enhanced curriculum that fully engaged the school community. However, despite attempts to replicate the approach in other regions of New Zealand, similar outcomes have not been achieved. The context-specific nature of Manaiakalani, strong and visionary leadership, and an ability to unite community and business for a 'common cause', have proven to be unique attributes that are difficult to replicate. For the most part, ICT use to engage schools with parents and communities is for administrative purposes, with the vast majority using it for simple communication including email (93%); information on a school website (91%); newsletters (89%); social media (74%) and text services to report absences or truancy (72%).

8.7 Conclusion

Despite a lack of national support for PLD and the continuing reluctance of government to invest in hardware for schools, New Zealand teachers remain very positive about the potential and relevance ICT holds for enhancing student learning, and are aware of its importance to the future of students they teach (RNZ, 2017). While some barriers that existed 30 years ago are still present today—including inadequate device/student ratios; the high cost of continual technology upgrades; concerns relating to device costs for parents; cost of online services; technical support, and ensuring safe and productive device use, substantial progress has been made towards seamless curriculum integration. As with other countries, challenges still remain to translate this progress into widespread and significant advantages and outcomes for students, that will better-prepare them for their increasingly technological future.

[2]Full details of this can be found at https://www.manaiakalani.org/home.

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Chapter 9
Moving with Times: Singapore's Evolutionary Trajectory in Integrating Technology in Education

Yancy Toh and Chee-Kit Looi

9.1 Case Overview

Singapore's stellar performance in the recent international benchmarking exercises has placed the small country on the global map. Dubbed as a high-performing system, Singapore students have consistently aced the maths, science and reading assessments and more recently, in collaborative problem-solving skills too (OECD, 2017). Notwithstanding these achievements, it is noteworthy that the country has its humble beginnings, struggling precariously with survival after an unanticipated independence. During the survival-driven stage from 1959 to 1978, ethnic divisions, high unemployment rate and poor infrastructure plagued the then young and vulnerable state. There was dire need to provide education. The provision of centralised curriculum enabled a low initial base of educational literacy to be augmented quickly. During the efficiency-driven stage from 1979 to 1996, the country placed emphasis on creating economic competitive advantage regionally and internationally. There was mass customisation of education to reduce wastage and maximise talents. The ability-driven stage from 1997 to 2011 saw Singapore's efforts in galvanising momentum for globalisation, placing a premium on creating a creative, autonomous and knowledge-based workforce capable to compete in value-added markets. During this phase, there was a movement to encourage curriculum innovations and adaptivity in schools. Technology was introduced in schools to prepare students for the future workforce, as well as to support the pedagogic transition from a teacher to student-centred instruction in Singapore schools. The current student-centric, values-driven phase aims to anchor students in values and character and to prepare them to do well in life

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_9

by embarking on lifelong learning. The use of technology has been and will continue to be an important driver for change in Singapore's educational landscape, as seen from the four successive waves of the implementation of ICT Masterplans from 1997 till the present day. Figure 9.1 shows the policy imperatives undergirding the four major waves of Singapore's educational reform.

In 2017, with a population of 5.6 million, there are about 359 schools and 436,426 students, 33,163 teachers, as well as 8001 educational partners which comprise allied educators, executive and administrative staff in the system (Data.gov.sg, 2019). According to the Human Development Report (2014), Singapore allocated about 3% of its annual budget for education—significantly lower than most developed nations such as Finland, whose education budget is 6.8%. This signals that Singapore as an education system, is efficient, evident from its modest spending and high rate of student achievement. Although the nation has scored outstandingly in the various benchmarking tests, it is cognisant that what has worked in the past may not be viable for the VUCA (volatile, uncertain, complex and ambiguous) world. Against this backdrop, this chapter delves into Singapore's reform trajectory of technology integration into schools over the years, as exemplified mainly by the four ICT Masterplan for education. Policy perspectives underpinning each wave of Masterplan will be discussed, accompanied by a retrospective look at the implementation strategies and outcomes of the national reform. As the documentation on earlier days of ICT Masterplan implementation is limited, the chapter draws related data primarily from Koh and Lee (2008); Second Information Technology in Education Study (see Law, Pelgrum, & Plomp, 2008; Pelgrum & Anderson, 1999), and online reports published by the Ministry of Education, Educational Technology Division

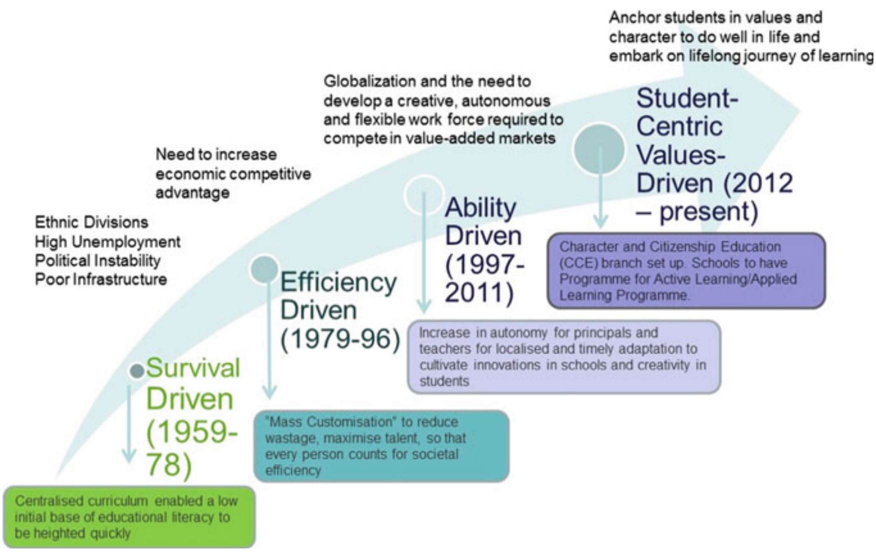

Fig. 9.1 Policy imperatives undergirding the four major waves of Singapore's educational reform

on their ICT connection website (see https://ictconnection.moe.edu.sg/). The chapter concludes with reflections on the challenges and issues ahead.

9.2 Policy Perspectives

Singapore's educational directives are largely tied to macro national strategies, which allows the nation to be coherent in terms of policy making and implementation. This could be seen from the ways the ICT Masterplans were being conceptualised and cascaded to schools. This segment, discusses at length, the philosophies undergirding each wave of Masterplan, as well as the respective implementational considerations such as infrastructure, educational resources, ICT integration and practices and teacher development before concluding with outcomes in terms of student achievements after traversing the two-decade long journey.

(1) ***Masterplan One: Building the Foundation (1997–2002)***

Overview.

The first ICT Masterplan for Education (MP1) was unveiled in 1997. Spanning over a period of five years, its goals then were tied to the educational movement of "Thinking Schools, Learning Nations" where there was prevalent emphasis on critical and creative thinking skills. MP1 aimed to accentuate these skills by enhancing linkages between the school and the broader global environment so that both teachers and students can expand and enrich the learning environment by collaborating with global learning partners. It also aimed to foster creative thinking, lifelong learning and social responsibility by engendering innovation in education. Administrative and management excellence in the education system was also highlighted to support the operationalization of the goals. To sum up, this phase was about laying a strong foundation for schools to be equipped with the skills to harness ICT proficiently, as well as providing the basic infrastructure and building capacity for teachers to have basic skills in integrating ICT into their lessons. By the end of this phase, Singapore schools had made great strides in terms of infrastructure, educational resources, ICT integration into practices, students' competency and teachers' professional development.

Infrastructure.

A lot of emphasis was placed on infrastructure during the earlier days of reform. A significant portion of budget was spent to create technology-enabled environment so as to provide students with access to infocomm in all learning areas of school. In conjunction, there was ambition to leverage school-wide network to link all schools and to provide hardware for enabling high-speed delivery of multimedia services across the island. There were plans to decrease the student-computer ratio gradually over the years. By the end of MP1, student-computer ratio was decreased from 6.6:1

to 2:1. Every school was able to achieve a teacher-notebook ratio of 2:1, thanks to the heavy subsidy provided by MOE. MOE also centralized the procurement of hardware so as to achieve cost efficiency. A centralized portal was also created to serve as a single point of access to student data and resources within schools and across clusters. There was also re-configuration of school space to accommodate essential power points, network points and server rooms. Likewise, school space renovation was centrally managed by MOE too at this early phase.

Educational Resources.

As the ICT capacity base was still low then, many activities were coordinated centrally at MOE's level. Acting like a central clearing house, the MOE intranet-based website known as Edu.Mall evaluated and recommended related resources. Intensive resources were also invested to produce videos and CD-ROMs, both in-house and in collaboration with industry, thus engendering the embryonic growth of an ICT-enabled ecosystem which accentuated the tripartite partnership between the Ministry of Education (MOE), Economic Development Board (EDB) and local industries. EDB provided the much-needed development grants while MOE provided pedagogical and content advice. Local industry focused on development and marketing. This period also saw a flurry of industry-led activities to develop a whole suite of learning solutions comprising content management systems and learning content for teaching and learning. A "Digital Media Repository" for lesson plans and licensed digital resources was also made available for school consumption.

ICT Integration Into Practices.

The integration of ICT into practices can be examined from the conceptualisation and development of curriculum and assessment. At this phase, there was cognisance about the need to achieve a better balance between acquisition of factual knowledge and mastery of concepts and skills. Students were encouraged to engage in more active and independent learning with the help of technology. This shift of engagement was also accompanied by the incorporation of assessment modes that would measure higher-order skills such as critical thinking and application of information. Assessment became more holistic, which encapsulated project works and the use of digital tools and software for scientific investigations. For these to materialise, MOE implemented a more radical move to reduce the curriculum content of 30% to create more space for schools to infuse of ICT-enhanced lessons and student-centred activities that promoted thinking skills.

Teachers' Professional Development.

The success of reforms cannot be divorced from the capacity of champions spearheading the programs. In the education context, teachers are the agents of change driving purposeful reforms in their classrooms and beyond. To equip teachers with essential ICT-related skills, the Educational Technology Department was established for capacity building. Working closely with other divisions such as the Curriculum and Planning Development Division (CPDD) and Information Technology Branch (ITB), ETD fulfilled their mandate to train every teacher in the meaningful use of ICT for teaching and learning. To operationalize such a Herculean task, the massive effort was segmented into three phases, starting with the training of teachers in 22 ICT demo schools and slowly increasing the numbers to 100 and subsequently 250 schools. In addition, all in-service teachers were required to go through 30 h of related training. As for trainee teachers, they had to design small units of constructivist-based multimedia packages known as microLessons as part of their curriculum while undergoing training at the National Institute of Education (NIE). In 2002, a network of teachers and officers from MOE became trailblazers to explore emerging technologies. Known as TecXplorers, these agents experimented and shared their ideas to peers. Here, we see that capacity building efforts entailed multilateral partnership, underscoring the importance of harnessing complementary strengths to achieve desirable outcomes (Koh & Lee, 2008).

Students' ICT competence.

Masterplan One concluded on a high note, with Singapore receiving international accolades. In the Global Information Technology Report 2001–2002, Singapore was earmarked as one of the countries that had been "progressive in using ICT to create one of the most ICT-savvy societies in the world" (Kirkman, Cornelius, Sachs, & Schwab, 2002, p. 274). Students had opportunities to collaborate with overseas schools through a networked environment, honing their communicative and collaborative problem-solving skills. In general, students achieved the baseline ICT standards (such as basic typing) to support them in learning, as attested by surveys where students indicated that they had the necessary skills to complete ICT-based assignments. In the ThinkQuest International competitions which promoted the creation of web-based educational materials by teams of students, Singapore had the highest number of finalists after USA (Koh & Lee, 2008).

In short, MP1 had built a solid foundation, be it infrastructure, capacity building or curriculum reform, to pave way for subsequent waves of reform. Notably, this phase had created a paradigm shift regarding the acceptance of the use of technology for student-centred and constructivist learning. Teachers had higher level of readiness, as reflected by the "Second Information Technology in Education Study" (or SITES 2-M1) conducted by the International Association for the Evaluation of Educational Achievement (or IEA) in 1999. Singapore scored phenomenally well in areas of teachers' knowledge of ICT-based instructional practice, avenues to develop their ICT skills and school principals' attitude towards the use as compared to other educational systems (Pelgrum & Anderson, 1999). While there were many celebratory moments during the MP1 phase, the peaks of excellence were contained within pockets of schools. There were also signs that centralized efforts to streamline processes may not be efficacious as before, leading to a different approach of ICT integration in MP2.

(2) ***Masterplan 2: Seeding Innovation (2003–2008)***

Overview.

Building upon the solid foundation enabled by MP1, the vision of MP2 was to use ICT pervasively and effectively to enhance educational processes and structures as well as to customise learning to support and develop lifelong learners with diverse needs—goals that were in alignment with the macro policy of "Teach Less, Learn More" (TLLM). Implemented in 2005, the TLLM initiative underscored the importance of engaged learning, as opposed to performative pedagogies that focused myopically on assessments. With the reduction of content across subjects to free up 10–20% of curriculum time, schools had more "white space" to become agents of change to develop their own pedagogical approaches that were more finely tailored to the needs of their students (MOE, n.d.; Toh et al., 2015).

MP2 aimed to redesign the curriculum to integrate ICT in a more holistic way, with a clear focus to advance from a teacher-centric pedagogy to a student-centric pedagogy. As schools had become more diversified in terms of ICT capacity by the end of MP1, MOE advocated a more decentralised approach to allow schools to have greater autonomy in utilising their ICT funds to customise their ICT integration plans. There were six intended outcomes of this phase: (1) ICT would be increasingly used for active learning; (2) greater links between curriculum, instruction and assessment would be forged; (3) teachers would be harnessing ICT for professional and personal growth; (4) schools to develop capacity for using ICT for school improvement; (5) active research in ICT in education would be implemented and that (6) infrastructure would be developed to support the pervasive use of ICT in schools. Cognisant of the differential pace of ICT integration across schools, MOE adopted a differential approach to policy implementation. Whilst setting a realistic baseline ICT competencies that were to be met by all schools, MOE also encouraged schools that were ahead of the curve to push their frontiers further. The latter was bolstered by the introduction of recognition schemes and collaborations with industry partners, which will be elaborated in the following segments.

Infrastructure.

Koh and Lee (2008) articulate the shift in emphasis from the MP1 to MP2:

> The focus in the First Masterplan was to provide schools with the basic infrastructure and provisions, whilst that in the Second Masterplan was to provide schools with an enhanced ICT infrastructure that could facilitate different modes of lesson delivery and support varied learning, that is, one that could support an undisrupted delivery of powerful multimedia and full interactivity of instructional content. (p. 73).

To achieve this, infrastructure has to be dependable, flexible and safe to provide a "multi-purpose, multi-functional, pervasive and ubiquitous ICT-enriched environment, and flexible support framework" (Koh & Lee, 2008, p. 73). During this phase, the exploration of collaborative technologies was encouraged and supported by wireless networks. Student-computer ratio was reduced further to 6.5:1 for primary schools and 4:1 for secondary schools and junior colleges. Each school was provided with support services such as a central Helpdesk deployment of technical assistants and additional professional services could be procured with ICT funds.

Educational Resources.

Aligned with the principle of ubiquitous ICT-enriched environment, various resource sharing platforms were also established. Notably, edumall 2.0, a web-based resource repository managed by MOE was set up to ensure teachers had a single point portal to access the multitude of resources and to promote the use of resources to enhance teaching and learning. To enable the sharing of digital resources created by teachers, an inter-cluster resource sharing platform known as i-SHARE was also set up to share expertise. This development signalled the maturity of teachers' capacity to create ICT-related resources in our system.

ICT integration into practices.

By 2006, MOE initialled the roll-out of a set of baseline ICT standards across all schools. Examples of baseline standards include knowledge about the use of basic ICT tools, namely, Internet, email, word processing and presentations. Concomitantly, schools that demonstrated higher level of readiness in integrating ICT acted as trailblazers, experimenting with the use of emerging technologies to advance student-centred pedagogies and taking a greater lead to raise the bar of other schools. The inception of LEAD ICT@Schools (Leading Experimentation and Development in ICT) in 2006 and FutureSchools@Singapore (FS@SG) programmes in 2007 provided these forward-looking schools with the space to continue their experimentation. These schemes also acted as a platform to recognise their efforts.

15–20% of schools were recognised as technologically advanced under the LEAD ICT@School Programme. These schools were ready to achieve a higher level of IT use for at least one subject across one level. With additional funding from MOE, they will be able to act as testbeds to continue their research in emerging technologies or to scale up their existing practices at a more significant scale. Another 5% of the schools were awarded the FS@SG status for their readiness to use ICT across all subjects and levels at a school-wide level. Serving as peaks of excellence for their exemplary use of ICT, these schools had to spread their innovations to propagate informed practices on the use of ICT to enhance engaged learning. Supported by the National Research Foundation, these schools worked closely with MOE, Infocomm Development Authority, industry partners and Institutes of Higher Learning to bring their concepts of transforming teachers and students' learning experiences to fruition.

The establishment of the Learning Sciences Lab (LSL) at the National Institute of Education (NIE) in 2005 was also part of MOE's multi-pronged effort to spearhead research and development work with schools to encourage experimentation with cutting-edge ICT-mediated pedagogical practices at schools. To ensure valuable insights would not be lost, the Educational Technology Division (ETD) at MOE synthesised the findings of research conducted by MOE and NIE and these reports were available on platform known as Knowledge Repository.

Students' ICT competence.

According to survey conducted by MOE, students were competent in the use of basic ICT tools, which largely met the baseline standards established by MOE (Koh & Lee, 2008).

Teachers' professional development.

With the broadened vision to integrate ICT more pervasively, there was growing momentum to augment teachers' capacity concurrently. During this phase, mass customisation programme was adopted to cater to the differentiated needs of teachers. Some of these programmes were tailored based on domain-specific requirements and conducted for schools or clusters. Professional Development Guides for teachers and HODs were developed to help school fraternity in "profiling their ICT competencies, identifying their learning needs and planning their own professional development" (Koh & Lee, 2008, p. 67). School teachers and leaders also had opportunities to attend international conferences or programmes conducted by NIE. More importantly, social and peer learning were much foregrounded during this phase. ETD established several Communities of Practice (CoPs) to tinker ideas, provide support, share practices and discuss issues of ICT integration amongst schools. Cross-disciplinary consultancy teams from different organisations were also formed in 2004 to help schools to set up the ecosystem to get MP2 going.

These pivotal developments of MP2 culminated into widespread integration of ICT in schools, albeit at differential pace and depth. Notably, Singapore was ranked 5th in the Global Information Technology Report 2007–2008 (MOE, n.d.). According to Koh and Lee (2008), 80% of the schools have met MP2 outcomes, with another 15% exceeding expectations. Other challenges that surfaced during this phase include the inadequacy of traditional assessment modes in measuring 21st century learning skills; variegated level of support from school leaders and the need to bridge the gap between research and practice. In 2006, the "Second Information Technology in Education Study (SITES)" conducted a worldwide survey on the pedagogy and ICT use in schools around the world. Culminating in a report (Law, Pelgrum, & Plomp, 2008), the survey results were benchmarked against 9000 schools of 22 participating countries from Europe, Africa, Middle East, North America and Asia. 164 Singapore schools participated in the quantitative survey. Singapore schools scored overwhelmingly high in these dimensions: re-allocating workload for collaborative planning (85%), reviewing pedagogical approaches of teachers (97%), monitoring implementation of changes (94%) and having teachers collaborate with external experts (89%). Singapore also fared well in terms of ICT applications and facilities. Many schools also recognised the value of technology in terms of preparing students for the future and using it as a means to change school practices. However, they were also cognisant about their limited competency in integrating ICT into lessons as school leaders struggled to develop a common pedagogical vision of student-centred learning which teachers could identify and subsequently internalise (Pelgrum & Plomp, 2008).

(3) ***Masterplan 3: Strengthening and Scaling (2009–2014)***

Overview.

The third Masterplan for ICT in education (MP3) continued the thrusts of MP1 and MP2 to continue to enrich and transform the learning environment of students and equip them with critical competencies and dispositions to succeed in a knowledge economy (MOE, n.d.). In particular, self-directed learning (SDL) and collaborative learning (COL) skills were foregrounded, together with the trend of highlighting CyberWellness so that students can be discerning and responsible users of technology.

It was envisaged that teachers would have the capacity to plan and deliver ICT-enriched learning experiences that enculturate these skills and school leaders would provide directions and conditions to harness ICT for teaching and learning. There was continuous emphasis on ubiquitous learning which called for a ICT infrastructure that supported teaching and learning anywhere and anytime.

Infrastructure.

Two principles underpinned the design of learning environment under this phase. They were: to establish a responsive and flexible ICT learning environments in schools; and accessibility to learning resources from home. To operationalise these two principles, it was envisaged that the ICT environment would have to be nimble enough to respond to the changing curriculum needs and the customised demands stemming from individual schools as well as to keep pace with technological developments to avoid obsolescence. The environment would need to support ubiquitous learning and easy access to computing devices to support multimodal learning. A range of technical support services had to be readily available. In terms of ICT provision, every student would have access to computing device equipped with the necessary supporting applications and bandwidth to enable learning from home.

This phase saw the upgrading of bandwidth to 20 Mbps for all schools in May 2010 (MOE, n.d.) and more schools were using mobile devices instead of desktop computers to utilise the affordances of mobility in supporting the goal of learning anytime and anywhere. In addition, MOE and IDA also jointly developed backend technology to enhance the interoperability of content across all Learning Management Systems (LMS) used by schools.

Educational Resources.

A one-stop Resource Portal known as OPAL (One Portal All Learners) was set up to host all digital resources that were created, procured or curated by MOE. Examples of resources include ICT-enabled lesson plans exemplars created by schools. Schools would be able to submit, view, search and manage lesson exemplars. As these resources would be evaluated by MOE, there was assurance to their quality. The platform allowed teachers to participate in discussions related to teaching and learning and be part of the learning community.

ICT integration into practices.

The use of ICT was more deeply embedded into curriculum, pedagogy and assessment under this phase. More importantly, there were efforts to engender "greater alignment of students' learning outcomes in the syllabi, national examinations, classroom experience and 21st century learning skills such as ICT skills, and the ability to communicate persuasively and collaborate effectively" (MOE, n.d.). The baseline ICT standards was revised to include core ICT skills that would equip students with skills to prepare them for the future. Students need to leverage ICT to look for information, synthesise reports and contribute their part to peer learning by providing feedback and working with peers both within and outside school for all subjects. A core set of subject-specific ICT-enriched learning experiences was codified and piloted before formal embedding into syllabus. Similarly, for assessment, there were efforts to expand the repertoire of tools designed to evaluate students' competencies, particularly, for SDL and COL that were not readily captured by traditional assessments. MOE also developed a CyberWellness Framework for curriculum integration in 2008 which was implemented by all schools.

For the first time along MOE's ICT journey, MOE specifically delineated the role of school leaders in supporting ICT integration. School leaders were expected to provide strategic directions by promulgating shared school ICT vision, goals and expectations as well as to translate them into strategic plans. They were also expected to create conditions to foster strong ICT culture and systemic support culture to help their schools advance the use of ICT for student-centred learning. For teachers, to promote SDL and COL, they would be expected to establish teacher-student partnership, experiences for extension of students' learning and conditions for students' self-management and monitoring of their learning, provide assessment of individual and group learning, structures for collaboration and effective group processes among students (MOE, n.d.).

Students' ICT competence.

In collaboration with NIE researchers, MOE commissioned a research study on the evaluation of implementation of MP3 and its impact on Singapore schools. The study reported students' high competencies in basic ICT skills. The students also perceived themselves to be frequently engaged in SDL and CoL using ICT. However, students' perception of SDL was largely academically driven and revolved around achievement of better results. Likewise for CoL, the students were more motivated by task completion than to advance their understanding of subject knowledge. The researchers also cited room for improvement especially for using reflection tools to advance meta-cognitive skills (Tan et al., 2010).

Teachers' professional development.

To support schools and teachers in transforming their teaching practices, MOE had put in place multi-pronged professional development strategies by leveraging expertise from multiple partners. Working closely with university researchers from NIE, two monographs on SDL and CoL were published to illuminate the concepts as well as assessment strategies of the two constructs. Considering the nascent discussion of SDL and CoL, the monographs were much needed to demystify their application in learning contexts that are aligned with the overarching goals of MP3. MOE also collaborated with NIE to develop the capacities of teachers and school leaders through various leadership programmes.

To help school personnel understand their roles in the implementation of ICT, an ICT-PD framework was devised. The framework also served as a roadmap to guide ETD in their planning of nation-wide professional learning programmes. MOE also continued their consultancy support to schools, especially in terms of addressing the need for discourse to promote depth in action research. They also organised yearly educational technology conference for schools to showcase exemplary practices and to promote critical discussion on the use of ICT in enhancing teaching and learning.

The ICT Mentor scheme was also rolled out to all schools to cascade ideas in a more efficient and effective manner. Each school will nominate their ICT mentors who would meet regularly with mentors from other schools to exchange ideas related to the use of ICT in their respective disciplines. Promising ideas were then contextualised and harvested in their respective schools. The training of these mentors as reflective practitioners of ICT use was carried out in 6 phases from 2010 to 2012.

Research constituted another important feature of teachers' professional programme. Strong support was given by MOE to encourage schools to tinker with ICT-mediated pedagogies and marry both research and practice. The eduLab programme, which was a joint effort between MOE and NIE, was established to enhance teachers' pedagogical understanding of ICT use, support schools' ground-up initiatives, translate research into classroom practices, broker industry partnership and to scale up innovations that had achieved proof-of-concept to benefit more schools in the system. With evaluation from experts across different disciplines, research funds were disbursed to schools that submitted promising proposals to advance teaching and learning.

Overall, the suite of professional learning programmes highlighted the commitment of MOE to provide centralised leverages to support ground-up initiatives. Systems-structure approach to seed innovations in classroom; the levelling up of teachers' competencies with regard to innovative pedagogies and enculturation of innovative dispositions were evident.

To sum up, this phase propelled several reforms as encapsulated by the shift from centralised control to decentralised autonomy; from teacher-centric to student-centric pedagogy; from quantity to quality of educational outcomes and from content-heavy to judicious content-reduction efforts to create more space for innovations. The ICT MP3 report conducted by NIE indicated that teachers had reported high competencies in their basic ICT skills and were comfortable using existing ICT tools to support their classroom teaching. However, specific uses of ICT for SDL and CoL were still sporadic (Tan et al., 2010).

(4) ***Masterpan 4: Deepening Learning, Sharpening Practices (2015–2020)***

Overview.

Recognising the need for an infrastructure to support a 21st century education, MOE has introduced a framework to promote 21st century competencies such as Communication, Collaboration and Information Skills (CCI); Critical and Inventive Thinking Skills (CIT); and Civic literacy, Global awareness and Cross-cultural (CGC) skills (MOE, 2014). In addition, there is more emphasis on a student-centric values-driven education that anchored students in values to do well in life and embark on lifelong journey. The direction of MP4 to nurture future-ready and responsible digital learners is thus well aligned with this overarching vision, so is the broadened focus on total curriculum to develop 21st century competencies. In this light, Cyber Wellness continues to be an area of focus. As expounded by MOE, the goal of MP4 is to put "Quality learning in the hands of every learner—empowered with technology" (MOE, n.d.). To see this to fruition, two enablers were identified: (i) Teachers as

Designers of Learning Experiences and Environments; and (ii) School Leaders as Culture Builders. MOE also elucidated 4 approaches for operationalising the vision. They are namely: deeper ICT integration in curriculum, assessment and pedagogy; sustained professional learning; translational research, innovation and scaling; as well as connected ICT learning ecosystem.

Infrastructure.

Consistent with MP3, MP4 looked into developing future-ready, scalable, and reliable infrastructure in every school to support learning anytime and anywhere. Advancing from MP3, the connected ICT learning ecosystem outlined not only the importance of physical infrastructure but socio-cultural infrastructure as well. Through home-school-community collaborations, it was envisioned that the infrastructure set up would be able to provide flexibility and agility in ICT implementation. During this phase of scaling and strengthening, the wireless coverage and bandwidth in schools would be upgraded. Current security policies would be reviewed to minimise disruptions to school innovations. Example include the move to support an increasing number of schools implementing Bring-Your-Own-Device (BYOD) initiative. MP4 aims to achieve 1:1 access. Schools have the prerogative to determine the resource configuration and level of school readiness before embarking on this initiative. To ensure equitable access, funds will be provided to help schools support needy students.

Educational Resources.

Moving beyond the provision of Learning Management System (LMS), the new development of Student Learning Space (SLS) is a major effort to provide students with equitable and self-paced access to high quality digital resources developed, procured and curated by MOE in collaboration with internal and external partners. Also accessible to teachers, these resources, together with pedagogical scaffolds and instructional guides, would be aligned to curriculum foci and recommended pedagogies to augment teachers' capacity to create lesson packages. Teachers could draw upon the galore of artefacts to plan lessons tailored to students' needs. Sociality is also embedded in the design of SLS, evident from the fact that collaboration amongst students and schools would be made possible through the integrated portal. The ability to customise publication, track performance, develop portfolio and connect web-based app complements personalised learning—important facet of lifelong learning.

ICT integration into practices.

With a renewed focus on preparing future-ready students, the baseline ICT standards for digital learners now includes the development of skills, values and attitudes for students to succeed in a new economy. The baseline standards comprise technical understanding of tools, searching and organising information, evaluating resources, creating digital multimodal products and collaborating respectfully as well as connecting and communicating digitally. Adopting a more integrative approach, the Cyberwellness Programme is now incorporated into the Character and Citizenship Education curriculum.

Undergirding the philosophy of teachers as designers of learning experience, teachers are to promote engaged learning through transformative use of technology and be reflective practitioners who ponder critically upon the learning gains of technology in adding value to advancing subject disciplinarity and 21st century competencies. As culture builders, school leaders empower the school team to engender teacher ownership in the use of teaching and learning.

Building on the eduLab initiative, MP4 focuses on translational research, innovation and scaling where the propagation of evidence-informed innovations will gain traction to benefit other schools under this phase. To better integrate ICT into practices, eduLab will scan, seed, translate and diffuse successful practices for adoption and adaptation across schools.

Teachers' professional development.

To be an efficacious learning designer, teachers have to understand the pedagogical affordances of technological tools, evaluate their ability to achieve the instructional goals and design the learning environment that will enhance engaged learning. To support teachers in developing such capacities, a myriad of professional development programmes have been put in place. ETD will conduct strategic and instructional design sessions with schools. Teachers can attend online modules, face-to-face workshops and on-site coaching sessions, or participate in subject-based and interest-based learning networks to deepen their knowledge. Milestone courses to train middle managers and school leaders are also available to train these personnel to be instructional leaders of technology.

These PD opportunities serve to advance teachers' understanding about the role of technology in curriculum, pedagogy and assessment, expertise to plan professional development for technology integration and ability to provide supporting structures for monitoring and evaluation for technology for their own schools.

MP4 is currently still underway and it is premature to comment on its impact and achievement. Overall, the espoused intents underpinning the formulation of MP4 is more holistic compared to the preceding milestones. Professional Learning is more broad-based, situated and systematic, as seen from capacity-building of school teams and strengthening of networked learning communities for technology in learning. These strategies broadened the capacity base of ground-up champions. Potentially, there appears to be deeper *ICT integration in curriculum, assessment and pedagogy—an effort that stemmed from collaboration across departments* within MOE and with partners spanning industry sectors and institutes of higher education. Effort to level the field by focusing on equitable and scalable access to quality resources is also a positive move to be more inclusive.

9.3 Discussion and Conclusion

(1) ***Outcomes and achievements***

Table 9.1 summed up the salient features and shifting priorities of the four Masterplans. The trajectory showed a consistent commitment towards harnessing technology to foster student-centred learning by giving both teachers and students greater ownership in the knowledge co-construction process. The infrastructure architecture and apparatus for capacity building also gravitated towards enhancing social learning and coherence in planning and enactment. These signalled that the policies involving the use of ICT in Singapore's educational landscape is now increasingly participatory, evident from the following:

(1) There was embodiment of cognitive diversity, as seen from the numerous emergent consultations amongst teachers, students, academics, industry players and policymakers across different disciplines—as opposed to top-down control of instructional supremacy. There was deepening of collaborative modes between multiple stakeholders, establishing an ecosystem that attempted to augment knowledge transfer amongst MOE, schools, universities and industry.

Table 9.1 Salient features and shifting priorities of the four Masterplans for ICT in education

	MP1 (1997-2002) Buidling Foundation	MP2 (2003-2008) Seeding Innovation	MP3 (2009-2014) Strengthening & Scaling	MP4 (2015 -) Deepening Learning, Sharpening Practices
Overarching mission	Thinking School, Learning Nation	Teach Less, Learn More	Intelligent Nation, Global City	Student-centric, Values-driven education
Pedagogy	Largely teacher-centred pedagogies	Implementing learner-centred pedagogies	Emphasing self-directed learning and collaborative learning	Emphasing 21st century competencies
Curriculum & Assessment	Enhance Delivery of curriculum	ICT integrated into curriculum planning & design	ICT integrated into curriculum planning, design, & implementation stages	Total curriculum for subject mastery, 21st CC, new media literacy and cyberwellness
Professional Development	Core teacher training	Differentiated professional development programme	ICT mentorship Professional Learning Communities	Networked Learning Communities
Capacity Building	Centralised top-down approach	Top down support for ground-up initiatives	Ground-up and centralised top-down approach to drive innovation for selected schools	Build ICT capacity of school team to develop good ICT practices
Research & Development	Launched school-industry partnership scheme	-LEAD ICT schools - FutureSchools	Network of Educational Labs	Translational research, scaling and innovation
Infrastructure & Support	Setting up basic infrastructure	Inter-cluster sharing of resources	Nationwide wireless broadband network Using Web 2.0 technologies	Conected ICT ecosystem including physical infrastructure such as SLS and socio-cultural infrastructure encapsulating partnerships

(2) Ecological outlook that took into consideration the inter-relationships between different phases of ICT implementation and interactions amongst different layers of the system was embraced.
(3) There were multi-pronged opportunities for social learning, as witnessed from the growth of learning communities and social apprenticeship opportunities led by ETOs, researchers and school teachers. There was cognisance of the importance to build capacity from within the school for a sustained trajectory. There were more evidences of maturing of teacher capacities where confident teachers had been serving as change agents to propagate sound pedagogical practices within and across schools.

(2) ***Challenges***

Amid the upbeat developments, there were challenges that may forestall the momentum of ICT integration. They are delineated below:

(1) At the policy level, whilst centralised supports such as consultancy teams were deeply appreciated by teachers, the labour-intensive social apprenticeship process had its limitations, especially in terms of diffusing innovative practices. Pedagogical innovations need to reach self-sustaining state as external resources will dissipate. ETD evinced a profound awareness of this issue and had been actively enabling capacity on the ground to take the diffusion work further.
(2) At the network level, consolidation efforts in terms of connecting pockets of excellence had been a highly complex endeavour. The SLS initiative was an attempt to synthesise insights accumulated over the years.
(3) At the school level, the variegated landscape had been a perennial issue. Some schools had been using ICT in perfunctory ways while some were recognised both internationally and locally for using ICT in deep and meaningful ways. The next step is to continue to leverage ICT-enriched schools in learning networks to level up the capacity of other lagging schools in the same network.
(4) School teachers are still citing time constraint and incompatibility with high-stake exams as major challenges of using technology for student-centred instruction. Schools with reform experience need to share success stories of how they managed to navigate the issues to infuse technology-mediated learning in their schools.
(5) Students are still using ICT for academic purposes, and not advancing disciplinary knowledge (Tan et al., 2010), which is largely congruent with other research findings about the focus of "performative pedagogy" in our system. Transformative change needs to be accompanied by change of mindset of actors in the ecology, including students, teachers, school leaders, policymakers and parents.

(3) ***Reflections and issues***

Amid the fact that ICT implementation may be hampered by ground issues, there are strengths in our system, especially ecological coherence and feedback loops across different phases of policy formulation, bolstered by strong tripartite relationships between government, schools and universities (Toh et al., 2014, 2016). Emphasis on documentation, such as exemplary lesson plans and policy reviews also impel the transfer of organisational memory, which contributes to coherence. The implementation of Student Learning Space (SLS) signalled an important step towards equitable learning which is laudable. However, there is also a need to exercise caution to ensure the implementation departs from the efficiency paradigm and the old centralised mode of content creation and dissemination. As espoused by MOE, there must be participatory efforts amongst actors. Dialectical interplay of ownership between those who create and use the resources must be present to ensure teachers are not outsourcing good teaching to ready-made materials. Lastly, changing culture requires time and alignment across pedagogy, curriculum and assessment. We are seeing nascent changes in mindset over the years. If there is sustained effort to maintain coherence in years to come, we can be judiciously optimistic about enabling the lasting impact and change that we want to see.

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Chapter 10
ICT in the Education System: A View from Slovakia

Juraj Šebo and Dana Pal'ová

Abstract This chapter will provide information about the education system in Slovakia, major education policy documents and priorities, the current ICT (Information and Communications Technology) infrastructure, open educational resources, data about ICT competencies and skills of students, teachers' skills and professional development and finally about the outcomes and challenges. The introductory part will give an overview of the education system in Slovakia as a whole. The policy perspective section will look at the institutions, legal acts and newly developed National Programme for Upbringing and Education Development in the Slovak Republic until 2027 (called "Learning Slovakia"). It was published in September 2017 and focuses on ICT issues. In the infrastructure section, the situation in the field of ICT (hardware, software, connectivity) at different educational stages will be described. The ICT indicators in education in Slovakia will be compared with the EU average. The next part will look at educational resources in Slovakia at the EU, national and university level. This will present different initiatives, projects and portals with case studies. The part related to students´ ICT competences will outline ICT use for learning purposes in comparison to the EU average in addition to initiatives and activities towards ICT skill development. In the section looking at teachers´ professional development, there will be a comparison of teachers' ICT skills and needs with EU countries and the OECD average. In the final part, digital literacy challenges will be addressed.

Keywords Education system · ICT · Policy · Infrastructure · Open Educational Resources · E-skills

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_10

10.1 Introduction

Slovakia is a country located in Central Europe with a population of 5.43 million people and covering an area of 49,035 km^2 (2016). It shares borders with 5 other countries including Austria, the Czech Republic and Hungary. The capital city is Bratislava and it has a parliamentary republic political system. Prior to 1993, Slovakia was part of Czechoslovakia and since 2004 it has been a member of the European Union (EU). In 2009, Slovakia joined the Eurozone and uses Euro as its currency. The Gross Domestic Product (GDP) is equal to €80.958 billion (2016). The official language in the country is Slovak [adapted from (European Commission, 2017b)].

The Slovak education system is divided into four stages (pre-primary (ISCED 0), primary (ISCED 1, 2), secondary (ISCED 3) and higher education (ISCED 5, 6)) based on the age of the student. Every stage is supported by a complex network of institutions focused on a different field of education. The education system is comprised of 10 compulsory years of schooling. This is until the age of 16 without exemptions. Following this, it is possible to enter the labour market or continue with further study at secondary school and then at higher education institutions including universities.

Generally, Slovakia has achieved very good long-term results in the availability of secondary education (i.e. fully completed secondary education). In Slovakia, up to 70% of the population aged 25–64 have attained at least upper secondary education. This is the second largest proportion in OECD countries. The proportion of young people currently finishing secondary school is even higher. The availability of tertiary education illustrates the ability of a country to provide advanced workers with specific expertise and skills. In 2016, 30.5% of the population aged 25–64 in Slovakia were in tertiary education. In the OECD countries, this figure stood at 35% of the population. The employment of Slovak graduates stands at 75.2% (European Commission, 2016; OECD, 2016). In recent years however, there has been a demographic decrease of students in the whole education system, excluding pre-primary education [based on data from the (Statistical Office of the Slovak Republic, 2017)].

In terms of funding education in Slovakia (as a percentage of GDP and combining all education stages), it is among one of the lowest in the OECD countries (OECD, 2016). State expenditure on education in Slovakia was 4.1% of GDP in 2014. This is much lower than the 4.9% EU average (Eurostat, 2017). In Fig. 10.1, it is possible to see a comparison of funding education with selected EU countries and the OECD average based on "per student" expenditure.

10.2 The Policy Perspective

The governance of the public education system is shared between central government and the regional and municipal authorities and schools. At the central level, the Ministry of Education, Science, Research and Sport of the Slovak Republic (Ministry

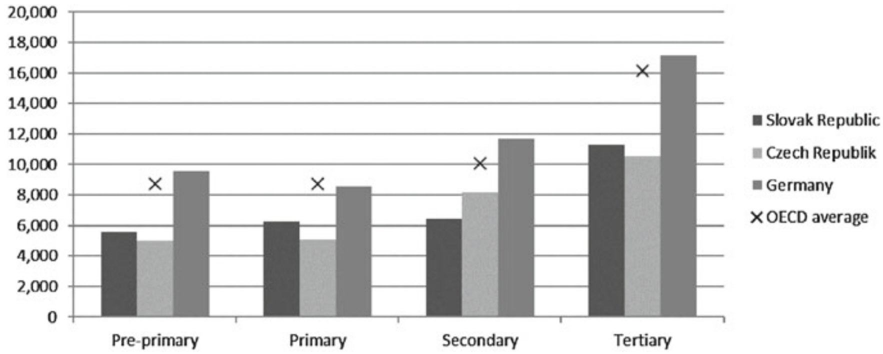

Fig. 10.1 Expenditure per student (annual, equivalent USD using PPPs). *Source* own, based on (OECD, 2017)

of Education) provides the educational goals and content for all supported stages. The Ministry of Education sets out the framework for schooling, manages the school network, allocates financial resources and monitors school compliance and student performance (OECD, 2016). There are also other education central bodies which are responsible for education policy: The National Institute of Education, National School Inspectorate, The National Institute for Certified Educational Measurements (NICEM), The National Institute of Vocational Education, The Methodology and Pedagogy Centre and The Slovak Centre of Scientific and Technical Information. Local authorities (municipalities) administer and provide most of the pre-primary, primary and lower secondary education while self-governing regions are in charge of upper secondary education (called “regional education” in Slovakia).

The goals and content of the educational system in Slovakia are covered by the following main acts:

- The School Act (approved in 2008) aims to increase the equity and quality in the education system and to prepare students for the future. It presents several funding schemes by the Slovak Government with support from the EU. The new act encourages learning of new languages and ICT and harmonizes the classification of education in Slovak schools with the International Standard Classification of Education (ISCED).
- The New Act on VET (Vocational Education and Training; approved in 2015) aims to link education and training better to the needs of the labour market. It introduces an option for providing VET in a dual system (mix of “training on the job” and “attending regular classes at school”).
- The New Curriculum defines education areas, focuses on the development of logical thinking and working with text as well as increasing the number of compulsory hours in mathematics and natural sciences.
- The Act on Higher Education (last version approved in 2013) aims to improve the higher education accreditation process. It also introduces new criteria for assessing

a university's competence to award the academic titles of Associate professor and Professor.

In the field of ICT in education, Digipedia 2020 (the strategy for Informatization in the Education Sector) seems to be the most important. This defines the way in which the education sector should be aligned with global digitalisation trends and how to equip students with the information and communication technology skills essential in the labour market. The main points of this strategy are the provision of digital education and teaching materials (e.g. interactive boards), fully digitalised learning materials and access to the digital world for all students.

In addition to the main education acts, there is the education policy based on the "National Programme of Upbringing and Education in the Slovak Republic" (called "Millennium"). It was approved by the Slovak government in 2001 for the following 10 years. More recently, there has been a newly developed National Programme for Upbringing and Education Development in the Slovak Republic until 2027 (called "Learning Slovakia"). This was published in September 2017 and offers goals and guidelines for improving the Slovak education system over a 10-year time frame.

In the first chapter of 'Learning Slovakia' (Burjan, Ftáčnik, Juráš, Vantuch, Višňovský, Vozár, 2017), the "use of ICT" is defined as a sub-goal from the 11 basic goals of the Slovak education system. In the part related to learning resources, materials and equipment, it has been noted that there is a problem of not enough textbooks. A partial solution can be offered in the form of an e-Aktovka (e-Briefcase) electronic portal that contains freely available digital versions of textbooks. However, there are not enough of them yet. It also mentions the need to provide the necessary material and technical equipment for schools including the correct technical conditions for the use of modern technologies, digital content and resources. Yet, schools do currently not have enough financial resources to provide the necessary equipment or teaching materials to enrich education. In the part related to measurement, testing and examinations, the trouble-free provision of building an electronic/digital test system by NICEM is outlined. In the part related to the school environment and school facilities (interior and exterior), the sub-goal of having a learning environment with integrated modern information and communication technologies is discussed. The part related to informal education and learning, where the sub-goal is providing informal education and training, examines financial support. It highlights where financial support by the Ministry of Education is recommended e.g. Slovak Wikipedia pages, Khan Academy education video subtitling, creation of e-learning courses (MOOC) for Coursera, Udacity, etc. The second chapter, related to teachers, looks at measures with a focus on ICT: financing technical staff for ICT care. The third chapter, related to vocational education and training, outlines measures with a focus on ICT: promoting the dissemination of digital teaching materials. In the fourth chapter, related to the financing of regional education in relation to ICT, there are recommendations about increasing the normative payment "per student" and taking ICT equipment of school into account when calculating their operational norm. It is also recommended that the resource allocation system considers all statutory obligations that have been added to the schools without any increase in funding (e.g. network administrator, ICT administrator). In the fifth to eight chapters, dedicated to higher education, the focus is also on on-line education. It recommends the preparation of e-learning courses and the use of information and communication technologies in education in Slovakia.

10.3 Infrastructure

The use of ICT tools for teaching and learning are currently promoted in the majority of European countries (European Commission, 2013). ICT and interactive technology are used in every kind of school from pre-schools and primary schools to secondary and higher education. Most countries recommend teachers using a wide range of hardware including computers, projectors or beamers; DVDs, videos, TVs, cameras; smartboards; and virtual learning environments. This integrates a range of ICT infrastructure to create a personalised online learning space. In a few European countries (including Slovakia), there are no official recommendations or guidelines regarding ICT tools. Nevertheless, support is provided to schools and teachers for using a range of ICT tools (EACEA, 2011). The EACEA (2011) study has shown that most European countries recommend the use of particular ICT software more than hardware for teaching and learning in the classroom. The types of software which almost all countries promote include tutorial software; general office applications such as word processing and spreadsheet programmes; multimedia applications; digital learning games; communication software such as email, chat or discussion forums; and digital resources e.g. encyclopedias and dictionaries. In Slovakia, most schools use ICT to communicate with parents about general information, marks and extra-curricular activities (EACEA, 2011). Based on a report by the European Commission (European Commission, 2013), only a few schools in Slovakia have reported the use of e-readers, mobile phones and digital cameras for teaching purposes.

The main basis of successfully integrating ICT into education is the development of supportive infrastructure. This tends to reflect the ICT behavior of a country as a whole. In 2016, Slovakia had an Internet user penetration of 82.5% of the total population (InternetLiveStats.com, 2017). The availability of computers in households with dependent children increased in Slovakia between 2006 and 2009 from 69 to 85% (EU average: 76–86%). The availability of internet access in households with dependent children increased in Slovakia between 2006 and 2009 from 34 to 81% (EU average: 61–79%) (EACEA, 2011). However, the situation in education lags far behind this. Despite the majority of Slovak schools having access to computers and internet and having had 17 years of different governmental activities and projects, the level remains under the EU average in most ICT in Education indicators (Fig. 10.2) (European Commission, 2015).

While most Western European countries recommend where ICT equipment should be located in primary and general secondary schools (separate computer labs, computers in common spaces and computers in the classrooms), Slovakia

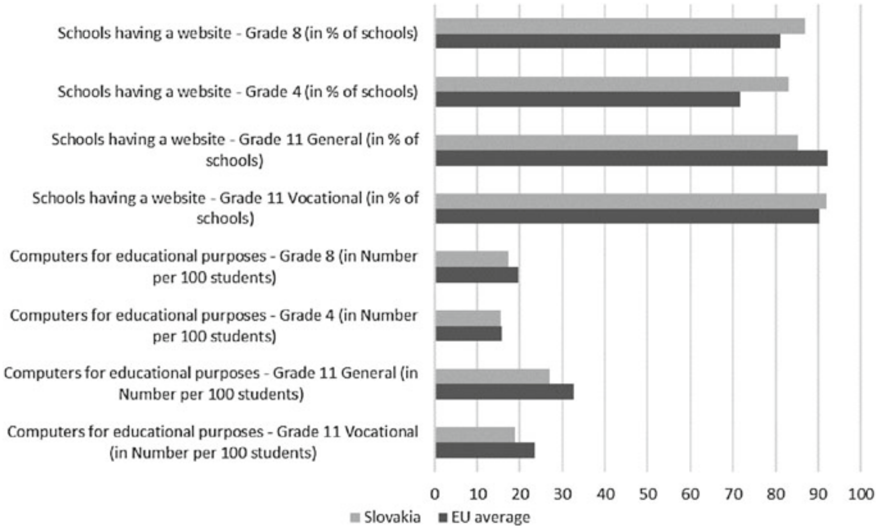

Fig. 10.2 Country profile for Slovakia, ICT in Education indicators. *Source* own, based on (European Commission, 2015)

only recommends the first two options (EACEA, 2011). As such, computers in the school environment are most commonly placed in computer labs (approximately 80%) (OECD, 2016).

The updating of computer equipment and procuring educational software is a responsibility delegated to schools. As a result, the process of infrastructure development is slowed down significantly. In twenty European countries (including Slovakia), partnerships of some kind exist for the private funding of hardware and software for educational purposes (for example the multilicence programme Microsoft Select). There are also some private activities in ICT infrastructure development. One of these has been in Košice, a city in the east of the country, where there has been rapid development of IT industries in the last 10 years. IT Academy, an initiative of the Košice IT Valley association, wants to equip Science Labs (for physics and chemistry) in 60 primary and 30 secondary schools.

In Slovakia, 87% of those in the fourth grade use ICT during lessons. This compares to an EU average of 75%. In the eighth grade this falls to 77% (69% EU average) while 55% of those in the eleventh grade (60% EU average) and 78% in the eleventh vocational grade (80% EU average) use ICT during lessons (European Commission, 2013). In Fig. 10.3, it is possible to see that the number of students per computer, per data projector (beamer) and per internet connected computer decreases with the age of the student.

An EACEA study (EACEA, 2011) has shown that at least 50% of students in Slovakia are at schools where one computer is available for every three students (in other European countries it is one for every two students). Moreover, only 47% (EU average 56.6%) of Slovak students in the fourth grade have computers available

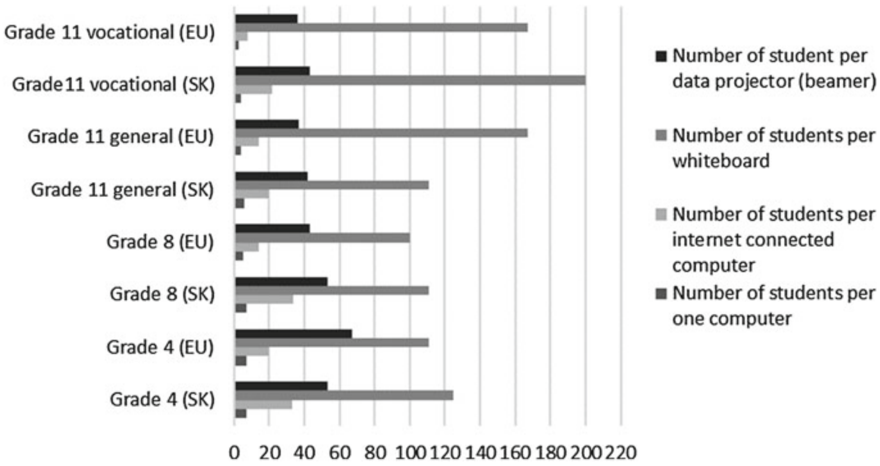

Fig. 10.3 Comparison of the main ICT in Education indicators in particular grades; The EU value presents the average value of EU27. *Source* own, based on (European Commission, 2013)

during their maths lessons while almost half of students (EU average: almost 30%) in the fourth grade is affected to some extent by the lack of computers in maths and science classes.

Based on the latest officially collected data (European Commission, 2013; Šiškovič & Toman, 2015), all primary and secondary schools in Slovakia have access to the Internet at present. The national programme "Infovek" (2003–2017) has made significant improvement in terms of school access to the Internet. In 2007, two-thirds of schools had internet connections with speeds slower than 2 Mbit/s. However, this number has decreased to 38% for primary and secondary schools. While the speed of the Internet is comparable to that in the business sector these days, i.e. approx. 13 Mbit/s., only every fifth school from all primary and secondary schools currently has this speed guaranteed.

Universities, in comparison to regional education (pre-school, primary and secondary level) are in a better situation. Universities are connected through one of the fastest networks in Europe. This is provided by SANET (Slovak Academy Network) where speeds begin at 10 Gb/s and reach levels of 100 Gb/s. The availability of ICT at universities is also better than in the case of regional education institutions. At an average university, there are 2.8 students per computer. The problem of these figures, however, is that only two thirds of these computers are used for educational purposes. Statistics have shown that almost 36% of university computers are used for administrative jobs (Šimášek, 2013).

Since 2009, Slovakia has been a member of European Schoolnet (www.eun.org). Here there is the possibility of participating in working groups concerned with ICT implementation problems. It regularly informs the EC about the use of ICT in the Slovak education system based on different surveys, use cases and participation in different projects (eTwinning, eQnet, iTEC, Spring Day, Nanoyou, U4Energy, etc.).

It is also helpful during different stages of ICT implementation project proposal design (Institute of Information and Forecasting of Education, 2010).

In Slovakia, the most complex programme focused on ICT in education is DIGIPEDIA 2020. It receives funding of 50 million euros a year from the state budget, EU funds and other private sources. It deals with the strategic issues of the digitalization process in the education sector such as digital content, modernization of the necessary infrastructure (high-speed internet and modern educational technologies that will enable using digital educational content in lessons), increasing digital skills of teachers, cooperation with employers and simplifying access to optimized e-services. The target group of the program is regional education, i.e. pre-primary, primary, secondary and higher education, science and research as well as sport (Ministry of Education, Science, Research and Sport of Slovak Republic, 2009; Šimášek, 2013). There are several other programs and projects at the national and sub-national level, mostly funded by the state budget and EU funds. These are aimed at bringing computers, other devices and solutions to the classroom as well as creating digital content, training trainers and transforming the content of education at primary and secondary schools using innovative forms and teaching methods (Ministry of Education, Science, Research and Sport of Slovak Republic, 2017a; Digiskola.sk, 2016). There is an additional government programme which aims to provide internet access services to school facilities in regional education, services related to operating the virtual private EDU network, centrally managing WiFi coverage and educating teachers about the services concerned (Ministry of Education, Science, Research and Sport of Slovak Republic, 2016a). There are also some private initiatives such as the "School to Touch" project. This is run by the non-profit organization EDULAB and company Samsung Electronics and has provided about 510 tablets to 10 schools aiming to highlight the multifunctionality of tablets (EDULAB, 2017).

10.4 Educational Resources

However, well-built ICT infrastructure is not enough in the innovative process of education. In addition to infrastructure, it is necessary to have appropriate educational resources. Based on EvaluEdu (www.evaluedu.sk), an applied research project, educational resources can be divided into the following categories (just resources used in Slovakia are listed):

- comprehensive educational environments—www.edupage.org, www.nauctevia c.sk, www.zborovna.sk, sk.wikipedia.org (Slovak version of Wikipedia), www.oskole.sk and www.mapaslovakia.sk,
- LMS (Learning Management System)—Moodle, Blackboard, Claroline,
- instructional programs (commercial interactive digital maps by Cartografia publishing), applets, software modules and plugins (Wolframalpha, GeoGebra, FyzWeb—applets, etc.),

- presentations developed using Microsoft PowerPoint, Prezi, Adobe Captivate and mind-map designing programs like Xmind, MindMap,
- programs delivered to interactive boards—ActivInspire, Flow!Works, etc.
- other digital tools—highly specialized tools like interactive worksheets, crosswords, digital forms, digital notebooks, electronic devices (Raspberry, NAO Robots, Lego MINDSTORMS, WeDo 2.0).

In terms of Open Educational Resources (OER), it is important to ensure that educational materials produced with public funding are available to all and that learning can happen anytime, anywhere. At the European, national and university level, there are different supportive initiatives and portals which provide OER.

The EU-funded Open Education Europa portal (www.openeducationeuropa.eu) provides access to the many resources available. It is a community for all those involved or interested in digital, open and innovative education. In addition, large-scale pilot projects such as Open Discovery Space, co-funded by the European Commission, work with teachers to create and make better use of OER. The European Union Statistical Office (Eurostat) is another important portal of EU open resources. Furthermore, there are a number of projects aimed at developing and providing OER. Massive Open Online Courses (MOOC) is one example provided by Slovak universities as part of a European initiative supporting university online courses (www.openuped.eu). OpenupEd is the European equivalent of Coursera for online learning. Its courses cover areas from maths to economics, computer skills to e-commerce, climate change to cultural heritage as well as language learning and writing fiction. These courses are available in 11 European languages including Slovak and typically last between 20 and 200 h. Courses either lead to a certificate or credits that can be counted towards obtaining a degree [adapted from (Slovak University of Technology in Bratislava, 2013)].

In Europe, centrally promoted online resources are widely available to teachers to support them in using ICT for innovative teaching and learning in the classroom. In most countries, there are online platforms, forums, blogs or similar social networking sites that facilitate collaboration, the sharing of experience and exchange of material among teachers. However, it has been noted in Slovakia that the sharing of presentations at the school level is not organized but amongst smaller groups of teachers (Sebo, 2018).

In addition, centrally provided gateways link other sites of interest to teachers such as those providing educational materials, teaching resources and software, information about new technologies, or to commercial sites providing news and information about current affairs (EACEA, 2011).

At the national level in Slovakia, there is a general initiative by a non-profit organization about the internet called Open Education (www.otvorenevzdelavanie.sk). This offers simple structured general information and is a gateway to national and international OER.

The Ministry of Education in Slovakia has provided the key public education portal, the “Planet of Knowledge”, since 2011. The primary objective of this portal is to provide pupils and teachers with quality and attractive teaching materials for the modernization and streamlining of the learning process. These days, the portal contains more than 30,000 educational materials from various fields such as maths, physics and biology. The educational materials include videos, presentations, simulations, animations, 3D models, pictures, photos, illustrations, interactive exercises and lessons (Ministry of Education, Science, Research and Sport of Slovak Republic, 2017b). Despite the undoubted advantages of the portal, there have also been some criticisms. Ján Žabka, who develops textbooks, has pointed out that the portal is not a digital textbook but rather an encyclopedia, which contains the completed facts, which it then presents to the pupil. Furthermore, he has argued that the the portal does not do what it is supposed to do at school: to teach the pupil to think. The videos present the final knowledge, testing by looking for the correct answer by the trial and error method, the pre-prepared steps to solve the equation. There is no development of divergent thinking. On the other hand, teachers have claimed that the "Planet of Knowledge" is a rightly recognized teaching resource (Dobrá škola, 2017).

It is possible to find different types of OER at universities in Slovakia. These are mainly the outputs of educational and research projects financed by the EU and national grants or open access journals provided by the university. It is important to note that some of these EU-funded ones only have free access to selected users with logins and passwords to access the course. The resources and courses are also not provided for an infinite length of time. They may only be accessed for the duration of the project or a few years after it finishes. A good example of a successful and nationally financed OER project is the open access on-line book "E-methodology" [see (Gavora, Koldeová, Dvorská, Pekárová, & Moravčík, 2010)].

10.5 ICT Integration into Practices

At present, most lessons at schools take place in the form of ICT-supported teaching. Few subjects in Slovakia are done in the form of ICT-provided teaching such as distance learning. This practice is of more relevance for universities because in lower educational stages (mainly at primary schools), the nature of teaching is in the live contact between the teacher and pupil (Mišút, 2013).

According to a European survey of schools (European Commission, 2013), teachers mostly use ICT for preparing activities for teaching (browsing to prepare lessons, preparing tasks for students, preparing presentations, collecting online resources to be used during lessons). As a result, teachers are able to cover the whole education process from preparation, implementation and subsequent evaluation. The use of specific tools depends on the teacher's personal interest in implementing ICT in the subject as well as his/her ICT skills. In their efforts, teachers are supported by different national and international activities and projects, e.g. eTwinning (www.etwinning.sk), School Education Gateway (www.schooleducationgateway.eu), European SchoolNet (www.eun.org) Open Education Europa portal (www.openeducationeuropa.eu), Eduworld.sk (eduworld.sk) and eAktovka (www.eaktovka.sk).

10.5.1 ICT Integration into Primary and Secondary Schools

In Slovakia, the use of ICT by teachers in more than 25% of lessons is higher than the EU average. ICT is most used in Grade 11 at vocational schools where 73% of teachers use ICT in more than 25% of lessons (in comparison to Grades 4, 8 and 11(non-vocational) where it is around 50%) (European SchoolNet and University of Liège, 2012).

The use of ICT (including digital educational resources) at primary and secondary schools for educational activities is influenced by the available ICT infrastructure, digital educational resources, willingness and skills of teachers.

In ICT infrastructure, the differences among Slovak schools are high in terms of the amount of classes equipped with interactive boards (between one tenth and one half of classes depending on school). The differences are less noticeable when the availability of multimedia projectors is compared. In order to manage the ICT, most schools hire an external expert who administers all ICT equipment (e.g. once every 3 months). Alternatively, they use their own teachers such as IT teachers depending on their professional skills. A European survey of schools has shown that Slovakia has a higher percentage of students than the EU average at schools with a website in Grades 4 and 8. However, this percentage is less in terms of students with a virtual learning environment at school, most notably in Grade 11. The percentage of ‘unconnected’ schools is similar (European SchoolNet and University of Liège, 2012).

Teachers in Slovakia have different resources available for teaching maths, Slovak language, natural sciences, etc. These are often in the form of software which uses an interactive board. This software covers different topics, contains a variety of exercises and uses simple games (e.g. crossword puzzles, memory games) to motivate students. However, it does not complexly cover the course/subject as a full package curriculum for ISCED 1 (e.g. Active Learn Primary (Pearson) for English-based schools) which contains teaching methodology, lessons, support materials for teachers, files for practice and so on. In addition, this software does not cover assessment so teachers need to use different software for assessment (e.g. programalf.com—licensed for 100 €/year). The exception being English language courses where schools use well-developed full package curriculums (e.g. I-Tools (Oxford)). There are also some pioneering teachers who have tried to adapt full foreign package curriculums to their courses (e.g. Scratch (MIT) for Informatics). It seems that the development of such complex (full package) digital curricula for all courses or education stages will be a great challenge for Slovak education institutions in the future.

With regards to the willingness and skills of teachers, young teachers are prepared to work with digital presentations although there are some indications that they are not prepared to work with new ICT technologies. One example of how a teacher’s willingness and skills influence ICT use is related to the previously mentioned Samsung School project which supported tablet use. In one school, this technology was abandoned after the teacher who had implemented the project left the school (Sebo, 2018).

For administrative activities, primary and secondary schools can only use one of two software applications (E-skoly, ASCagenda), both licensed (300 €/year for a school with 600 students). These applications (based on databases and dynamic websites) cover the school agenda related to education (e.g. evidence of attendance and assessment by teacher, on-line student assessment book for parents, on-line canteen menu) and enables the school to send compulsory monthly data to the Ministry of Education's information system. There is some evidence that the unwillingness or aversion to digital technologies has led to prohibiting the use of some tools such as digital assessment evidence due to the disapproval of the majority of school staff (Sebo, 2018).

10.5.2 ICT Integration in Higher Education

From the point of view of higher education, the use of ICT is directly dependent on the decision of the head of the course. This is in contrast to primary and secondary schools where it is the Ministry of Education who monitors and actively supports ICT. In university education, ICT is heavily used in the form of lectures with digital presentations (e.g. MS PowerPoint, Prezi), online study materials and diverse simulation environments. On-line materials are provided in the Learning Management System (LMS), most commonly Moodle, Blackboard and Sakkai (Fabuš & Fabušová, 2015), where they are protected from public access by users' access data. The LMS at university aims to support regular education forms rather than full online education. In general, online study or courses are very limited in Slovakia (Rusinková, 2015). The only exceptions to this are the branch of the City University of Seattle located in Trenčín or some MBA courses at private universities (e.g. Lings University) which provide full online education.

10.6 Student ICT Competencies (skills)

In Slovakia, access to digital literacy has changed significantly in recent years. At present, 60% of the population over the age of 14 has adapted to ICT without any major issues. On the other hand, the share of those who have refused to learn and adapt (about a quarter of the population) has not changed for a long time (Institute for Public Affairs, 2015).

Despite a range of national and pan-European digital competence initiatives, research from the "EU Kids Online" project (The London School of Economics and Political Science, 2016) has shown that the levels of digital competence in children and teenagers remain inadequate. This is particularly in the dimensions of critical and participatory literacy (Johnson et al., 2014). Based on data in 2015 (Vlačuha, Kotlár, & Želonková, 2015), it was found that 91% of Slovak students aged between 17 and 24 used a computer almost every day. Moreover, 98.8% of students had used the Internet within the last three months. According to EACEA (2011), students in

Slovakia use computers less and browse the internet similarly in comparison to the EU average (Fig. 10.4).

Figure 10.5 presents the experience of primary and secondary school pupils with ICT in the learning process.

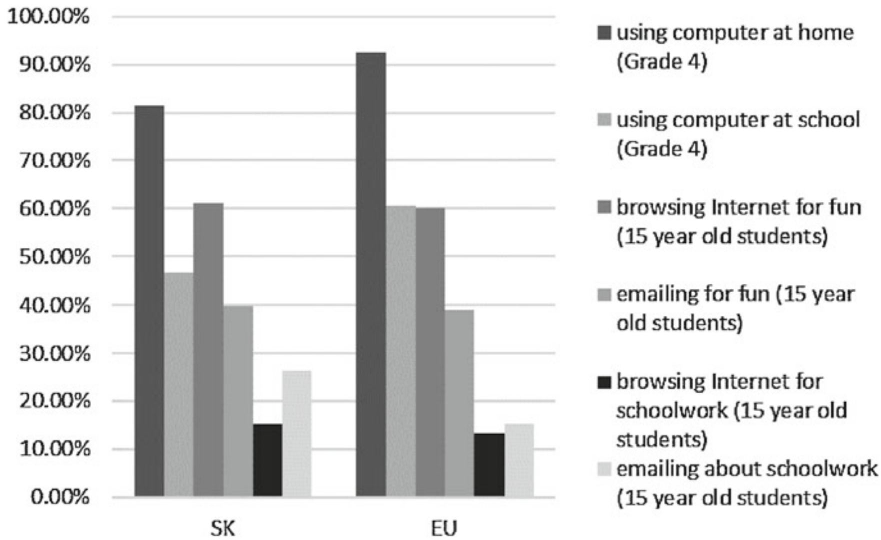

Fig. 10.4 Comparison of ICT use for educational and non-educational purposes by young people. *Source* own, based on (EACEA, 2011)

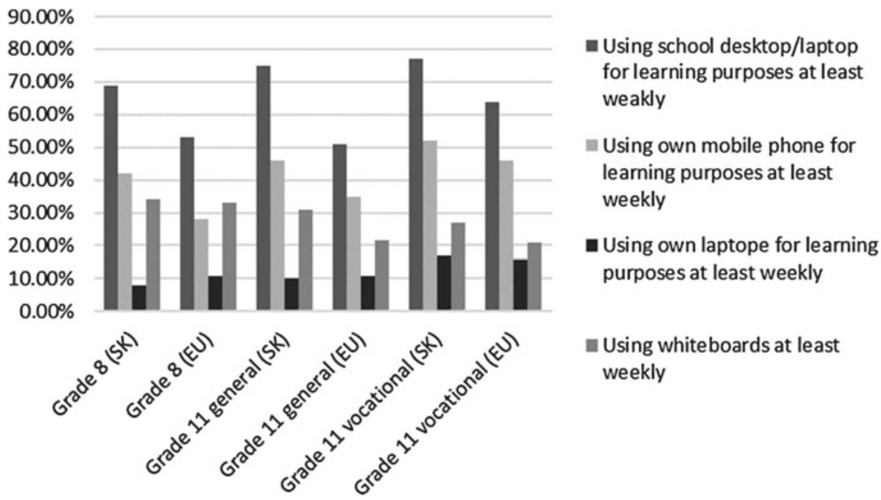

Fig. 10.5 Using ICT for learning purposes by students (according to age). *Source* own, based on (European Commission, 2013)

In terms of the ICT competencies of students in selected Slovak universities, a study about Basic, Application and Ethical ICT Competencies (Kiss, 2017) has shown that almost 81% of students feel competent using a variety of digital resources in interaction and collaboration with partners. In addition, between about 62 and 77% feel competent in using an application in a productive way, using the main informatics and network resources and applying digital tools to obtain information from a variety of sources as well as solving problems and making decisions using the appropriate tools and digital resources. On the contrary, only around 19% feel competent in using models and simulations to explore complex topics and 21% in creating original works as a medium of personal expression (Kiss, 2017).

10.6.1 Initiatives and Activities Towards ICT Skill Development

In accordance with the main targets of the Europe 2020 strategy, the Digital Agenda for Europe and The New Skills Agenda for Europe encourages all EU countries to gradually implement and improve ICT in their school curricula. ICT has been part of the school curriculum in Slovakia as a mandatory subject at all levels of compulsory education for a number of years. At first, it was introduced in 1985 at upper secondary school, in 2005 at lower secondary school and finally at primary school in 2008. ICT learning objectives are included in central steering documents for primary and general secondary education. These include knowledge of computer hardware and electronics, using a computer, using mobile devices, using office applications, searching for information, using multimedia, developing programming skills and using social media. The latter two objectives are only for secondary education. The use of ICT is recommended in steering documents as a tool for encouraging pupils to develop cross-curricular skills. These can be used with respect to developing pupils' creativity, critical thinking, problem solving, communication, collaboration and initiative and self-direction skills (EACEA, 2011).

The Slovak government's activities in the field of digital competence are closely connected with the EU and include large-scale programs, projects and portals. Besides these, there are some special initiatives such as eSkills Week. It was introduced in 2010 and provides tools and know-how to help young people understand the opportunities related to careers in ICT as well as the relevance of digital skills for their prospects in the labour market more generally. As a result, a so-called IT 'fitness test' was carried out in 2010, 2012 and next years. The aim was to evaluate the IT skills of secondary school and university students, track changes over time and compare them to other countries. The Czech Republic, Poland and the Russian Federation were also included. IT Academy is another initiative which aims to boost digital skills in Slovakia and increase the numbers as well as the level of skills in ICT students. The project targets schools and universities, pupils and students and aims at training teachers so they can use digital technology and innovative practices.

10.7 The Professional Development of Teachers

In Slovakia, around 87,000 teachers (including other pedagogical and specialist employees) work in primary and general secondary education while 10,000 work in higher education. International comparisons have shown that teachers in Slovakia have one of the lowest salaries in the OECD countries. They earned 57% of the salary of a university graduate in 2013 while the OECD average was 80%. From the other OECD countries, only the Czech Republic has a lower percentage (52%) while the neighboring countries in central Europe are better off than Slovakia (Hungary—62%, Poland—86%) (OECD, 2016).

In most EU countries including Slovakia, a teacher's use of ICT is recommended for a variety of subjects (languages, maths, natural sciences, etc.). ICT as a subject is taught at primary school by general teachers while it is taught by specialist ICT teachers at secondary school (EACEA, 2011).

In Slovakia, all specialist teachers at secondary school have ICT-related skills included in the core curriculum in their initial teacher education: internet use, subject-specific training, multimedia operations, creating websites and pedagogical issues. The first 3 skills are also included in the core curriculum for general teachers (EACEA, 2011).

After this initial teacher education, it is crucial that teachers continue to develop and refresh their ICT knowledge and skills through Continuing Professional Development (CPD). They should have the opportunity to deepen their understanding and mastery of ICT as a tool for innovating teaching and learning approaches (European Commission, 2008). According to an OECD study (OECD, 2014), participation in CPD by teachers in Slovakia is low. Moreover, the courses teachers attend do not always correspond to the needs of the participants. In terms of the necessary ICT skills in teaching, 18.6% of Slovak teachers (19.7% of OECD) have highlighted the need for further professional development in this area (Fig. 10.6) (OECD, 2014). Teachers in primary and general secondary education can use websites and platforms

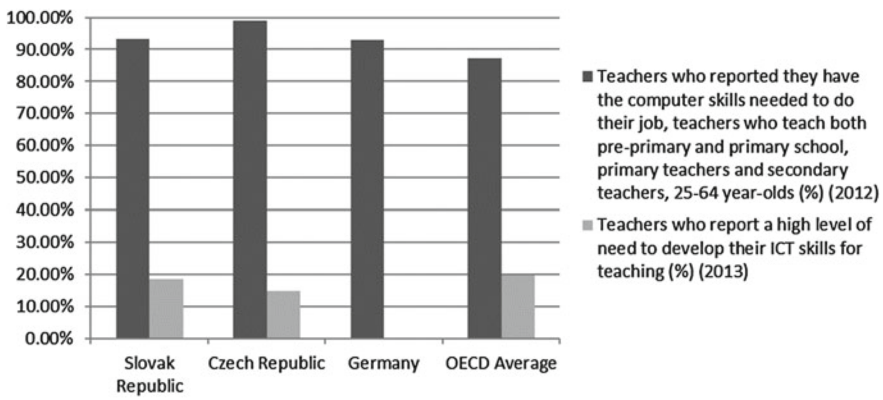

Fig. 10.6 Comparison of teachers' ICT skills and need to develop ICT skills. *Source* own, data from (OECD, 2017)

for teacher collaboration about using ICT for teaching and learning to improve their skills. In addition to interacting with other teachers, there is also staff available to help teachers with ICT (60.4% of Slovak pupils in Grade 4 go to a school with staff available to help teachers with ICT (EU average: 73.1%)). Other data from 2005–2006 has shown that the percentage of pupils in Slovakia in Grade 4 whose teachers report having participated in CPD on integrating ICT into teaching maths was 54.9% (EU average: 25%) while in science it was 44.8% (EU average: 16%) (EACEA, 2011).

The findings from a European Commission (2013) survey have shown that teachers are confident in using ICT, positive about ICT's impact on student learning and organise more frequent ICT-based activities than before. At the EU level, only around 25–30% of students are taught by teachers for whom ICT training is compulsory. This is in contrast with around 70% of students that are taught by teachers who have engaged in personal learning about ICT in their own time. Although online resources and networks are widely available in Europe and at the national level [e.g. OpenInn, see (Korobaničová, Paľová, & Urbančíková, 2015)], they are a relatively new way of teachers engaging in professional development and only a minority of these opportunities are used by schools.

With regard to evaluating teachers' ICT skills, only internal assessment in Slovakia has been used for this purpose (EACEA, 2011).

10.8 Discussion and Conclusion

Based on the presented data, it can be concluded that Slovakia is not one of the leaders in the EU in terms of ICT in education. It is clear that the values in many indicators need to improved and the education system faces a number of challenges.

In relation to the expected future development of the Slovak and world economy (e.g. Industry 4.0), the slowly developing Slovak education system is at risk of failing to prepare suitable people. There is a need to reform the education system with regard to the needs of the labour market and fund it in a more effective and efficient way.

One of the most important challenges is improving the employment of school leavers and graduates in the field in which they finished. In 2016, up to 60% of secondary school leavers were working in positions that did not correspond to their education (TREXIMA, 2017).

It is apparent that teachers are insuffiently ready for the fast changes in ICT and their incompetence in implementing the available features into an innovative learning process is evident. Despite more than 90% of the regional education teachers undergoing ICT training between 2007 and 2013, only 20% of them acquired advanced knowledge in this area (Ministry of Education, Science, Research and Sport of Slovak Republic, 2014).

Students still lack awareness regarding the importance of ICT. They rarely use technology for critical and creative problem solving. On the other hand, they freely use it for social networking without realizing the security risks of ICT.

There are also other issues in ICT in education such as delays in procurement, relatively slow internet connections, the underutilization of on-line courses and LMSs and VLEs as supportive tools in the learning process (Ministry of Education, Science, Research and Sport of Slovak Republic, 2016b). There is also a lack of financial support from the Ministry of Education with regards to implementing state-of-art technologies into education (European Commission, 2017a; Rusinková, 2015). This is one factor which influences the rate of development in education.

The potential success of integrating ICT (including digital educational resources) into primary and secondary schools is influenced by a number of factors. Firstly, there is the available ICT infrastructure which differs substantially between different schools. In addition, there are the digital educational resources in which the complex (full package) curricula are missing for individual courses or whole study levels. Finally, there are different levels of willingness and skills of individual teachers. Motivated and able teachers can implement a foreign full package curriculum for example. In the case that full packages curricula are available for different educational levels (ISCED), the standard/minimal level of education quality could be better. In addition, teachers would not have to learn and use a number of different applications for designing presentations, class administration, assessment, communication with students, lesson planning etc.

In university education in Slovakia, eLearning and its methods are used as supportive tools in full-time study. However, as in case of primary and secondary education, there is an absence of any long-term development strategy. The use of MOOC at Slovak universities is problematic because of the language barrier on both sides of the education process (teachers and students), reluctance of teachers to publicly share developed courses, missing methodology and publishing policies connected to electronic courses (Rusinková, 2015).

Despite these unfavorable figures and subsequent challenges, it is possible to see some gradual progress in ICT in education towards meeting the current demands in the labor market with rapidly changing ICT skills.

Acknowledgements This contribution has been supported by research grant KEGA 002TUKE-4/2020 "Implementation of intelligent technologies and advanced technologies to support transformation processes and future production design".

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Chapter 11
South Africa's (Unequal) Digital Learning Journey: A Critical Review

Shafika Isaacs

Abstract This chapter is an attempt at a critical review of South Africa's digital learning (DL) journey since the dawn of democracy in 1994. It reviews DL policy, practice and scholarship based on six themes: DL policy, DL infrastructure, digital integration in learning and teaching, digital skills and competencies of learners and teacher professional development. It combines Feenberg's critical theoretical approach to technology with Cultural-Historical Activity Theory (CHAT) as analytical framework. It uses a social justice and equity lens to review three national government policies related to digital learning: the *eEducation White Paper*, the *White Paper on Post-School Education and Training* and *the National Integrated ICT Policy White Paper.* Four key tensions in the digital learning activity system are highlighted: between rules and subject, subject and object, subject and mediational tools and subject and division of labour. It concludes with the need for more critical research, conversations and interventions that challenge predominant globalization narratives and calls for a more concerted social justice research agenda that engages with current debates on decolonizing education in South Africa.

Keywords ICT in education · Digital learning · Equity · Social justice · South Africa · Education transformation · Digital integration

11.1 Introduction

Whilst there are some examples of positive learning effects (Hull and Duch, 2018; Peters et al., 2018), the vast majority of digital interventions globally, have had either no impact or a negative impact on student learning (Slavin, 2018; World Bank, 2018: 146). Coupled with reports on the negative effects of Internet addiction among youth (Kim, Lee, Lee, Nam, & Chung, 2014; Yu & Shek, 2013) a more critical reflection on digital learning investments in education is emerging. The French government's

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_11

2018 legislation banning smart devices from their schools, offers one example of a policy decision influenced by evidence of screen addiction by teenagers and higher test scores in schools where cell phones were banned (Smith, 2018). While this negative view has not gone unchallenged (Livingstone et al., 2017) it shows the beginning signs of a technology backlash in education on the one hand. On the other hand, this backlash' combines with another a potential hype cycle trigger (Gartner, 2016) on why education systems need to explore artificial intelligence (Xing & Marwala, 2017) and consider frontier technologies to meet education's development goals (UNESCO, 2018).

These divergent perspectives have also characterised the national discourse on digital learning in South Africa (SA), where techno-hype has met with complex local reality amidst conflicting discourses and a limited evidence base. Since the onset of DL interventions in the late 1990s in SA, there has been some evidence of learning success and improved digital access. These include amongst others, a mobile learning Mathematics (Maths) application which enabled both improved motivation to learn Maths and better Math test scores (Roberts, Spencer-Smith, Vanska, & Eskelinen, 2015); and an integrated teacher tablet project in 26 schools in deep rural Eastern Cape which showed growth in teacher confidence and improved their teaching practice (Botha & Herselman, 2015a). These successes have been the result of carefully designed projectized interventions. At a number of universities, institutional DL policies (Ng'ambi, Brown, Bozalek, Gachago, & Wood, 2016) have also enabled across-campus digital access and learning programmes for students and lecturers to a limited extent.

However, when viewed with a system-wide lens, the much-vaunted positive relationship between digital technologies and expanding education access, quality and equity, show mixed results and arguably more 'failures' (Amory, Rahiman, & Mhlanga, 2015). Interventions to date have focused on expanding digital access, growing digital skills and to a lesser extent in schools than higher education institutions (HEIs), on institutionalizing shifts in learning cultures. These mixed results are opening up opportunities to reframe the national conversation beyond a narrow focus on access, skills and improved learner and teacher performance because more critical issues are at play: issues of equity and social justice which have been marginalised in the national DL discourse. SA can learn from countries like Peru (Cristia, Ibarraran, Cueto, Santiago, & Severín, 2017) and Uruguay (Pittaluga & Rivoir, 2012) who framed their One Laptop Per Child (OLPC) initiatives as social equity programmes, especially from their experiences of failure to realise quallity learning and social equity objectives. The inequality crisis in education ranks among SA's most urgent problems (Chisholm, 2012) and takes centre stage in national conversations. This chapter argues that a similar urgency and attention to social justice and equity is required in the national DL discourse.

The chapter combines a critical theoretical view with cultural historical activity theory (CHAT) as a systems-oriented lens in reviewing SA's DL transition since 1994. It is guided by the question: *How has equity and social justice, been framed in DL policy, practice and scholarship in South Africa?* It examines six themes: DL policies; digital infrastructure; digital integration in learning and teaching; learner performance, competencies and digital skills; and teacher professional development.

11.2 Snapshot of an Inequality Crisis in Education

DL interventions emerged in the late 1990s when SA's fledgling democracy promised socially-just education transformation (Ambrosio, 2017; Badat & Sayed, 2014) amidst the pressures of intensifying neoliberal globalisation (Tikly, 2011), underscored by exponential growth in consumer technologies and paradigmatic shifts in learning and teaching (Facer, 2011).

Significant strides were made in eradicating the formal racialised structures in education. These strides are evidenced by the following: the enshrinement of the right to basic education for everyone in SA's Constitution (Republic of South Africa (RSA), 1996); approximately 70% of public schools are fee-free schools; the number of formally qualified teachers have expanded substantially (Chisholm, 2012); more children are accessing registered Early Childhood Development (ECD) services and a reception year (Grade R) had been introduced in schooling with significant enrolment increases (Atmore, 2013; Department of Basic Education, 2016b); enrolment in higher education doubled in terms of its racial and gender demographic (Department of Higher Education and Training (DHET), 2018); the government is feeding 9.1 million children in the most disadvantaged schools (Jet Education Services, 2016); and issues more than 12 million child-support grants to poor families monthly (Hall, 2017). By 2017, the education system had grown larger and institutionally more diverse as illustrated by Table 11.1.

Table 11.1 Size of the SA education system. 2017

Early childhood development	Registered early childhood development centres	20,233
Basic education (2017 estimates)	Schools (including public and independent) (2017)	25,762
	Educators in public and private schools (2017)	433,320
	Learners in public and private schools (2017)	12,892,273
Post-school education (2016 estimates)	Public universities (2016)	26
	TVET colleges (2016)	50
	Registered private universities (2016)	123
	Registered private colleges (2016)	279
	Community education and training colleges (2016)	9
	Total no. of post schooling institutions (2016)	487
	Total no. of learners enrolled in post-schooling institutions (2016)	2,290,984

Source DBE (2018), DHET (2018)

That deep-seated structural inequalities in education have persisted, despite these substantial changes, have been well-documented. By any measure SA ranks among the most unequal countries in the world (Sulla, Zikhali, & The World Bank, 2018), recording the world's highest income inequality (Alvaredo, Chancel, Piketty, Saez, & Zucman, 2018). Despite recent signs of improvement (Roberts, 2018), SA's education system continues to rank low in international tests: 134th out of 138 countries in terms of the quality of its education system in 2016 compared to 139th out of 143 countries in 2015 (WEF, 2017). These indicators have been used not to validate performative truths, but for illustrative purposes whilst noting that their methodologies are flawed (Bowen & Moesen, 2007; Fougner, 2008). High levels of teenage pregnancy and a lack of access to sanitary towels militate against the participation of girls in school; high attrition among over-aged learners who drop out from school; and the prevalence of anxiety and depression among learners and teachers, are further manifestations of a 'silent exclusion' (Chisholm, 2012). Continuing protests heightened by the 2015–2017 student struggles against high university fees, further awakened SA society to the deepening inequality crisis in education (Mutekwe, 2017).

Scholarly analyses of this crisis range from illuminating tensions between equity, redress and global competitiveness (Spreen & Vally, 2010); to recognising the intersection between academic under-performance and racial, spatial, gendered, linguistic, disability and class manifestations of marginalisation and exclusion (Spaull 2013; Chisholm, 2012). Inequality is also experienced as a systemic, naturalised and institutionalised misrecognition of predominantly poor, black power-marginalised learners (Agherdien & Petersen, 2016; Fataar, 2018). Bozalek and Boughey (2012) applies Fraser (2008, 2009) three-dimensional model (economic, cultural and political) of social justice to analyse the way inequality has been framed or misframed in higher education. These analyses challenge a prevailing neo-liberal onslaught in education (Tikly, 2011) that perpetuates a deepening systemic inequality, leading to calls for social justice-oriented actions (Badat & Sayed, 2014).

Under the influence of dominant global discourse focused on performativity and competitiveness, analysis on equity and social justice has been glaringly absent from the DL literature. Czerniewicz, Williams, and Brown (2009) rank among the few scholars who frame the experience of disadvantaged students at three universities and their lack of access to ICT within an analysis of the socially-determined structure of exclusion and the lack of agency of disadvantaged students within this.

11.3 Analytical Framework and Methodology

This review distinguishes between equality and equity. Equality addresses the principle of sameness, uniformity and standardization for everyone but which on its own do not address systemic structural deficits. Equity however, relates more substantively to systemic, fair and just treatment that includes redress through positive discrimination towards those who have been historically disadvantaged as part of a broader social justice-oriented institutional and systemic transformation agenda

(Ambrosio, 2017; Badat & Sayed, 2014; Cooper, 2015). Here Fraser's (2008, 2009) three-dimensional theory of social justice which incorporates an economic dimension relating to redisribution, the cultural dimension relating to recognition, and a political dimension, relating to representation, informed this chapter's framing of social justice.

'Digital learning' is an overarching reference to the integration of emerging digital technologies (Bozalek, Gachago, Alexander, Watters and Wood, 2013) in education, as adopted by the Department of Basic Education (DBE). It incorporates eLearning, ICT in education, mobile learning and 'edtech' (DBE and UNICEF, 2017).

In taking a critical theoretical stance, the review draws on Feenberg (2017) whose philosophical underpinnings have been informed by the Frankfurt School Critical Theory and Science and Technology Studies (STS) and who acknowledge affordances of technologies to catalyse change but within a social context where power is unequally distributed. Such a critical stance is reconciled with Engeström, Miettinen, and Punamäki-Gitai (1999)'s third generation cultural-historical activity theory (CHAT) as an analytical lens. CHAT has been widely applied in analysis of socially situated transformation including in human computer interaction (Kuutti, 1996); student views on social learning (Agherdien & Petersen, 2016); and in the adoption of authentic learning by higher education educators (Bozalek et al. 2013).

CHAT evolved over three generations of thought originally inspired by Vygotsky's (1978) classic mediational triangle depicting the tool mediation and object-orientation of an individual subject within a social system which was identified as the first-generation CHAT. Leontiev (1981) drew a distinction between individual and collective activity and added the division of labour to a second generation framing of CHAT. Engeström (1999, 2001) expanded rules, community and division of labour as crucial nodes within a dynamic, complex and contradictory activity system. His third generation CHAT applies to larger systems and institutions and locates the activity system within a social transformational milieu centering on historically-accumulating, endemic internal tensions and contradictions. Here he highlights how the transitions and re-organisation of interacting activity systems emerge from these inherent tensions and contradictions, as illustrated in Fig. 11.1.

Based on five principles, Engestrom's third generation CHAT provides a conceptual framework with which to analyse conversations, multiple perspectives and networks of interactive activity systems. The first principle places as a unit of analysis, the tool-mediated, object-oriented base upon which the network of relations interact within an activity system. The second principle acknowledges the prevalence of many actors and role-players ('multi-voicedness'). The third highlights the historical evolution of a system over time (its 'historicity'). The fourth highlights the internal contradictions that drive change within and between interacting activity systems whilst the fifth proclaims the expansive qualitative transformation of the activity system over time.

The review locates the emergence of DL policy, practice and scholarship in SA as an activity system (Fig. 11.2) within a historical and cultural context and it situates

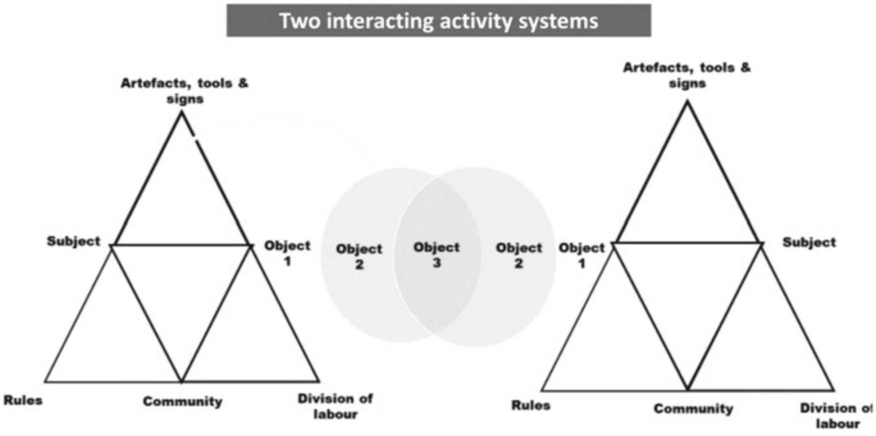

Fig. 11.1 Illustration of two interacting activity systems (Engeström, 2001)

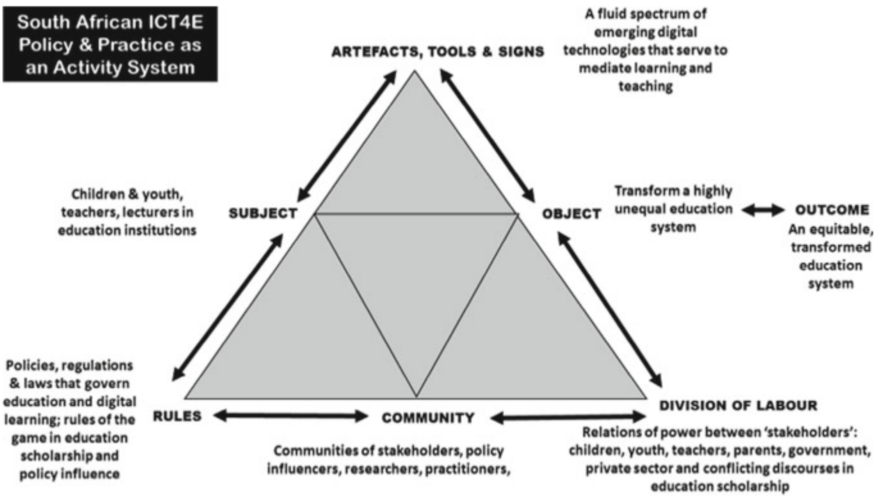

Fig. 11.2 SA DL policy and practice as an activity system

the transformational, emancipatory object-orientation towards an equitable education system, within an analysis of internal tensions and contradictions. Conceptually, digital technologies are not value neutral and are viewed as a fluid spectrum of socially-constructed emerging digital artefacts, tools and symbols which mirror power relations in society (Feenberg, 2017). These relations predominate in rapid change and convergence of technologies that are becoming increasingly mobile, wearable, embodied, artificially-intelligent and embedded within the social fabric of education systems and society over time (Adams Becker et al., 2018; Freeman, Adams Becker, Cummins, Davis, & Hall Giesinger, 2017).

The 'subjects' of the DL system are the diverse range of children, youth, teachers, lecturers, in and out of schooling and post-schooling institutions, particularly those who are marginalized from power and resources while the 'object' as espoused in policy texts and practice, is to transform a highly unequal education system towards an outcome based on a transformed, equitable education system. The DL activity system recognises the laws, regulations and policies at system and institutional levels as the socially constructed rules of the activity system; the range of actors in the policy and practice community that engage with the subjects, make up the community while the division of labour highlight the power relations that prevail between the various actors and role players especially in relation to the subjects.

Document analysis (Prior, 2008) was applied to the review three national government policies that relate to DL and the framing of equity and social justice whereas journal articles on DL trials and evaluations in SA were reviewed as reflective of practice and scholarship. Google Scholar, Mendeley and the University of Johannesburg online library databases were searched with South Africa and education policy, education practice, DL, ICT in education and mobile learning as key words. Specific references to inequality, equity and social justice were considered when scanning scholarly literature and policy documents.

11.4 DL Policies and Strategies

By illuminating policy as the rules within a cultural and historical activity system, this review acknowledges Ball's (2015, 1990, 1998) evolving conceptualisation of policy as both text and deeds in a given context; as the outcome of contestations between different role players; and a function of both local and global influences.

SA's DL policy space is a complex, fluid web of policies, laws and regulations that govern a growing education system and its intersection with information and communication technologies (ICT), media, publishing, broadcast, skills development and social development sectors and differing perspectives of wide-ranging stakeholder networks (Isaacs, 2015). These digital policies are linked to broader policies and strategies in education such as the *South African Schools Act*, the *National Education Policy Act* and the *2001 National Plan for Higher Education.*

Three DL-related policies are reviewed: the *e-Education White Paper, or White Paper 7* (Department of Education (DOE), 2004); the *White Paper on Post-School Education and Training* (DHET, 2013), and *the National Integrated ICT Policy White Paper* (Department of Telecommunications and Postal Services (DTPS), 2016). Notably these policies fall within the broader SA government's 15-year strategic vision, defined in the National Development Plan (NDP) 2030, which articulate a role for digital technologies in educational change (National Planning Commission, 2011).

White Paper 7 highlights the importance of connecting learners and teachers to each other and to professional support services and provides for the establishment of platforms for eLearning. It also seeks to connect learners and teachers to better information and ideas via an effective combination of pedagogy and technology in support of education reform. Its primary goal is to equip every basic and further education and training learner with the knowledge and skills needed to use ICT confidently, creatively and responsibly by 2013. This goal is supported by a strong policy framework consisting of four components: equity; access to ICT infrastructure; capacity building; and norms and standards. The policy also outlines the characteristics of a typical e-school which includes learners using ICT for meaningful learning; principals and teachers who are competent at managing and teaching with ICTs respectively; ICT access to support curriculum delivery; access to ICT infrastructure and connects with the community. Equity is mentioned 44 times as a policy principle and objective although it emphasises equity in access to digital resources. Social justice does not feature in *White Paper 7* although redress is mentioned twice in the context of equity.

Vandeyar (2015) found that district and provincial officials had a superficial understanding of this policy; they lacked a sense of ownership of the policy; and considered themselves responsible mainly for disseminating policy. Officials also lacked capacity and competency to implement the policy and the silo-ed behaviour between different directorates within education departments militated against effective policy implementation. Mooketsi and Chigona (2014) confirm, based on their study of teachers from schools in a black township in the Western Cape, that teachers were not aware of the policy nor were they basing their embrace of digital technologies on an understanding of *White Paper 7*. Others show the challenges and failures that have been experienced with policy implementation based on techno-centric design of DL initiatives (Ford & Botha, 2010). Ineffective implementation limited the extent to which the policy was able to meet its espoused goals for access, quality and equity in education (Amory et al., 2015).

The *White Paper on Post-School Education and Training* adopted in 2013 covers all education and training provisions for those who have completed school, those who have not and those who have never attended school. It highlights the need for equitable access to appropriate technology. Whilst SA does not have a coherent national policy on DL in higher education, this *White Paper* recognises that ICT is indispensable for effective education provision and central to open learning. It suggests plans to improve ICT access and calls for teaching and learning interventions using ICT to be carefully planned and implemented. It also commits to promoting open learning and supporting the development and use of open education resources (OER). Equity is mentioned 15 times in the text: as a policy principle along with social justice which is mentioned seven times and redress, four times. Equity is raised in terms of gender, race and disability; in ensuring employment equity and the provision of student financial aid to the poorest students. The policy draws a distinction between equity of access and equity of outcomes and it frames social justices as being central to the policy, as part of historical struggles for social change (DHET, 2013).

This policy was adopted amidst contesting ideas transforming the post schooling sector in SA, reinforced by student voices calling for free, decolonised higher education. At the heart of these debates are challenges to whether this *White Paper* promotes equity and social justice with some arguing that the labour market-centric nature of the transformation agenda focuses narrowly on skills and loses sight of the broader systemic ways in which exclusion and marginality are perpetuated (Maringe & Osman, 2016; Valley and Motala, 2014). Alternative pedagogical and epistemological models are currently being debated in the context of decolonisation (Fataar & Kruger, 2017; Osman & Hornsby, 2018). However, these conversations do not include the digital aspects of the transformation project whilst DL in higher education literature raises the equity and social justice issues marginally. Whilst Ng'ambi et al. (2016) anticipate that the next phase of digital integration will demand of higher education institutions (HEIs) to respond to more widespread digital access, cloud-based services, the growth in OERs and Massively Open Online Courses (MOOCs); they do not include in their analysis, challenges faced mainly by black students from impoverished backgrounds with digital access and the lack of policy to reflect this reality, Czerniewicz and Rother (2018) applied an equality lens to analyse the discourse in institutional policies at four SA universities. They conclude that explicit reference to the enabling role of technologies to support equity imperatives are absent from the institutional policies. Moreover, in her response to UNISA's open distance and eLearning (ODeL) policy, Nqubane-Mokiwa, (2017) warns of the potential to perpetuate exclusion and inequality since black students living in remote areas would not have access to connected devices to participate meaningfully in ODeL.

The *National Integrated ICT Policy White Paper* outlines how government plans to provide access to modern communications infrastructure and services to facilitate the entry of new players and meaningful participation of all citizens, including those in rural areas. Its provisions include the creation of wireless open access network (WOAN) which will be a public-private sector-owned and managed consortium; open government and open access; net neutrality; cyber security and combatting cyber-crime; creating an enabling environment to facilitate universal service and access; and meeting set targets for broadband access to all. It also emphasises policy provisions on e-literacy and e-astuteness as critical areas for intervention and propose the need for collaboration with all stakeholders across government, business, education, civil society and global development partners to address this decisively. It also proposes more co-ordination at building e-literacy skills; an assessment of skills gaps and capacity needs to drive digital transformation; and support training at public access sites. It envisages that e-skills programmes will be integrated into primary, secondary and tertiary education institutions to the benefit of all students. This policy makes no reference to equity or social justice but references equality 23 times and social inclusion twice, in the context of the constitutional rights of everyone; the NDP's aspiration to grow an inclusive and equal society by 2030; the need to mobilise the potential of ICT to reduce poverty and inequality and a recognition of Government obligation to address inequality by ensuring access to digital networks and services to all and that interventions need to address market failure and the need for social inclusion (DTPS, 2016).

Whilst all three are aspirational about promoting equity in digital access and skills development and frames equity as part of interventions to promote social inclusion, the three policies differ in their equity orientation. The two education DL policies reflect more of a policy commitment to equity, human rights and social justice compared with SA's cross-cutting ICT policy which is more exposed to and strongly influenced by the needs of the ICT industry. This explains this policy's technology-determinist market logic focused on global competitiveness and economic growth. These global economic pressures faced by the ICT industry invariably influences government to compromise on the issues of equity because there is often a trade-off between equity and economic growth thereby causing tensions between the policy, the subjects, object, community and division of labour within the DL activity system.

11.4.1 Action Plans and Implementation

Isaacs (2015) provides a descriptive overview of a host of national action plans, strategies and flagship programmes in basic and post-schooling education that relate to implementing these national policies. By then the national system had experienced the 'failures', successes and lessons of large scale initiatives like Gauteng Online; the Khanya Project (Ford and Botha, 2010; Sadek, 2016); the leadership development modules (Musgrave & De Wet, 2017) and the Ukufunda Virtual School (Isaacs, Roberts and Spencer-Smith in press; Spencer-smith & Roberts, 2016). In their analysis of the status of ICT in education in 2015/2016, Meyer and Gent (2016) propose a pathway to progress that emphasises system capacity building in view of slow progress with policy implementation. Moreover, one of SA's recent flagship initiatives to implement the *White Paper 7*, is *Operation Phakisa in Education (OPE)*, an overarching presidential initiative designed to fast-track the implementation over a short period of time (DPME, 2016). These reports and articles confirm that the equity and social justice imperatives were not considered nor prioritised because their purposes were focused mainly on enabling access to relevant digital resources as well as training teachers to use technologies in their pedagogical practice.

11.5 Equity and Digital Access in Education

In SA promoting universal quality access to digital infrastructure and services is framed as a quest for digital equity in view of the prevalence of a 'digital divide'. The three national policies and scholarly research highlighted above, express a shared view that the digital divide is a multi-faceted, dynamic concept that locates digital access disparities within the complex, deeply entrenched societal inequities that have racial, class, linguistic, gendered, geographic and cultural manifestations.

However, reports on progress with digital access still emphasize physical access to digital resources, particularly the Internet. This is consistent with Gillwald's (2018) view that data related to digital access and use remain deficient. At school level, 64.9% had some form of access to the Internet and 32.6% had a computer centre in 2016 (Kekana, 2018). Kekana (2018) does not elaborate on the nature and quality of digital access at these schools; nor the disparate levels of access across school quintiles.[1] Moreover, it does not report beyond physical access to include levels of motivation, access, skills, use and learning cultures by learners and teachers. However, Chingona, Chingona, Kayongo, and Kausa (2010) and Gudmundsdottir (2010) explain the linkages between digital inequality in schools and other forms of societal disparities.

Post-schooling institutions tend to have greater institutional digital access provisions in their libraries and via computer labs initially which later evolved to both institutional and personal access and use by students and staff. Ng'ambi et al. (2016) show that digital access models evolved toward bring your own device (BYOD) approaches that leveraged individual staff and student access to their own networked devices and more recently, their use of social media, social networking. They also show how the pedagogical integration shifted from using ICT to reinforce traditional practice to more diffuse use of technologies at both individual student, staff and institutional levels.

Makoe's (2010, 2012) studies on mobile phone use in distance learning are further examples. However institutional-level studies also reveal multi-faceted nature of digital disparities that are skewed against poorer, black students attending post-schooling institutions. Czerniewicz and Rother (2018) show how disadvantaged students at a university in Cape Town, face problems of access and accessibility including language inaccessibility causing them to be reluctant to interact with digital technologies.

Digital infrastructure also relies on basic physical infrastructure which remain elusive for a number of schools. Of SA's 23,577 schools in 2016, 2923 schools had an unreliable electricity source and 5004 had an unreliable water supply (DBE, 2016a, 2016b).

At household level in 2016, 59.3% of South Africans had an internet connection at home, work, place of study or Internet cafés or at least one person per household had access whilst 87% of SA households exclusively used cellular phones (Statistics South Africa, 2017a).

At an individual level, explosive growth mobile subscriptions opened up personal access to digital resources and the prospect of mobile learning (Isaacs, Roberts and Spencer-Smith in press). By 2017, 3G connectivity via mobile phone was almost universal while 4G networks reached 75% of the South African population (GSMA, 2017). However Spencer-smith and Roberts (2016) show limited access to mobile data by disadvantaged communities unless they are zero-rated and that even when physical access to a mobile learning resources were available, they were under-utilized.

The lack of adequate digital infrastructure in poor communities; high data costs and bureaucratic constraints with policy implementation, have been major influencing factors prohibiting universal, quality access. A 2017 study found that the

[1] According to SA's National Norms and Standards for School Funding, the quintile system allocated all government schools into one of five categories, with quintile 1 schools designating the poorest institutions while quintile 5 denoted the least poor public schools (Department of Education, 1998).

"cheapest cost for a 1 GB basket" in SA was much higher at US$7.49, compared to Egypt (US$1.41), Kenya (US$4.92) and Nigeria (US$3.21). Even though more people access the Internet via their mobile phones, high data package costs and out-of-bundle rates still pose a challenge to affordable quality access for low income users (Mothobi, 2017). In this context, the recent #datamustfall campaigns and calls for zero rating of education data will remain ongoing struggles (Du Plooy, 2017). These continuing struggles for basic infrastructure alongside universal access to digital infrastructure raise questions about the efficacy of scaling high-cost technologies like robotics and virtual reality required to prepare children and youth for the 'fourth industrial revolution'.

11.6 Digital Integration in Learning and Teaching

Digital integration in learning and teaching involves harnessing the mediational capabilities of emerging digital technologies to support the DL activity system subjects in realizing the educational object and outcome. Digital integration under appropriate and relevant conditions, catalyzes curriculum and pedagogical shifts in the learning process and teaching practice, enabling flexible, self-directed, self-paced, active, interactive, formal and informal mobile learning in and across contexts. These are dependent on a context that includes optimal digital access, teacher knowledge, relevant digital content and scaffolded local learning ecologies that build learner trust (Henning & Van der Westhuizen, 2004). Tedre, Apiola, and Cronje (2011) proposes 100 different attributes that influence digital integration in developing country contexts reflecting the multi-faceted complexity involved.

The SA literature confirm that in general teachers lack access to ICT to support their teaching practice (Mofokeng & Mji, 2010) although they have personal access to mobile technologies (Sadek, 2016); they are not trained sufficiently to integrate technologies in their teaching of subjects (Mofokeng and Mji 2010); they do not integrate technologies in their teaching practice (Chikasa, Ntuli, & Sundarjee, 2014); where they have access, they resist technologies or fear the associated changes (Ostrowick, 2015: 61) or use technologies to reinforce traditional teaching practice (Ndlovu & Lawrence, 2012).

Ndlovu (2015) found however, that the teachers she researched, believed in the affordances of digital technologies; the value of their pedagogical beliefs about their subject teaching; and the value in meeting the needs of learners. These beliefs enabled them to overcome their challenges with digital access. Similarly, Chikasha et al.'s (2013) showed that teachers who believed ICT had potential to enhance teaching and learning of their subjects, were more likely to integrate ICT. Sadek (2016) found that teachers at two school in the Western Cape were engaged in using technologies in their lessons, in teacher assessments providing learners with digital resources and getting them to find information.

Whilst digital integration at universities that have been studied, appear to be more widespread including the use of massive open online courses (MOOCs) (Batchelor &

Lautenbach, 2015; Goto, Batchelor, & Lautenbach, 2015), equity issues also militate against their optimal use and integration by faculty and learners both in and beyond campus (Czerniewicz & Rother, 2018). Xakaza-Kumalo (2017) highlight the influence of a range of contextual, pedagogical, content and cognitive motivational factors that influence digital integration at two SA universities.

11.7 Learners: Performance, Competencies and Digital Skills

The 'learner' is identified as one of the subjects in the DL activity system. However, there is a disconnect with how 'the learner' is theorized in DL literature relative to the general education literature. In DL scholarship the learner is conceived as a 'digital native', drawing on Prensky (2001) or in the case of youth from marginalized contexts at SA universities, as 'digital stranger' based on their lack of physical and social access, experience and opportunities with technologies, particularly off-campus (Czerniewicz & Brown, 2013), or as consumer at the behest of the DL market (Selwyn and Facer, 2014), or in neutral terms as active learning agent who can through the affordances of digital technologies learn creatively and build knowledge flexibly, interactively, autonomously, authentically and engage collaboratively in complex problem solving (Scardamalia & Bereiter, 2014).

The reference by Czerniewicz and Brown (2013) to power-marginalised learners as 'digital strangers' compares with a social constructivist conceptualisation of the learner in non-digital education literature, as social being (Agherdien & Petersen, 2016; Fataar, 2010) or learning subject (Fataar, 2010; Soudien, 2006) imbued with cultural wealth that they mobilize to navigate challenging conditions. Joorst (2015) shows how five black, poor, working class Grade 11 youth in a rural township in the Western Cape are 'self-schooled' through their display of aspiration; religion-inspired hope; imaginativeness and bodily adaptation practices. More recently, Fataar's (2018) edited volume highlight the educational practices and pathways of working-class youth appealing for recognition of their hidden cultural wealth.

This contrasts with a dominant performative discourse that highlight learner performance in standardized tests; the connection between under-performance and social, economic, cultural and political marginality; and a focus on preparing learners for a globally competitive labour market. For example, the recent PIRLS study that revealed 78% of SA's Grade 4 learners could not read for meaning in any language, sparked concern about the widespread prevalence of a learning crisis in SA (Martin & Hooper, 2016; Spaull, Pretorius, & Mohohlwane, 2016). This raises the spectre that should this situation continue, those learners who do not make it through the education pipeline to the labour market, fall within the ranks of the structurally unemployed youth, sometimes referred to in deficit-speak, as not-in-employment-education-or-training (NEETS). Youth unemployment which was 54.3% in the first quarter of 2017 (Statistics South Africa, 2017b) is one feature of the skills crisis in

SA alongside a shortage of people with ‘e-skills’. E-skills includes digital literacy skills; workplace e-skills and ICT specialist skills. The extent and nature of the e-skills shortage is unclear due to conflicting reports (Alexander, Lotriet, & Matthee, 2009). Kraak (2013) highlights state failure in addressing the challenge of NEETs and also highlight how non-government organisations at a micro level have been able to support unemployed youth with entry into their first jobs.

Amidst these challenges, a wave of optimism about the need to grow ‘fourth industrial revolution skills’ among youth and children including coding and robotics, have emerged. The Tshimologong Digital Innovation Precinct in Johannesburg has been host to many such programming and coding workshops, supported by the private sector. Some of these have also focused on tackling youth unemployment through the promotion of start-ups (Wits University, 2018). A number of private sector coding workshops for children and youth have also been sprouting, as once-off training programmes outside of formal schooling hours or during school holidays (Lotz, 2018; Moeng, 2018). The bigger systemic challenge relates to ‘coding as literacy’ as identified by Freeman et al. (2017) to be integrated into the curriculum and how coding can support reading skills, the arts and mathematical understanding.

11.8 Teachers and Teacher Professional Development

The pre-service and in-service teacher is another subject in the DL activity system. Many interventions in SA have attempted to provide teachers with digital access and have included a host of DL and teacher professional development (TPD) programmes for pre-service teachers at university (Batchelor & Lautenbach, 2015; Goto et al., 2015) and in-service teachers, often supported by private companies. Some, like (Botha & Herselman, 2015b) also developed a locally-relevant model for digital integration in teacher professional development.

In 2017, the DBE adopted a *Professional Development Framework for DL* (DBE and UNICEF, 2017) based on extensive consultations with teacher unions, provincial education departments, higher education institutions and the South African Council of Educators (SACE). It is SA’s response to UNESCO’s ICT Competency Framework for Teachers and builds on a previous *Guidelines for Teacher Training and Professional Development in ICT* adopted in 2007. This PD Framework serves to guide the ecosystem of TPD providers involved in delivering ICT integration training for in-service teachers and to support and guide higher education institutions who are preparing pre-service teachers to be competent in DL. The Framework provides 4 major learning areas, 13 competencies and 69 indicators that guide individualised learning pathways for all teachers, education officials and policy intermediaries in the system. This allows the many teacher development projects and programmes currently under way, with an opportunity to align to a national framework (DBE and UNICEF, 2017). The framework states its main aim as defining professional development for digital learning in an education system that seeks to improve access, quality, equity, redress and efficiency. Whilst this framework identifies equity as part of its main objective, it is not designed to engage with the inequity issues related to SA teachers such as the crisis in teaching and teacher capacity, their lack of pedagogical and content knowledge and teacher shortages (Chisholm, 2012). Whilst DL promises opportunities for virtual teaching to help address teacher shortages, these attempts have been limited. Moreover, no links are drawn between their life histories, identities and life-worlds of teachers in general and their digital cultures or lack thereof in particular. Paige, Chartres, and Kenyon (2008) and Henning (2000) provide examples of ways to understand the life-worlds of SA teachers while Fataar and Feldman (2014) show the importance of understanding the internalized habitual pedagogical practices and professional socialization of teachers over time, in order to shift their teaching practice. These analyses provide conceptual maps towards understanding the digital cultures of teachers that can inform how professional learning can be designed.

11.9 Discussion

Applying CHAT involves surfacing relevant tensions and contradictions within and between nodes in the activity system. In applying CHAT as an analytical framework, it is evident from the above that there are a number of tensions inherent in policy and practice of DL that militate against the system achieving its espoused transformational and emancipatory equity outcomes. Four inter-related tensions are identified in Fig. 11.3.

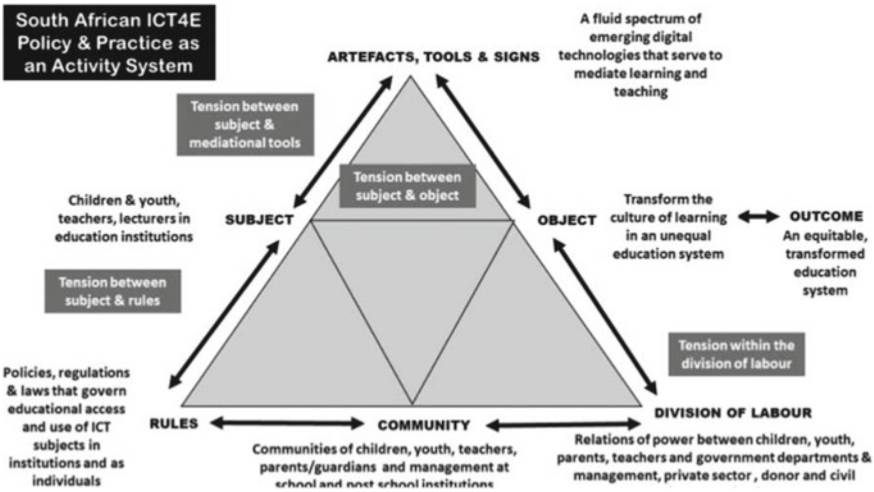

Fig. 11.3 Four tensions in the DL activity system

11.9.1 Tension Between Rules and Subject

A key tension exists between equity and social justice as espoused in DL policy (or not) and the disposition of SA learners and teachers as subjects. Not only is this reflected in the limited implementation or 'failure' of existing policy, but also in the absence of a national DL policy for the post-schooling sector and the need to update White Paper 7. Perhaps above all, attempts to reconcile contradictions between international policy-borrowed performative discourse (Ball, 2016) on digital access and skills for a globally competitive economy with 'social inclusion' yet not institutionalising the realities of power-marginalised learners and teachers as social beings (Fataar, 2012), how this experience still reflect the deep psycho-social nature of the legacy of apartheid (Crain, 2006) and the cultural capital to navigate their precarious lives. The irony is that the DL policy, practice and scholarship place great emphasis on 'learner-centredness' again borrowing from a global discourse.

The lack of awareness of existing policy and lack of agency by teachers are further manifestations of this tension. Perhaps the most glaring evidence of this tension is the growing protests by students against the lack of transformation through the #feesmustfall and Equal Education movements (Lance Robins & Fleisch, 2016) and their proactive calls for education decolonisation. These tensions demonstrate that the impetus for change in SA's education system reside not only in the technical and technological domains but that social mobilization by the subjects in their interaction with the system's rules continue to drive change is a consistent feature of the country's historical and cultural context.

11.9.2 Tensions Between Subject and Mediational Tools

There are evident tensions between the subject of the activity system and their embrace and adoption of learning technologies in formal institutional settings in particular. The literature points to limited examples at an institutional level. The tensions reside in the non-use or under-utilisation by learners and teachers due to limited institutional access to digital resources especially Internet connectivity; the non-use of available digital resources due to lack of awareness that they are available; the lack of relevance of digital content; the non-use of available resources among teachers due to their unfamiliarity with the digital resources; and that teachers use the technologies for administrative purposes in the main and less for learning and teaching. Moreover, in at pre-service level, teachers are reportedly under-prepared to use technologies because of the way they have been taught (Chigona & Chigona, 2013).

The analysis to date speak less of teacher and learner digital identities and cultures based on their life-worlds, their worldviews and their embedded pedagogical habits in and across contexts. Further study in this regard would surface clarity on the learning lives in naturalistic informal settings and what the implications are for designing appropriate learning interventions.

11.9.3 Tension Between Subject and Object

The literature also highlights tension between learners and teachers and the object to transform a highly unequal education system. The analyses on continuing inequality in relation to digital access and skills, the misrecognition of power-marginalised learners and teachers in the context of a performative discourse are systemic tensions that are evident in the literature. These tensions are a function of a deep-seated structural problem with the education transformation project in South Africa that relate to the lack of active participation and inclusion of the 'subjects' particularly from marginalized communities, in the process of change. Because of the exclusion from engagement and decision-making, protests have emerged among students, teachers and university staff from disadvantaged communities who will continue to demand that their voices, views and perspectives be considered.

11.9.4 Tension Between Object and Division of Labour

This tension relates to contending approaches towards DL by different policy networks involving private sector, government and civil society. These range from challenging technocentric versus pedagogy-centred approaches to DL policy and practice (Ford & Botha, 2010) to market-centric versus social-justice-centric approaches (Selwyn, Facer, & EBSCOhost, 2013) which also manifest as tensions between contending stakeholders. These tensions are often obfuscated by a dominant neutral discourse related to forging partnerships and networks without engaging with inherent contradictions in world-views within and between partners. These tensions suggest that the DL space will continue to be a contested terrain with strong political overtones.

11.10 Conclusion

In answering the question: *How has equity and social justice, been framed in DL policy, practice and scholarship* this chapter has attempted to combine a critical, high-level review of six intersecting dimensions of DL in SA with a deeper analysis and conversation that foregrounds equity and social justice. This approach aligns with a call by UNESCO to rethink education towards a global common good (UNESCO, 2015b), echoed by the Qingdao Declaration on ICT in Education that was inspired by a humanistic vision of education focused on human rights and social justice (UNESCO, 2015a).

The chapter shows how equity, social justice and related concepts such as redress and social inclusion, are marginal in DL policy, practice and scholarship. Based on a brief analysis of three digital learning related government policies the absence of explicit references to social justice and equity reflect a marginalisation of an important goal of SA's burgeoning democracy. The reasons for this marginalisation could be attributable to a systematic erosion of developmental and equity-centric goals in view of global pressures to shift the policy narrative over two and a half decades as explained by Bozalek and Boughey (2012) and (Badat & Sayed, 2014).

The chapter has also shown that digital infrastructural inequality is organically linked to systemic social, economic and political inequality in SA society. Framing the prioritisation of universal sustainable, quality access to digital infrastructure, resources and services needs to be tied to the broader equity and social justice goals for societal transformation.

Similarly, digital integration in learning and teaching, learner performance and skills and teacher professional development are not isolated from broader systemic influences. The chapter has shown a dominant market-centric performative discourse, under the influence of globalisation have influenced the narrowing of focus to issues of digital access, skills, capacity building and institutionalising shifting cultures geared towards the needs of a twenty first century education and labour market. That more impoverished and remote rural schools and institutions have consistently been chosen as sites for DL intervention, reflecting an imagination of equity associated with access to resources and opportunities for communities who are marginalised from power. Whilst results have been mixed, it raises questions about how to reframe the national conversation more strongly towards an emancipatory objective.

The tensions identified in the DL activity system will likely exacerbate as inequality deepens in the face of a rapid technological change. Current narratives related to the fourth industrial revolution and education threaten to intensify already existing intersectional disparities along race, class, gender, language, geography and ability and the spectre of a deeply-entrenched oppressive society in which the majority are relegated to social oblivion.

This raises questions about whether and how the fourth industrial revolution can be captured in support of an equitable education system and society. An approach towards a socially-just DL system will require recognition of trade-offs and contestations between market-centric and social-centric interventions that invariably relates to the distribution of power. Here the SA DL community can learn much from researchers in the social science and humanities disciplines in South Africa who have addressed ways to model emancipatory approaches that draw on SA's rich experience with community organisation and mobilization. The DL research communities elsewhere have developed critical agency frameworks that focus on power-marginalised communities identifying, acknowledging their disempowered condition and mobilizing their resources through strategies that conform, reform and transform their lives (Roberts, 2015).

The impetus for change in education in SA is partially technological but has largely been social and political. A recognition of this also challenges the dominance of an unchangeable, taken-for-granted technological inevitability narrative. The analysis in this chapter has been very limited and served mainly to open the door to reframing the national DL discourse towards an equity-centric research agenda and expanding the theoretical and methodological repertoire on DL in ways that engages with current debates on decolonizing education in South Africa.

Acknowledgements The author wishes to acknowledge Ms. Dudu Chulu from the UJ Library who has been been very helpful with sourcing references when conducting research on this chapter.

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Chapter 12
ICT in Education in Sri Lanka

Sujata N. Gamage

Abstract ICT in education as practiced in Sri Lanka can be differentiated as 'ICT education' and 'ICT as an enabler of education'. Although the stated objectives of policymakers or funders is the latter, after nearly two decades of investments in ICT infrastructure and teacher training in Sri Lanka, ICT as a stand-alone subject to be tested through examinations is well-entrenched in the education system, but there is very little evidence for the integration ICT in the teaching and learning process as an enabler of education. In the absence of data on ICT use in schools, we take an in depth look at the state of ICT as an enabler of education using three schools and a university in Sri Lanka as case studies. We selected institutions with functioning infrastructure and committed leadership so that we do not arrive at the all too familiar conclusions that point to the lack of those. The case studies revealed that Sri Lanka is indeed ready to move from the 'ICT education' stage to an 'ICT as enabler of education,' but, a system-wide transition is only possible through a concerted national effort within a master plan which stays constant as regimes change. Government investments up to date have been driven by promises in election manifestos by each incoming regime and the availability of donor funding. A master plan alone is not sufficient. Implementation of a plan will not be successful without changes to the largely examination-driven education system in Sri Lanka which has made ICT another subject to be tested on paper rather than a tool for life-long learning, and living and working in a technology driven world.

12.1 Country Overview

12.1.1 Education System

Sri Lanka can be proud of its school enrollment rates with almost all children in a given age cohort continuing onto secondary education. Various welfare schemes,

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_12

beginning with the midday meal program first offered in 1946, and the free provision of text books starting in 1980 and culminating in the provision of free school uniforms beginning in 1993 are important factors in these enrollment outcomes.

Education is provided through three levels of schooling—Primary from Years 1–5, Junior Secondary from Years 6–9, Senior Secondary from Years 10–11 leading to the General Certificate of Education Ordinary Level (GCE O/L) examination, and Senior Secondary from Years 12–13, leading to the General Certificate of Education Advanced Level (A/L) examination.

Almost 100% of students make the transition from Primary to Junior Secondary level from an original cohort of about 350,000 a year. About 90% of the original cohort makes it to the first stage of the Senior Secondary level. However, only about 50% are able to meet the requisite six passes including passes math and language and move onto second stage of the Senior Secondary level. The sharp drop in enrollment from Junior Secondary to Senior Secondary is due the inability of almost half the students to clear the GCE (O/L) hurdle.

Although the school curriculum is designed, by intention or otherwise, for progression to higher education in a university, only 7.4% of the age 19–24 cohort in the population progressed such (UGC, 2018). It is estimated that a total of twenty percent of the youth cohort in the 20–24 age bracket may eventually pursue some kind of tertiary education including those getting into public universities or enrolling in technical and vocational education, private higher education and external degree programs at public universities.

The Department of Examination which conducts these public examinations is perhaps the government department with the most impact on society in Sri Lanka. Families organize their lives around the schedules of the three national examinations—Scholarship Examination at end of Year-5, GCE (O/L) at the end of Year-11 and GCE (A/L) at the end of Year-13. Success at these examinations is largely seen as the only avenue of social mobility, but this exam-centered nature of the education system is also seen as the root cause of problems of education in Sri Lanka. This observation is reiterated in the key reports on the examination system and/or general education published recently (MoE, 2009; NEC, 2014). For example:

> [P]ublic examinations receive too much attention from students, parents and schools. The level of motivation in students, backed by the parents to ensure the student's success at any of the three public examinations, namely the Scholarship Examination, GCE O/L and GCE A/L examination has created too much of stress in students, besides, it has created a culture of heavy dependence on extra coaching by external tutors. The heavy examination orientation has brought adverse effects on the total development of the student. The overall development of student personality is seriously neglected or ignored by students and parents as students forgo all other co-curricular activities, social activities at school, home and community to attend coaching classes. Further, examinations are loaded with cognitive material and the school system has failed to ensure the total development of the child as envisaged by its broad goals and objectives of the reforms introduced in 1997. (NEC, 2014)

This examination centeredness is reflected in the ICT use in education as well. 'ICT education' is well-entrenched in the education system since 2004 with ICT been offered as a subject to be tested through national examinations. A total of 3500

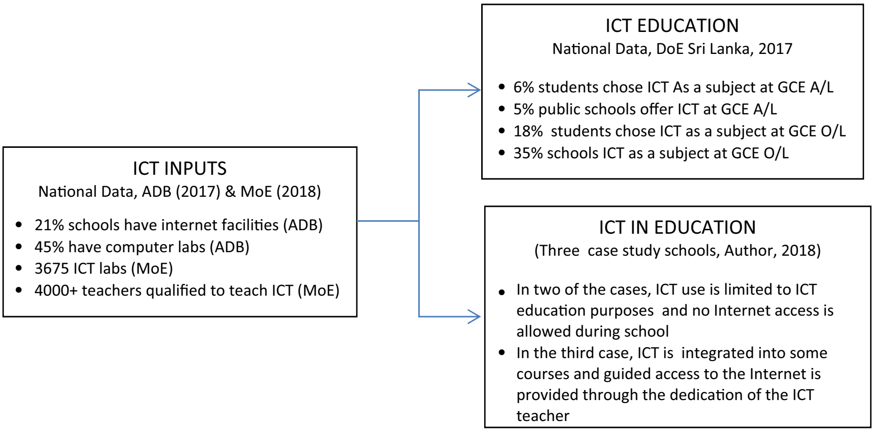

Fig. 12.1 ICT inputs and 'ICT education and ICT in Education' outcomes

schools offer ICT as a subject at GCE O/L or 35% of public schools. Up to 5% of public schools offer ICT at GCE A/L (Top right, Fig. 12.1). However, one is hard-pressed to find evidence of the use and the integration of "ICT as an enabler" of the teaching and learning process.

At the tertiary level, enrollment data in the public sector is deceptive because there is no official count of the private and professional opportunities available. The 15 public universities together take in about 20,000–22,000 students a year through a highly competitive process which is strictly based on the results of the GCE (A/L) examination. Admission to university programs in professions such medical, dental, veterinary sciences and engineering are particularly competitive. Even well-to-do parents try hard to get their children into these programs because these programs are tuition-free. Those who fail to get into these programs may take and retake the GCE (A/L) examination before opting for other tertiary opportunities. Those who are able to pay would follow foreign degree programs, the costs of which can run in hundreds of thousands of dollars in the case of medical degree programs.

Higher education too is thought to be largely based on rote-learning methods, though the evidence is only anecdotal. Unlike the school education system where the openness of examination system allows one to judge the nature of the education, it is harder to do so in university system where the teaching and learning process is highly decentralized. The use of ICT for education in universities is additionally hampered by the fact that at least one third of the academic programs are conducted only in the mediums of Sinhala or Tamil, the local languages. Those students could easily spend 3–4 years at the university without accessing the global knowledge base available in the English language and accessible through ICT.

12.1.2 Policy Environment

In Sri Lanka, even before independence, there was a practice of publicizing a white paper on any policy initiative. However, after 1981 when a white paper on education had to be abandoned, not due a proper critique of its contents, but on the strength of the protests against it, this practice is no more. Now the norm is to use the election manifestos of the winning Party as the basic policy document of the government or to proceed ad hoc. Policies are simply reflected in the actions of the government. In 2018, the Ministry of Education in partnership with UNESCO initiated a Master plan for ICT in Education, but a document is yet to be released.

12.1.3 Methodological Issues

One of major issues in describing the scale and nature of ICT in education in Sri Lanka is the lack of data with which to paint an accurate picture. A recent report by Asian Development Bank (ADB, 2017) presents an analysis of the current practices and policies in information and communication technology (ICT) in education in three South Asian countries—Bangladesh, Nepal, and Sri Lanka. That report is comprehensive on government policies and programs, but limited in regard to the impact of those. 'ICT education' data are presented but reliable data on use of 'ICT as an enabler of education' is missing. In a recent working paper on "ICT in education statistics: Shifting from regional reporting to global monitoring," UNESCO (2016) too notes the difficulties in collecting data on ICT use.

The discrepancy in measures reported by UNESCO (2016) and ADB (2017), respectively, further highlights the difficulty of capturing accurate country data on ICT in education. For example, UNESCO reports a student to computer ratio of 98 for Sri Lanka from its UIS database, while the ADB report cites a 4–26 based on two unpublished surveys. The difference could be due to a definition issues. As the UNESCO report points out, in many developing countries, it is unknown if the presence of Internet is intended for pedagogical use, administrative use, or both. The same issue applies to counting computers in use in school since it is not known how the computers are allocated.

Another issue in reporting on ICT in education in a developing country is the fact that irrespective of the quality of the data the conclusions of the studies are more or less predictable. Inconsistent policy making, weak implementation, poor coordination and/or lack of follow-up by the government are the usual suspects. For example, the ADB report concludes with a call for (A) Better Technical Support; Just-in-Time and Differentiated Professional Learning; Pedagogical Support; Localized and Customized Intelligent Tutoring Systems and learning materials for teachers and schools, (B) Better Coordination of ICT in Education Initiatives and Efforts within the Education Sector and with Other Sectors and (C) Better Monitoring and Evaluation of ICT use in Schools.

Better support for teachers as in (A) cannot happen if the policy initiatives are not coordinated and implemented and evaluated as in Items (B) and (C). It is not that governments are not committed. For example, in Sri Lanka there have been at least eight significant initiatives to provide ICT infrastructure to schools and train the teachers between 2000 and 2017 (Table 12.1). However, there is no continuation in implementation. Each regime begins anew.

In the present paper we see no reason to duplicate ADB report in its description of policies and policy initiatives in ICT in education in Sri Lanka. A national level data collection effort is also beyond the scope of the present study. Therefore we aim to complement the observations made in ADB study by viewing the scale and nature of ICT in school education through the lens of three schools where the school leadership is committed to ICT in education and has worked within existing constraints to harness resources and innovate. The objective is to uncover good practices that are possible in spite of infrastructural, digital content or human resource issues that are characteristic of ICT in education in a developing country. Two of the case studies schools are in the public sector with one based in Colombo, the capital, and the other a provincial school. For the third case study we selected a private school operating under the national curriculum but funded and managed independent of the state. Permission from the Secretary to the Ministry of Education was obtained through letter dated April 27 2018 to visit the schools and interview the principal and other personnel as needed to learn about good practices in ICT in education.

A technological university which is considered above average in Sri Lanka in the integration of ICT into teaching and learning processes is used as the case study for exploring ICT in higher education in Sri Lanka. A previous report compiled by the author for UNESCAP (2017) titled "Planning processes, policies and initiatives in ICTD education at institutions of higher learning (IHLs) in Asia and the Pacific: Sri Lanka Country Report" is used as the base document for that section.

12.2 ICT in School Education

12.2.1 Policy Perspectives

ICT in education policies in Sri Lanka are not explicitly stated but evident in investments by the government as fulfillment of election promises, or opportunities for funding from international lenders or donors. Government investments in ICT infrastructure, teacher training and content development, and schedule of introducing ICT as a subject at national examinations since 2000 are presented in Table 12.1 as a proxy for policymaking in ICT in education in the country.

Table 12.1 Initiatives in infrastructure, Teacher training and ICT Education in Sri Lanka, 2000–2017

Time period	Infrastructure and teacher training, by Project	ICT education
2003–2006	General Education Project, Word Bank	
	• Modernization of 2300 secondary schools with 800 of those with computer learning centers (CLCs), (Secondary Education Modernization Project 1, ADB)	• General Information Technology (GIT) paper for G.C.E. (A/L), since 2004
	• Train 6400 teachers in ICT literacy; 400 schools equipped with computer center; Pool of 80 IT trainer	• ICT paper for G.C.E (O/L), since 2006
2004–2009	Secondary Education Moderation Project II, ADB	
	• SchoolNet facility • International Computer Driving License (ICDL)/computer-assisted learning training for 10,600 teachers • Provide International Pedagogical ICT (IPICT) license for 18,000 teachers • Establish management information system	• ICT paper for G.C.E (A/L), since 2009
2008–2013	Knowledge Society Project, ADB	
	• ICT facilities for 2125 type II schools • ICDL training for 10,600 teachers • Provide IPICT for 18,000 teachers • Establish management information system	• ICT paper for G.C.E (A/L) Technology Stream, since 2013 • ICT as a subject assessed at school level for Vocational stream to be introduced from 2018
2012–2014	Government of Sri Lanka • 1000 schools Mahindodaya technological labs including IT labs	
	Government of Sri Lanka • Computer facilities at primary level in 5000 schools	
2012–2017	Foundation of a Knowledge Hub Project, World Bank • Enhance ICT skills of teachers, school administrators, and students	
2013–2017	Education Sector Development Program, ADB • 119 ICT labs and Staff development	

Source ADB (2017), Table A3.2 and MoE (2018)
Note The total number of schools in public sector is estimated at 9350

12.2.2 Infrastructure

Public investments in ICT in education in Sri Lanka commenced as early as 1999 when the Ministry of Education (MoE) established computer centers in 615 schools. There have been at least eight major initiatives since then, but due to the built in obsolescence of ICT equipment, only the facilities from recent initiatives are expected to be functional. Recent initiatives include the '1000 schools' project to provide technology labs including ICT labs from 2010 to 2015, and the investments since then to increase the number of currently functional ICT labs to nearly 3700.

A National Education Management Information System (NEMIS) too has been initiated, and efforts continue to be made to revive the SchoolNet that was introduced during 2004–2009 period and the E-Thakshalawa (or E-Academy) an initiative introduced in 2013 to provide educational content online.

How are these investments reflected at the school level as inputs to ICT in education? According the ADB (2017)—"45% of schools have computer labs while about 21% have internet facilities; A total of 3500 schools offer ICT as a subject at GCE O/L or 35% of government schools; Up to 5% of public schools offer ICT at GCE A/L; A total of 4000 teachers have been trained in ICT; and 150,000 teachers underwent basic ICT training; As many as 100,000 teachers or 45% went through Information and Computer Driving License training." A draft Master Plan initiated by the Ministry of Education (MoE, 2018) also notes that there are 4000+ teachers dedicated to teaching ICT and there are 3675 functional ICT labs in the school system, confirming ADB data (Left Hand Side, Fig. 12.1).

What is the extent of access to these ICT facilities by students? Are efforts made to integrate ICT into the teaching learning process? We have national level data on the extent of teaching and testing students on ICT as a subject but not on the extent of access to and general use of ICT facilities by students. In the absence of reliable data, we turned to the three case study schools to set some benchmarks for performance.

Access to computer labs: The computer labs from the 1000 school project are functioning well in the two public schools. Both schools also had one classroom called the smart classroom equipped with an electronic blackboard. Teachers had to book the room well in advance. The use of the smart classroom is totally dependent on the inclination of the teachers. In the public school in Colombo where the enrolment is at more than 5000 students, the lab facilities or one smart classroom was clearly not adequate. The use of the lab was limited mostly to students following the IT curriculum. The principal is on track to get a smart Blackboard for each class with the help of the alumni association of the school. In the provincial public school, where the total enrolment was about 1200, the single IT lab was used to its fullest with the IT teacher in charge using the facility to take students beyond the standard IT curriculum. The computers were equipped with open source applications for doing animations and the teachers had secured 'Microbit' equipment for doing IoT (Internet of things) projects with students. The private school in Colombo has procured its own computer lab and recently installed electronic blackboards in each of its 50+ classes. Earlier the teachers had to carry their own laptops and only some of the classes were equipped with multi-media projectors. The private school has less than 2000 studnets on roll.

Use of devices in classrooms: Use of devices such as tablet computer (or Tabs) in classrooms is non-existent in the case study schools. The principal of the public school in Colombo expects to equip the students with a tab each, along with electronic blackboard, so that some parts of the lessons can be made interactive. He expects to start with Grade 8 children such that students are groomed to become smart users early on. A sustainable model for funding these purchases is yet to be worked out. Bank loans can be arranged for parents, but charging a fee from students, however small, would be difficult in a country which prides itself on free education for all including free text books and uniforms. In the private school in Colombo, the principal does not see a need for student carrying their own tabs. Some teachers in the school are using the computer lab in creative ways in their teaching to give an individualized experience to students. In the provincial public school, tabs use is not yet a necessary, because students use their computer lab time to the fullest as we shall see in Sect. 12.2.4. In fact, having devices in the hands of individual students is not in the agenda nor feasible for the provincial public school. With the high level of creativity applied to use of existing facilities, it is rightly so.

Access to Internet: Although ADB (2017) report cites a 21% rate of Internet access based on a report by World Economic Forum, in all the three case study schools Internet facilities are limited and access to students is restricted. During the 2004–2009 period, a network called the SchoolNet with the ambitious goal of connecting nearly 9000 schools in the island to each other and to the educational administrative offices was set up under a World Bank project called the Secondary Education Modernization Project II (Table 12.1). The connected communities were expected to obtain online access to educational software, and enhance their teaching and learning processes on their own account (ADB, 2017). The case study schools have not used the facility for some time if not at all. Connectivity facilities notwithstanding, operational costs of connectivity are a major issue for government schools. Government pays a minimum amount for electricity but Internet access is not covered. Schools are expected to raise the funds themselves. In the case study provincial school, the IT teacher manages with 30 GBs of broadband per month at a cost of Rs: 1400 or less than USD 10, and the cost is borne by the Alumni Association.

Cyber Security: Vulnerability of young students to predators on the Internet is a real concern. Hence access to the Internet is restricted during school hours and students using the Computer lab are closely monitored. IT teacher at the provincial public school had made it known to the students that she has access to their search history at any time, and that has been a deterrent to misuse. However, students' use of the Internet after school hours, at least once a week, could be almost hundred percent. A survey of a focus group of ten students from Colombo consisting of all income groups show that all of them access the Internet at last once a week, using parents' or other's mobile phones. According to the ICT Facts and Figures Report, 72% of 15–24 age group youth in developing Asia access the Internet (ITU, 2017a).

Judging by the use of ICT infrastructure in the three selected schools we deduce that currently, ICT facilities are largely used to prepare students to face the ICT papers at the national examinations. School leaders who are looking to move beyond ICT as a subject to ICT as a tool for learning would be able to do so with existing facilities if school size is not too big and the teachers are committed and creative.

12.2.3 Educational Resources

Educational resources can be accessed online, offline through local area networks, or through content loaded on personal devices. Three major issues in regard to online education resource are the reliability of the Internet access, the availability and suitability of content in local languages, and the readiness of students to access and use this content.

Access to the Internet through broadband or always-on Internet will not be viable in the short term in Schools in Sri Lanka. According to the latest data from international Telecommunication Union (ITU, 2017b), in 2016, thirty two percent of the population in Sri Lanka reported that they used the Internet and twenty five percent reported having mobile broadband subscriptions. In contrast, South Korea, the exemplar in ICT indicators in Asia or the world, ninety three percent reported that they used the Internet and there were more than one hundred and eleven mobile broadband subscriptions per hundred inhabitants. These disparities are related to the level of the economy in each country and are not expected to disappear soon.

As regards content, the available Sinhala or Tamil content may not reach those who need it most due to poor Internet access and/or unsuitability of content. During a seminar on ICT in education held in November 2016, LIRNEasia, a Colombo based think tank brought together several local and foreign developers of educational programs. Local initiatives included E-Thaksalawa by the Ministry of Education and Web Patashala by Etisalat, a private telecom provider, offering Web portals with mostly PDF files of existing text books. Shipla Sayura is an initiative by a non-profit foundation by the name which offers online content in IT which is more interactive. Guru.lk by Dialog, another private telecom provider offers educational videos online. Tutorials are available free for schools through Nenasa TV broadcasts from Dialog. DVDs of tutorials are available for some Khan Academy videos in Sinhala and Tamil. Use data are available only for E-Thaksalawa. It reported a maximum hit count of 641,529 in July of 2016. The use data for other offerings are expected to be much less.

An alternative strategy would be to provide Tabs with uploaded content or content accessed through local area networks within the schools. ‘Raspberry Pi ‘ is a device that has made such local area networks economical for small groups such as a 20–30 students and their teacher each with their own or shared smart phones, Tabs or laptops. Here a complete syllabus with interactive interfaces can be uploaded into ta thumb size chip and the digital learning material made accessible to all in the classroom with the Raspberry Pi device mimicking a Web server. Kagnarith Chea (Chea, 2017), a young social entrepreneur from Cambodia and Niranjan Meegammana a social entrepreneur from Sri Lanka have both successfully used such intranets for teaching English and IT with teachers who are not computer hardware experts.

The electronic blackboard in each classroom in the private Colombo school has empowered some teachers to use the facility to search and upload content to make their lessons more interesting. The public school in Colombo too expects teachers to find their own content given the facility to share them easily with the students once the electronic blackboards are in place.

The provincial public school will not be able to secure electronic blackboards for each class in the foreseeable future, but they have demonstrated that with creativity they can accomplish much. One of their approaches is to make the Internet searches part of the class assignments (see Sect. 12.2.4).

12.2.4 Integration of ICT in Education

The case study schools are at different stages of integrating ICT in education. In the large public school based in Colombo, the Computer Lab is mostly for the use of students following the IT subject for GCE O/L or GCE A/L, or those doing mandatory IT modules. A few times a year, the teacher may do a lesson in the Smart Classroom to make the lessons more interesting with videos and slides, but with a student population of 5000+ and 100+ classes, a meaningful use of ICT in education cannot be expected. The principal is actively pursuing the installation of an electronic blackboard in each classroom, to make it easier for teachers to make the lessons more interesting but the interactivity of the lessons is not guaranteed. The principal is also interested in using the system as a teaching management tool to monitor the quality of teaching.

The private school in Colombo already has a learning management system to schedule classes and timetables, and the electronic blackboard is for the convenience of the teachers. Earlier the teachers had to carry their laptops from class to class. Teachers are slowly discovering way to make the teaching more student-centered with the help of the electronic blackboard. A teacher described an activity where students worked on a poem in the computer lab, illustrated it as a presentation and emailed it to the teacher, who then made the presentations available on the electronic blackboard in the classroom.

In the public provincial school, the IT teacher uses the IT courses as opportunities to give cross cutting competencies to students. One of her classes participated in an inter school program of the British Council and shared pictures with counterparts in India. When the Internet in the Computer Lab stopped functioning the teacher had to use her own phone to complete the video call. Her students use Scratch, an open source application, to create animations and Microbit sets to do simple IoT projects. Her students are eager to come to the IT class and would come there every day if they can, it seemed. The IT teacher also collaborates with other teachers so that students get to do presentations for their other classes while they are at the Computer Lab. One class teacher in the school got her students work as groups do their own presentations on a selected topic from the science curriculum and they became teachers for the day. All this is accomplished with a computer lab with 40 computer and 30 MB of Internet access and the dedication of the particular ICT teacher.

In all three case study schools, the computer labs are largely used by students following ICT as a subject at national examinations. National level data on the number of students sitting for ICT as a subject at GCE (O/L) and GCE (A/L) examinations (Top Right, Fig. 12.1) show that ICT investments (Table 12.1) have paid off in terms of ICT education. Although national level data on ICT use in education are not available, above observations on ICT use in the three case study schools are summarized in the Bottom Right Box in Fig. 12.1.

In Sri Lanka students spend only six hours per day for 250 or fewer days a year in the school. If the government focus on bringing broadband prices, and schools focus on digital literacy and class teachers assign homework to keep their internet browsing productive, if not for the language issue, access to digital content can be pushed to homework part of the learning. The innovation by a science teacher in the provincial public school where she challenged students to conduct a course unit on the topic of circulation of blood using internet resources with her as onlooker is a case in point. As broadband prices become more affordable, these assignments can be done after school at home. The survey of a focus group of students from Colombo showed that they all used WhatsApp or Facebook Chat to communicate with their friends about class schedules and assignments and share educational content, in addition to the usual social exchanges.

12.2.5 Teachers' Professional Development

ADB (2017) report gives a not so positive picture of the professional development for IT teachers in Sri Lanka but the focus is on traditional government led training. In the two case study schools from Colombo, the focus is on the use of the electronic blackboard more or less for traditional teacher-centered approach made more interesting with the technology. In the school that has already installed those in each classroom, the principal is happy with the training provided by the vendor of the devices. The school has a dedicated IT support person to maintain the Computer Lab and another teacher is in charge of the electronic blackboard system. The principal's approach is to allow the teachers use the device at their own pace and learn. Her approach is consistent with our findings from a systematic review of literature on integrating ICTS in K-12 classrooms (Gamage and Tanwar, 2017). A review of the literature published from 1990 to 2014 uncovered eight studies of sufficient quality from a pool of 11,000+ related papers. A meta-analysis of the findings of the selected papers showed that the perceptions of teachers about the usefulness of ICT device are twice as important as their perceptions of the ease of use of the device or application. In essence, if the teachers find a device or an application useful, they will learn to use it.

The case study provincial school showed the influence of a competent IT teacher can have on school as a whole to integrate ICT into the teaching and learning process. The case study private school from Colombo shows that a non-IT teacher too can become a champion and a peer who champions ICT use is more important than formal training for teachers. In fact, a systematic review of teacher training methods has shown peer-to-peer learning to be an effective training method (Orr et al. 2013). An example form Bangladesh where the government maintains a Web site for teachers to share their Power Point Presentations, lesson plans, and any other teaching materials is a good example of peer-2-peer learning in practice (https://www.teachers.gov.bd/).

12.3 ICT in Higher Education

12.3.1 Policy Perspectives

ICT policy for universities has been driven largely by aid programs. For example, the World Bank has funded the public university system in Sri Lanka since 2002 roughly at the rate of USD 5+ million per year and each cycle of funding has had some component to improve ICT infrastructure of the universities and increase ICT skills of students. Initiatives by the government using treasury funds are more recent. For example, the election manifesto of the government elected in 2015 had several proposals regarding ICT in higher education as well. Central to the higher education related proposals is the introduction of a ‘smart card’ with a special ID which includes Internet access package at a special price, pay-back method for a laptops obtained on low-interest loans and Wi-Fi zones in all libraries and reading rooms. The laptop program for universities is underway. It is too early to assess the success of the laptop program. The other programs are not in place yet.

12.3.2 Infrastructure

The most relevant national infrastructure to the case study university is LEARN or the Lanka Experimental Academic and Research Network. The university is largely unaffected by other policy initiatives by the government, because the university has been proactive in providing computer facilities and Wi-Fi zones etc. on its own. The LEARN network is driven by a national consortium universities.

LEARN was established in 1989 as a meager dial-up service connecting three universities. Today, the network serves as the default Internet service provider (ISP) for all state universities with each university purchasing its bandwidth requirements from LEARN. The network receives funding from the Ministry of Higher Education as well but is administered as an independent inter-university program.

The case-study university accesses the Internet exclusively through the LEARN network. It provides Wi-Fi coverage across the campus using the Local Area Network (LAN) linked to LEARN. There is a system to cache downloads from the Internet for the purpose of economizing the bandwidth used for Internet access.

Students gain access to the campus network through computer labs or their own mobile handsets, computer tablets or laptops. The university maintains a satisfactory level of access to devices by students for coursework related needs with a student to computer ratio is about two. There are multiple labs and students have access to the internet. The university provides a computer lab for each level (or year) of study.

The number of computers provided decrease by level of study, because the laptop ownership is nearly 100% by Level 2 (or year 2). From second semester onwards students use these computers for all their learning related requirements. In a trial conducted a few years ago, final year students were given a laptop at the beginning of the final year, which they had to return when they graduate. If they lose the laptop, they were to be charged a fine three times the price of the laptop. However, over the time, it was found out that the final year students prefer to buy their own laptops. Therefore, now the laptops are given to second or third year students who do not own a laptop.

12.3.3 Educational Resources

To the best of our knowledge there are no national initiatives to provide open educational resources at the tertiary level. One initiative by a university is limited to instructional videos for pre-university courses.[1]

12.3.4 Integration of ICT in Education

In order to increase the integration of ICT into the academic programs, the case study university recruited a webmaster who is responsible for the campus website and other web based applications. Each faculty member is given a laptop and a broadband connection with reasonable data access by the university. The faculty members extensively use ICT for instruction.

Furthermore, a Moodle based learning management system (LMS) at the university is used for content delivery, assignment submission, etc. All faculty members in the university are required to post their syllabi on the LMS, but using any additional features is optional. The respondent faculty member in the present study uses LMS extensively in her teaching. About 70% of the material in the curriculum which is not found in text books is posted on the LMS. Students are required to secure the remainder on their own through the Internet. She uses file management, storage,

[1] https://learn.sjp.ac.lk/.

retrieval and communication and collaboration functions of the LMS. In her estimate, LMS is optimally used by only 50% of the 20 faculty at the CS&E department. She estimates that only 10% of the other 400 faculty members in the engineering and technology university use it fully. Student registration is done through a separate student management system (SMS).

ICT use in other universities which are more comprehensive and include Humanities and Social Science faculties is expected to be lower. The fact that studies in Humanities and Social Science faculties are almost all carried out in the vernacular means that the incentives for students to use ICTs to access the global knowledge base to improve their learning is minimal.

12.3.5 Teachers' Professional Development

In the case study university in-house IT support personnel assist faculty. Typically there are no budget lines for ICT training and the professional development of teachers in the university system is largely funded by aid projects.

12.4 Conclusion

Outcomes and achievements: The pattern of investments in ICT infrastructure in schools in Sri Lanka (Table 12.1) shows that succeeding governments are committed to introduce ICTs into education. However, nationally available data only point to one impact—i.e. success in ICT education as evidenced by students completing credentials in ICT education in national examinations.

Challenges and strategies: The three case study schools (Sect. 12.2.4) have demonstrated that (a) current level of ICT infrastructure should not be a challenge if the size of the school is reasonable and the teachers, the teacher in charge of ICT in particular, are committed (e.g. the Provincial public school) (b) schools have to be equipped to according to size or limited to a size of 1000 or so to even begin to think of ICT use in education (e.g. Public school in Colombo), and (c) ICTs are currently used for the teachers' convenience (e.g., the Private Colombo school case study) but progress to a student-centered use of ICT require system wide changes in the examination centered nature of the public education sector. Peer-to-peer learning should be explored as a mode of teacher training (Sect. 12.2.5).

A master plan which prioritizes student learning outcomes lays out expectations from teachers and higher-ups is an imperative. Given the challenge of inconsistency in polices between regimes. Such a plan should be prepared with stakeholder participation and publish as an official gazette such that succeeding regimes make their investments within the larger framework of the master plan. An effort by the current Ministry of Education to develop such a plan is eagerly awaited.

In the case of higher education, students' lack of facility with the English language and a teaching learning process which is limited to teachers' notes presented in the vernacular are major challenges to use of ICT in education.

Reflections and issues: The two intractable issues that need to be addressed in parallel with such a master plan are the examination-centered education which limits ICT use in education, and the inability of curriculum developers and teachers to access and use global knowledge resources due to lack of competence in English, the lingua franca. ICT in education whether in schools or post-secondary education has to be addressed in the context of these two moderating, if not debilitating factors.

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Part III
Summary and Conclusion

Chapter 13
Diversity and Collaboration: A Synthesis of Differentiated Development of ICT Education

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Keywords ICT · Education · Belt and Road Initiative · Comparative Studies

13.1 Introduction

The Belt and Road Initiative (BRI) is a global development approach proposed by the Chinese government that involves investments and infrastructure development reaching out to countries and international organizations in Europe, Asia, Middle East, Americas, and Africa (Cai, 2017). In this initiative, information and communication technology (ICT) is an essential element which is critical in providing important communication channels for trade exchanges and transport and energy connectivity, global financial transactions, as well as scientific exchanges and socio-cultural collaboration between people, organizations, and countries along the BRI corridors (Kunavut, Okuda, & Lee, 2018). In this book, ICT in education in twelve countries of BRI initiative are studied including China, Croatia, India, Korea, Russia, Malaysia, New Zealand, Singapore, Slovakia, South Africa, and Sri Lanka. The ICT in the education of these countries are examined in terms of six major themes, i.e. ICT policy, ICT infrastructure, educational resources, ICT integration into practices, students' ICT competence, and teachers' professional development. The comparison of the current ICT in education for these eleven countries is revealed in Table 13.1.

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C.-K. Looi et al. (eds.), *ICT in Education and Implications for the Belt and Road Initiative*, Lecture Notes in Educational Technology,
https://doi.org/10.1007/978-981-15-6157-3_13

Table 13.1 Comparison of the current ICT in education for the eleven countries

Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
China	ICT in Education 2.0 action plan (2018–2022)	Three Connection and Two Platforms (TCTP) Project (2012–2017). "Three Connection" refers to access (1) to the Internet for each school; (2) to high quality educational resources to each classroom; (3) to virtual learning space for each student. "Two Platforms" refer to the platform (1) for educational resources; (2) for learning management system	The number of discipline resources of the National Education Resource Center which covers primary, middle, and high schools has reached nearly 26 million. These resources involve many aspects, such as core values, legal system, security, national unity, and national defense, etc.	New technology, such as cloud technology and e-Textbooks, are widely employed to explore new teaching patterns with the combination of formal and informal learning, which helps to transform learning through technology	According to the China Internet Network Information Center (2015), the majority of Internet users are from the younger generation aged between 10 and 39 years of age (78.1%), with the age group of 10–19, in particular, accounting for 22.8%	In order to promote teachers' ICT competence, China has carried out several large-scale teachers training projects, which aim to develop teacher' competence to use technology effectively in the classroom. For example, the National Teacher Education Alliance (NTEA, https://www.tuchina.cn) is an innovation project on teacher education, supported by MOE and jointly sponsored by more than 10 well-known domestic normal universities and research institutions
Croatia	National development strategy Croatia 2030 (2018–2030)	Student-to-computer ration is around 1 computer per 3 students. Almost all of the computers are connected to the internet, and only around 15% of available computers are portable	Digital educational resources in Croatia came from the grassroots through various teacher associations forming their own fora, websites and Facebook groups for development, exchange and review of digital resources, sharing their experience and pushing the market and public institutions to respond more promptly, with greater quality and a greater number of educational resources promoting the use of ICT in education	With e-services such as e-Class registry adopted by over 70% of Croatian schools, by simply providing tools that make teacher's administrative duties easier, technology is accepted more readily by the teachers in other fields of their work, and its use for teaching and learning seems to increase. One of the key outputs of the e-Schools project is a framework and a tool for evaluation of the use of ICT in schools on the K-12 level—framework for the digital maturity of schools	Based on the survey of ICILS (International Computer and Information Literacy Study), Croatian students have below average computer and information competence	Although Croatia has a dedicated agency, the Education and Teacher Training Agency (AZOO), in charge of school teachers' professional development, which is very active in providing various training for teachers, there is a dearth of recent evidence and research data for the characterization of teachers' professional development in Croatia

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Table 13.1 (continued)

Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
India	National Mission on Education through ICT (NMEICT) (2009–present)	Low-cost access and computing devices, such as tablets and laptops. 14.1 GBps bandwidth to 400 universities and high speed Internet to affiliating colleges	One of the main educational resources created by the FOSSEE project is the Textbook Companion. At present there are about 600 Scilab textbook companions and 500 Python textbook companions	Utilization of MOOCs in the university	Only about 10% of students in India have access to a computing device, such as laptops and desktop computers. A study conducted on 36,000 engineering students from IT related branches of over 500 colleges concluded that 95% of engineers in India are unfit for software development jobs. This study also finds that about 66% of students cannot even write code that compiles, and the code written by only 5% of them are correct, while only 1.5% can write functionally correct and efficient code	The Indian Government has come up with a mission Pandit Madan Mohan Malaviya National Mission on Teachers and Teaching (PM3NMT2). This Mission has come up with the concept of an Induction Training Programme me for new teachers. It plans to train 100,000 teachers, based on a concept note of a group of secretaries. Many of the 40 institutions funded by this Mission have conducted this training
Korea	5th Master Plan for Adopting ICT in Education (2014–2018)	Smart devices were supplied to each school; the new Information Strategy Plan to build the Foundations for a Cloud Educational Service created a ubiquitous cloud-based computing environment that stored learning materials and learner-generated records in personal Internet space, to be used and shared when needed	The 2011 Strategy for Promoting Smart Education was used to accelerate the development of digital textbooks for the amended curriculum	Smart-education and digital-textbook research schools are helping to integrate ICT into various fields	–	As software education has improved, software-education teachers have been trained to deliver it; ICT ethics training has also been strengthened, becoming an essential aspect of the field. The new Teacher Training Information Service enables teachers to find the training information they need at any time. This distance training is accessed by more than 1 million teachers every year

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Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
Russia	The program Digital Economy of the Russian Federation (2017–present)	One computer per five students	Created by multiple educational stakeholders, e.g., teachers themselves, e-learning vendors, etc., such developments include a diversity of websites and mobile applications featuring educational games and other interactivities, multimedia content, hypertext documents, virtual labs, etc. Today, these resources cover almost all subject areas, and they are typically arranged in a way to offer convenient access to individual repositories organized by a given field of knowledge, level of schooling, skill level, etc.	The processes of ICT integration into instructional frameworks may be described as still largely arbitrary and fragmented. Notably, this inconsistent and irregular nature of ICT integration patterns, which are basically not matched with any cohesive action plan, has been observed both at the cross-regional, regional and individual institutional levels	According to the ICILS international study of 2013, almost every tenth student (9%) failed to achieve the ICT Level One (i.e., basic literacy) score. The proportion of those scoring at the ICT Level One and ICT Level Two was 27% and 41%, respectively. Finally, a little more than a fifth (21%) of all Russian schoolers who took up the test made it into the ICT Level Three band. Notably, girls have scored on average 13 points higher than boys on the ICILS	A major downside that can be noted when discussing teacher professional development in Russia consists in the fact that only less than a half (42%) of all educators who sign up for training manage to complete their coursework (20% quit after the first lesson, and 38% do not even reach the middle). Furthermore, 6.5% of those who are allowed to take the final examination ultimately fail scoring substantially below the established passing threshold
Malaysia	Malaysian Education Blueprint (2013–2025)	Schools across the country have access to a cloud-based virtual learning platform and a high-speed connectivity	The FROG VLE system provides a plethora of educational resources and apps from around the web and makes it easily accessible during teaching and learning sessions. There are also the Open Educational Resources (OER) created in Malaysia for the benefits of providing access to high quality digital educational materials	Emphasize on e-learning	Generally the levels of ICT competencies among the Malaysian students are still very low	To ensure the success of the number of ICT reforms, teachers, school heads, and other educational personnel in Malaysia have been provided with on-going training and courses by the MOE. Malaysian teachers have been found to have a high level of ICT competency

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Table 13.1 (continued)

Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
New Zealand	Enabling the twenty-first century Learner (2006–present)	Ultrafast Broadband (UFB) project providing fibre-based ultra-high speed internet connectivity to 99% of New Zealanders by 2025, and to all schools by 2020. Nearly 80% of students in their school were able to access personal or school-owned mobile devices for learning purposes	POND is both a searchable resource repository and a forum for teachers to collaborate and extend their professional networks. It was established to allow teachers to engage collaboratively and share resources online using the UFB network	Despite the government's purchase of Microsoft 365 licenses for all teachers and students, only 14% of teachers indicated they used the Microsoft suite for teaching and learning purposes	–	In the absence of any nationally-coordinated ICT teacher professional learning (PLD) program, during this time schools and school clusters evolved their own professional learning programs, frequently responding to how they saw ICT supporting the learning needs of their students, and for some, engaging their communities. An example of one of these initiatives is the Manaiakalani ('The Chief's Hookline') cluster, located in the low socio-economic region of South Auckland
Singapore	Masterplan 4: Deepening Learning, Sharpening Practices (2015–2020)	1:1 access to device	Moving beyond the provision of Learning Management System (LMS), the new development of Student Learning Space (SLS) is a major effort to provide students with equitable and self-paced access to high quality digital resources developed, procured and curated by MOE in collaboration with internal and external partners. Also accessible to teachers, these resources, together with pedagogical scaffolds and instructional guides, would be aligned to curriculum foci and recommended pedagogies to augment teachers' capacity to create lesson packages	With a renewed focus on preparing future-ready students, the baseline ICT standards for digital learners now includes the development of skills, values, and attitudes for students to succeed in a new economy. The baseline standards comprise technical understanding of tools, searching and organising information, evaluating resources, creating digital multimodal products and collaborating respectfully as well as connecting and communicating digitally. Adopting a more integrative approach, the Cyberwellness Programme is now incorporated into the Character and Citizenship Education curriculum	According to a survey conducted by MOE, students were competent in the use of basic ICT tools	Teachers can attend online modules, face-to-face workshops and on-site coaching sessions, or participate in subject-based and interest-based learning networks to deepen their knowledge in ICT. Milestone courses to train middle managers and school leaders are also available to train these personnel to be instructional leaders of technology

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Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
Slovakia	National Programme for Upbringing and Education Development in the Slovak Republic (2017–2027)	At least 50% of students in Slovakia are at schools where one computer is available for every three students. All primary and secondary schools in Slovakia have access to the Internet at present	Educational resources can be divided into the following categories: • Comprehensive educational environments—www.edupage.org, www.naucteviac.sk, www.zborovna.sk, sk.wikipedia.org (Slovak version of Wikipedia), www.oskole.sk and www.mapaslovakia.sk, • LMS (Learning Management System)—Moodle, Blackboard, Claroline, • Instructional programs (commercial interactive digital maps by Cartografia publishing), applets, software modules and plugins (Wolframalpha, GeoGebra, FyzWeb—applets, etc.), • Presentations developed using Microsoft PowerPoint, Prezi, Adobe Captivate and mind-map designing programs like Xmind, MindMap, • Programs delivered to interactive boards—ActivInspire, Flow!Works, etc. • Other digital tools–highly specialized tools like interactive worksheets, crosswords, digital forms, digital notebooks, electronic devices (Raspberry, NAO Robots, Lego MINDSTORMS, WeDo 2.0)	At present, most lessons at schools take place in the form of ICT—supported teaching	In terms of the ICT competencies of students in selected Slovak universities, a study about Basic, Application and Ethical ICT Competencies has shown that almost 81% of students feel competent using a variety of digital resources in interaction and collaboration with partners. In addition, between about 62 and 77% feel competent in using an application in a productive way, using the main informatics and network resources and applying digital tools to obtain information from a variety of sources as well as solving problems and making decisions using the appropriate tools and digital resources	Teachers develop and refresh their ICT knowledge and skills through Continuing Professional Development (CPD). They should have the opportunity to deepen their understanding and mastery of ICT as a tool for innovating teaching and learning approaches. However, according to an OECD study (OECD, 2014), participation in CPD by teachers in Slovakia is low

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Countries	ICT policy	ICT infrastructure	Educational resources	ICT integration into practices	Students' ICT competence	Teachers' professional development
South Africa	e-Education White Paper, or White Paper 7 (2013–2030), the White Paper on Post-School Education and Training (2013–2030), the National Integrated ICT Policy White Paper (2016–2030)	At the school level, 64.9% had some form of access to the Internet and 32.6% had a computer centre in 2016	Post-schooling institutions tend to have greater institutional digital access provisions in their libraries and via computer labs initially which later evolved to both institutional and personal access and use by students and staff	Teachers lack access to ICT to support their teaching practice although they have personal access to mobile technologies; they are not trained sufficiently to integrate technologies in their teaching of subjects; they do not integrate technologies in their teaching practice	Youth unemployment which was 54.3% in the first quarter of 2017 is one feature of the skills crisis in SA alongside a shortage of people with 'e-skills'. E-skills includes digital literacy skills; workplace e-skills and ICT specialist skills. The extent and nature of the e-skills shortage is unclear due to conflicting reports	Many interventions in SA have attempted to provide teachers with digital access and have included a host of DL and teacher professional development (TPD) programmes for pre-service teachers at university and in-service teachers, often supported by private companies. Some also developed a locally-relevant model for digital integration in teacher professional development
Sri Lanka	ICT policy is not explicitly stated, but plan to initiate a master plan for ICT in education	45% of schools have computer labs while about 21% have internet facilities	The electronic blackboard in each classroom in the private Colombo school has empowered some teachers to use the facility to search and upload content to make their lessons more interesting. But the public school in Colombo too expects teachers to find their own content given the facility to share them easily with the students once the electronic blackboards are in place	In the large public school based in Colombo, the Computer Lab is mostly for the use of students following the IT subject for GCE O/L or GCE A/L, or those doing mandatory IT modules	–	ADB (2017) report gives a not so positive picture of the professional development for IT teachers in Sri Lanka but the focus is on traditional government-led training

13.2 ICT Policy

ICT policies vary from one country to another. According to the UNESCO Institute for Statistics (2014), there are different types of national plans with regards to ICT in education, namely standalone sector-wide ICT in the education plan, standalone ICT in education plan (not sector-wide), ICT mentioned in National Education Plan, or education mentioned in National ICT Master plan. These national plans also take many forms such as regulations and decrees, or investment programs and strategy papers which launch programs with short-term, medium-term, and long-term goals. As shown in Table 13.1, all the countries have their ICT policies, except for Sri Lanka. This indicates that the majority of the countries put emphasis on ICT seriously and have made policy efforts to integrate ICT in education. For instance, in Singapore, the incorporation of ICT in education has been implemented throughout four ICT Masterplans. The more recent one is the fourth Masterplan for ICT in education (2015–2020) which has been launched in Singapore to put "Quality learning in the hands of every learner—empowered with technology." The case of Singapore Master Plan 4, by incorporating scalable and reliable infrastructure in every school, exemplifies and highlights the importance of ICT to build the capacity to let students learn anytime and anywhere and achieve quality education.

13.3 ICT Infrastructure

Earlier studies revealed that deficiencies in ICT infrastructure have restricted the implementation of ICT in education. Relevant factors include resilience, availability, reliance, and affordability of broadband networks and services. Owing to the substantial infrastructure shortfalls in the region, the BRI initiative is undertaken to build ICT infrastructure through careful preparation, execution, and remarkable capital investment (Kunavut et al., 2018). There are various kinds of ICT infrastructure, ranging from television or radio to mobile devices, internets, and computers (UNESCO Institute for Statistics, 2014). In Table 13.1, it is noticed that most of the countries provide sufficient ICT infrastructure to the students in the schools, especially internet access and computers. For example, in Slovakia, at least 50% of students in Slovakia are at schools where one computer is available for every three students. All primary and secondary schools in Slovakia have access to the Internet at present. However, some of the countries such as Sri Lanka still have limited internet facilities and access to students also constrained.

13.4 Educational Resources

ICT plays a vital role in enabling a more inclusive learning environment which allows the students to access educational resources. In the report of UNESCO-Commonwealth of Learning (Patru & Balaji, 2016), the Massive Open Online Courses (MOOCs) should be open for all the secondary or postsecondary students rather than just open for students from the higher education to make sure the fair access and learning chances. From Table 13.1, we can see that all the countries have shared the diversity of educational resources to the teachers and students such as digital textbooks, multimedia contents, websites, mobile applications, instructional programs, and so forth. For instance, a textbook companion is one of the educational resources presented by Free and Open Source Software for Education (FOSSEE) in India such as about 600 Scilab textbook companions and 500 Python textbook companions. Not only that, more than 1500 courses have been released through MOOCs platform SWAYAM. There are also 14 million digital learning resources hosted by NDLI and currently, involving 1.4 million active users from more than 9000 institutes in India.

13.5 ICT Integration into Practices

The quality of education can be improved through ICT-enhanced pedagogies in terms of learning outcomes and teaching procedures. The application of ICT can also assist the teachers to utilize more student-centred pedagogical techniques in constructivist learning environments (The Head Foundation, 2017). By infusing ICT in education, the students can enhance their digital literacy for life skills and support their study (UNESCO Institute for Statistics, 2014). A lot of efforts have been done to integrate ICT into practices for all the countries, as shown in Table 13.1. For example, technology such as e-Class registry has been applied in most of the school in Croatia to help the teachers to conduct their administrative duties easier. Besides, a framework the digital maturity of schools was developed through the e-Schools project which consists of five areas including Leadership, Planning and management, ICT in Teaching and Learning, Digital Competences, ICT Culture, and ICT Infrastructure. It also comprises five levels of ICT implementation, intended at providing the schools and the educational system stakeholders with a clear indication of how ICT is being utilized in the educational setting. Nonetheless, some countries encounter difficulties of integration into practices such as Russia and South Africa. For Russia, the procedures of ICT integration into instructional frameworks are still largely fragmented and arbitrary due to not coordinated with any cohesive action plan at regional, cross-regional, and individual institutional levels. Meanwhile, for South Africa, the teachers lack access to ICT to assist their teaching practice even though they have personal access to mobile technologies. They are also not trained well to infuse technologies in their teaching and even do not incorporate technologies in the classrooms.

13.6 Students' ICT Competence

ICTs enable the students to enhance a set of fundamental competencies including think creatively, think critically, and work together to learn and search for new information and communicate well (The Head Foundation, 2017). As revealed in Table 13.1, three countries that have high students competence in utilizing ICT including Singapore, and Slovakia. Meanwhile, the students from the five countries (Croatia, Malaysia, India, Russia, and South Africa) have low competence in employing ICT. In India, the reason why the students lack ICT competence is due to the deficiency of ICT devices in the schools and only about 10% of them have access to a computing device.

13.7 Teachers' Professional Development

Teachers are often regarded as a precious role to elicit the most vital effect in the classroom to ensure that the students utilize ICT effectively during the learning process. Nevertheless, there has been little empirical evidence on how much teacher training is needed, how frequently it should be conducted, what type of training is most suitable and reasonable, and what it must cover to motivate the teachers to employ ICT in the classroom in terms of new pedagogies and new syllabus (UNESCO Institute for Statistics, 2014). In Table 13.1, it is observed that many countries have provided professional development programs and courses to train the teachers, for instance, the distance training in Korea accessed by more than 1 million teachers each year. However, there are teachers who were reluctant to take part in the training and their participation are low in countries such as Slovakia and Russia.

13.8 Conclusion

This book summary provides a comparison amongst eleven countries under BRI initiatives by looking at six main themes, which are ICT policy, ICT infrastructure, educational resources, ICT integration into practices, students' ICT competence, and teachers' professional development. The overall comparison indicates that there is still room for the development of ICT in education for all the countries in terms of these six main themes. Thus, it is suggested that all the countries of BRI can collaborate and help each other to improve the current situation of adoption of ICT in education, as well as to achieve successful implementation. To improve the quality, equity, and efficiency with ICT, a more holistic approach towards ICT in education was proposed by Ra, Chin, and Lim (2016) as displayed in Fig. 13.1. This holistic approach consists of ten dimensions, i.e., (1) National ICT in education vision; (2) National ICT in education plans and policies; (3) Complementary national ICT and

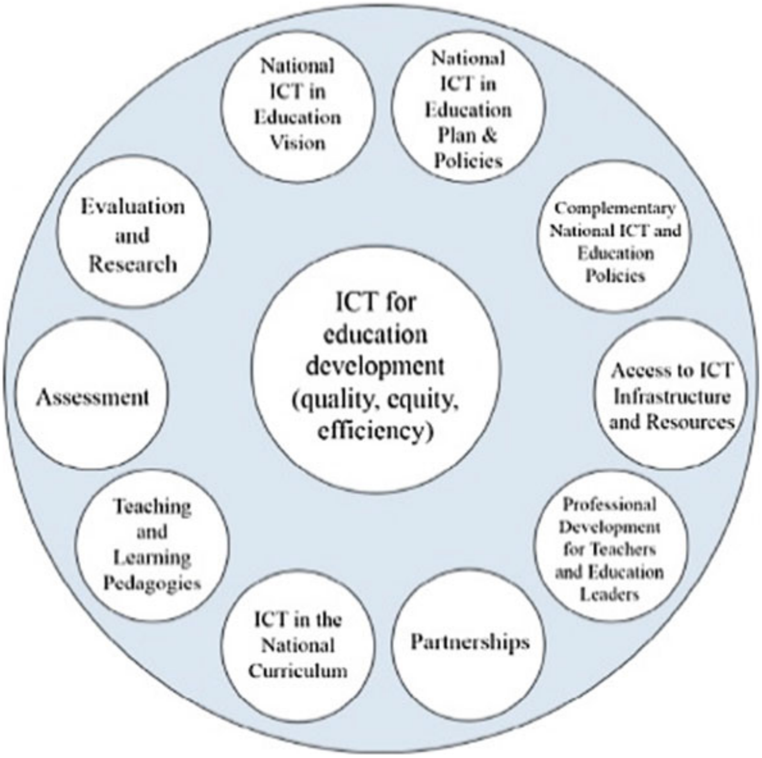

Fig. 13.1 A holistic approach towards ICT in education (Ra et al., 2016)

education policies; (4) Access to ICT infrastructure and resources; (5) Professional development for teachers and education leaders; (6) Partnerships; (7) ICT in the national curriculum; (8) Teaching and learning pedagogies; (9) Assessment; and (10) Evaluation and research. A clear and shared vision for national ICT in education should be formulated to determine how and why ICTs are employed to transform education. It enables instructors, instructor leaders, and policy-makers to communicate to their main stakeholders on how ICTs are utilized for the teaching, learning, and management to improve quality, and enhance efficiency and equity (Hew & Brush, 2007). After that, an ICT education plan for a national level ought to be executed to provide a guideline and framework to incorporate ICT in the education system. This intricate procedure necessitates planning and financial resource distribution, consultations with main stakeholders, and a good grasp of the global trends and growths, present and emerging technologies, and sociocultural-historical features of the system (Lim & Hung, 2003). The national ICT in education policies and plans are influenced and complement each other.

Access to ICT infrastructure and resources is a requirement for ICT to transform education in a country (Plomp, Anderson, Law, & Quale, 2009), for instance, computer rooms, placing of cables and network points, and rooms for servers. Professional development for policy makers, school leaders, and teachers is a crucial element of the holistic approach as well. They should be trained in the professional development programs of new roles and practices in ICT-enhanced learning environments Also, public–private partnerships play a central role to maintain the equity, quality, and efficiency of the education system. The national curriculum of ICT has to be formed based on the demands of ICT-enhanced learning environments and the potential of integrating ICTs in education. The suitable teaching and learning pedagogies are utilized together with ICTs to augment the quality of the education system. Not only that, the assessments that being used need to be aligned with the curriculum to track the students' learning performance. Lastly, evaluation and research should be implemented to gather the information about the evidence-based policies and practices for ICT in education, system-wide scaling up of innovations in ICT-enhanced learning environments, and amendment and customization of good models and practices of ICT education from one successful setting to another (Ra et al., 2016).

Conclusively, ICT in education is not just about and confined to education per se, but involves many aspects of society. Each country needs to make differentiated strategic choices and take diversified development pathways according to its own historical, cultural, and economic circumstances. Meanwhile, it also provides tremendous opportunities for extensive regional and international cooperation. Different countries can achieve both differentiated development and coordinated development from mutual learning and wide-ranging collaboration. The eleven country cases included in this book provide a unique macro perspective that will help readers gain a deeper understanding of opportunities and challenges afforded by ICT in education, and will also drive higher level of national development and international collaboration.

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