TechTrends (2019) 63:284–293
https://doi.org/10.1007/s11528-019-00396-0

ORIGINAL PAPER

National Policies and Educational Technology: a Synopsis of Trends and Perspectives from Five Countries

Jin Mao[1] · Dirk Ifenthaler[2] · Toru Fujimoto[3] · Andrea Garavaglia[4] · Pier Giuseppe Rossi[5]

Published online: 26 April 2019

Abstract
There have been continued efforts in exploring how educational technology impacts human learning and performance. Through a synopsis of the trends and perspectives on educational technology in five countries by using the STEEP (social, technological, economic, environmental and political) framework, the authors discuss the direct influence of national policies on educational technology implementation and research, the constraints of the local STEEP elements of culture on the adoption of and research on innovation and change, and the strategies and reforms that different countries have adopted to prepare the next generation for the constantly changing, globalized twenty-first century. Limitations and future research following this work are discussed.

Keywords Educational technology · National policies · Trends and perspectives

Introduction

Among the various technologies contributing to globalization, advances in communication technologies have changed how people access information and communicate with the outside world. Globalized environments have enabled learners to experience the world and form various perspectives without being constrained by the local norms and cultures. Facing these changes, educators and researchers have begun to consider many questions. For example, what does meaningful learning for the next generation consist of? What personal qualities are expected of the next generation who will live and compete in the fast-changing, globalized twenty-first century? What do teaching, learning, and instructional design mean in an artificial intelligence (AI) age?

These changes and questions have called for continued efforts in exploring how educational technology impacts human learning and performance with an understanding that technologies are no longer isolated from various systems and contexts. The purpose of this work is twofold: to provide a synopsis of the trends and perspectives on educational technology in five countries: China, Germany, Japan, Italy, and the United States (U.S.), and to discuss educational technology issues. The synopsis aligns with the STEEP (social, technological, economic, environmental, and political) framework. STEEP is a commonly used tool in business to analyze trends and predict future developments (Wozniak 2018).

Cronje (2016) adopted the STEEP elements of culture to categorize the trends in the environment at large and to determine how these trends will impact the future of the educational technology field. Cronje's view of educational technology aligns with Banathy and Jenlink's (2004) systems view by looking at a system connected to its parts and the environment. Systems theory and social systems design have been adopted in examining complex educational systems and change in education and training (Watson et al. 2008). Watson et al. (2008) suggested: "Educational systems also must transform into learning organizations to succeed in systemic change" (p.

✉ Jin Mao
jin.mao@wilkes.edu

Dirk Ifenthaler
dirk@ifenthaler.info

Toru Fujimoto
tfuji@anotherway.jp

Andrea Garavaglia
andrea.garavaglia@unimib.it

Pier Giuseppe Rossi
piergiuseppe.rossi@unimc.it

[1] Wilkes University, 84 W. South Street, Wilkes Barre, PA 18766, USA

[2] University of Mannheim, Mannheim, Germany

[3] University of Tokyo, Tokyo, Japan

[4] University of Milano-Bicocca, Milan, Italy

[5] University of Macerata, Macerata, Italy

696). Therefore, a STEEP analysis of educational systems as learning organizations would consider both a micro-environment that consists of learners and a macro-environment that includes the STEEP elements. In this paper, the STEEP framework is used for identifying the basis for synthesizing and comparing the trends and perspectives of educational technology from the five countries.

Educational technology is frequently associated with or even used interchangeably with Information Communication Technology (ICT) or new, emerging digital media, which indicates an oversimplified definition with a narrow focus on technology as a tool. Spector (2016) considers educational technology as "the disciplined application of knowledge for the purpose of improving learning, instruction, and/or performance" (p. 10). Based on Spector's definition, this paper defines educational technology as the technologies and techniques that are adopted to improve human learning and performance in various settings.

Method and Limitations

For each country, the search processes were conducted individually in the initial stage by using Google and other search engines native to the country being examined. The search covered both the published literature in electronic databases and the official reports from education departments. The search terms included "national policies," "educational policies," "educational systems," and key terms related to educational technology in K-12 and higher education. In addition to English, we also used the search terms in Chinese, German, Italian, and Japanese to search for information from local websites. The criteria used to determine the trends and perspectives from each country included: (1) major national political and socioeconomic policies that have influenced the educational systems in the past few decades; (2) major educational technology initiatives that have had national, statewide, or provincewide influences on education in the past few decades; (3) major changes and innovations in educational technology that correspond to the STEEP elements.

Due to practical constraints, only five countries were included in this study. This constitutes one limitation that presents a relatively narrow view of the topics in a global arena. The five countries have different economic growth indicated by the Gross Domestic Product (GDP) ranking as illustrated in Fig. 1. Ritchie and Roser (2018) summarized technology adoption in the world based on the data collected in 2015. Table 1 shows the use of mobile phones and the Internet in the five countries.

The GDP, technology adoption, and the different political and educational systems in each country provide a good basis to discuss these heterogeneous cases. However, including more countries and an additional analysis by each STEEP element individually should be a great research direction in the future to present a comprehensive picture of the topic. The other limitation is that the views on educational technology through this benchmark effort are closely associated with the authors' background, experience, and interpretation of the world.

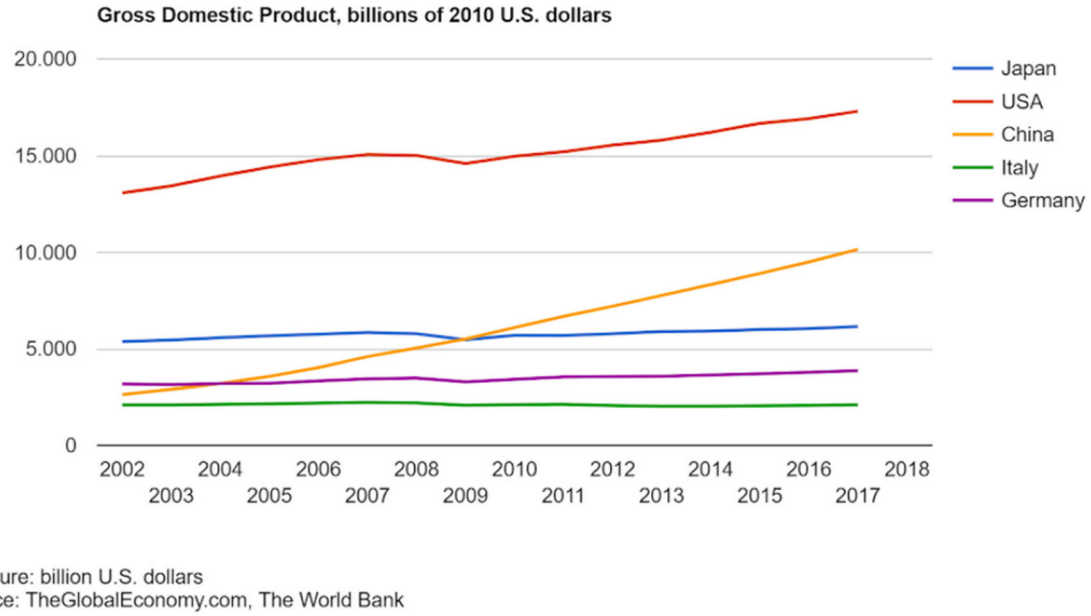

Fig. 1 Gross Domestic Product (GDP) for the selected countries. *Source:* Adapted from TheGlobalEconomy.com, The World Bank

Table 1 An adapted comparison of technology adoption among the five countries

Technology Adoption	China	Germany	Italy	Japan	U.S.
Mobile Phone[a]	92.18	116.71	142.12	126.54	117.59
Internet Access & Technology[b]	50.3%	87.59%	65.57%	91.06%	74.45%

[a] The number of subscriptions per 100 people. [b] Share of individuals using the internet by the percentage of the population, who have used the Internet (from any location) in the last 3 months via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.

Source: Ritchie and Roser (2018). Technology adoption. Our World in Data (2015) licensed under Creative Commons (CC BY-SA)

The Synthesis

The synthesis includes: (1) an overview of the country; (2) trends and perspectives in K-12 and higher education, and any other fields specific to the country; (3) status of Massive Open Online Courses (MOOCs); and (4) a brief summary. The status of MOOCs was used as a benchmark trend across the five countries.

China

China has achieved stable GDP growth since the turn of the century and is second in the world's national GDP ranking (World Bank 2017). In China, government appropriations for education are the main source of funding. In recent years, there has been a massive expansion in the development of educational technology in China. New startup businesses, major universities, and the Chinese Ministry of Education (MOE) have been working together to offer many flexible approaches to learning in accordance with the Outline of the National Mid and Long-Term Plan for Educational Reform and Development 2010–2020 (Johnson et al. 2016).

Trends and Perspectives

An increasing emphasis on using data from learning for formative improvements in real time and expanding open educational resources (OER) are two major trends and driving forces for the educational technology development in Chinese K-12 education (Johnson et al. 2016). One MOE-supported initiative started in 2002 titled the "Electronic Book Bag" project for elementary and middle schools. This project did not get full attention until recent years when advanced wireless technology and mobile devices became popular. The intended outcomes for the Electronic Book Bag project were to share course materials, offer real-time assessment and feedback, and improve teacher-student and teacher-parent interaction. The pilot is still ongoing, but there are concerns about its effectiveness due to a lack of teacher training, design methods, and challenges from the mindsets of traditional education (Xinhua News Agency 2018).

There has been a strong emphasis on the connection of the Information Technology industry and education in China as shown in the government's policies and funded projects. A focus on the education service industry and the demand-driven education service are among the major educational changes in China (Huang et al. 2017). The focus on education service in both policy and research is evidenced by projects and initiatives completed by Beijing Normal University and a number of key normal universities in China. For example, the "Internet + Education" initiative represents a trend of integrating digital tools, artificial intelligence and big data into daily work to enhance social and economic development (Li et al. 2017). Another example is the large-scale personalized learning initiatives supported by the dual-teachers model, or two-teacher system, which is a blended learning model in China, combining a local teacher and an online tutor. The trend of education service industry will impact future research on educational technology in China, especially when the dual-teachers model in Beijing is deemed successful and is advocated to use in other places nationwide.

The adoption of technology includes the form of online education programs, digital libraries, online testing, mobile learning, or online resource sharing in many universities. The higher education market has become internationalized with more western universities establishing their online programs or campuses run collaboratively with Chinese universities. However, adopting innovative pedagogical approaches is much slower than the rapid development of technology infrastructure strongly supported by the government. Among many challenges in educational technology, one clearly identified is a lack of personnel who have expertise in both education and technology in China (Chen et al. 2013; Lai 2017).

MOOCs in China

The MOOCs in China have demonstrated cooperation between education and industry. One good example is chinesemooc.org by Beijing University and Alibaba. Besides MOOCs offered in collaboration with Coursera and edX from the U.S., many MOOC platforms have been developed in China, including Xuetang X, Kaikeba, TopU, GuoKr MOOC and iCourse163 to name a few. The Chinese

government, industry, and educators have a strong interest in developing MOOCs and in using these platforms to solve educational issues about access and equality that are typically caused by gaps in the regional economy, gender, and learners with special needs (Huang et al. 2014). Research on MOOCs in mainland China has increased rapidly between 2013 and 2016 and its findings show that MOOCs, with a rapid development, face many challenges such as learning support requirements, curricular quality, assessment and evaluation, and students' integrity (Zheng and Yang 2017). MOOCs in China have had a substantial impact on its educational culture, assessment, and pedagogical approaches, which consequentially impact on the research trends and perspectives on educational technology.

Summary

The educational technology has been developing rapidly in both practice and research in China. The adoption of innovative pedagogical approaches and new educational models will need more systemic efforts. In addition, more well-trained and well-informed personnel who have expertise in both education and technology are needed to change the traditional test-oriented and teacher-centered educational landscape.

Germany

Germany has had a strong economy since the 1990s, and it is fourth in the world's national GDP ranking and first in the European GDP ranking (World Bank 2017). In Germany, education is largely free for students starting from primary grades to higher education. Over the past years, several large-scale innovations have taken place in its educational system (e.g., the establishment of all-day schools, the restructuring of the first years of preschool, and the modification of the segmented secondary education system with a more comprehensive system, changes in higher education accreditation and quality assurance). The innovations not only aimed to change the structure of the educational system to ensure more educational justice but also required new educational curricula and cooperation between different professions as well as cross-institutional communication (Bellin-Mularski et al. 2016). Although the advantages of technological innovations for learning and instruction are all beyond question, the pedagogically significant question as to how learning and instruction can be supported effectively is sometimes left out of the picture.

Trends and Perspectives

A large number of research projects are currently being funded by the German Federal Ministry of Education and Research as well as independent foundations focusing on technology integration in primary and secondary schools, educational platforms and analytics in higher education (Ifenthaler 2017). In addition, there is a strong trend toward digital workplace learning with a focus of lifelong learning as large companies embrace the developments of Industry 4.0 (Egloffstein and Ifenthaler 2017).

The school system in Germany is highly influenced by the federalist structure of the German state which has led to a variety of curricula and organizational structures. In recent years, approaches for coping with the increasing presence of technology in students' lives have been hastily developed and often inconsistent, leading to situations where computer science became mandatory in one year just to be canceled the following year. Despite the possession of smartphones by almost all German teenagers, research found that students demonstrated minimum ICT competencies and media literacy was a key concern for most of the schools (Delcker and Ifenthaler 2017). In order to proactively increase students' media literacy, the state of Baden-Wuerttemberg started a state-wide project by introducing tablets in schools. The project not only includes the implementation of technology but also supports professional development of teachers, instructional design of tablet-based curricula, and sustainable resource management (Galley and Mayrberger 2018). There have been other initiatives focusing on cloud solutions for schools.

In higher education, with an increasingly heterogeneous student cohort, institutions especially focus on supporting first-year students. To improve student retention, several German higher education institutions implemented learning analytics to provide personalized and adaptive support for students, flexible teaching opportunities and just-in-time feedback for teachers, as well as dynamic decisions by instructional designers (Ifenthaler et al. 2018). However, handling data privacy issues is one main concern in implementing learning analytics, particularly in regard of the country's data privacy act. The use of digital badges has also slowly entered the German higher education system. Digital badges are symbols for certifying learning achievements and competencies on web-based platforms (Ifenthaler et al. 2016). Another important trend is that German higher education has started reinforcing the value of teaching by supporting professional development in pedagogical and interdisciplinary collaborations to enhance students' academic competencies in competence-based education (Baartmann et al. 2007).

Workplace learning in Germany calls for a reconsideration of the form and design of learning environments, with a special focus on learning technologies and digital learning (Ifenthaler 2018). Emerging opportunities for digital learning include game-based learning, simulations, MOOCs, social networks, learning analytics, or mobile and augmented applications. Currently, workplace learning is mostly implemented as formal learning in the form of Cooperate Open Online Courses (COOCs).

MOOCs in Germany

The number of MOOCs has been increasing in Germany. As one of the biggest German speaking MOOCs providers, Iversity offers courses both for higher education and workplace professional development. SAPuniversity (or openHPI) is a MOOCs platform focusing on products of the software company SAP with topics on computer science and information technology. Many universities such as The Mannheim Business Schools started a MOOC initiative using the Open edX platform focusing on business topics such as value-based management and other courses for workplace learning.

Summary

The German educational system is largely influenced by advances in technology. Research in educational technology is slowly adopted when various solutions in K-12, higher education, and workplace learning are implemented. Still, more rigorous research with longitudinal designs is needed to document the efficiency and effectiveness of technologies for learning and teaching.

Italy

Italy is the ninth country in the world's national GDP ranking (World Bank 2017). The Ministry of Education, University and Research (MIUR) of Italy leads a centralized educational system with other regional authorities sharing responsibilities in education on the local level (OECD 2018). The limited autonomy at local schools makes it very difficult to spread a single solution to all schools. Over the past 20 years, the Italian government has moved towards the gradual introduction of technologies in classrooms.

Trends and Perspectives

The ICT projects in Italy have moved in three major directions: (1) the increase of the technological resources in schools, (2) the digital training of teachers, and (3) the innovation of teaching methods (Rivoltella 2013; Rivoltella et al. 2012; Rossi 2017). The programs initiated by the Italian MIUR during the past 20 years have focused mainly on the first two directions, while the third has been fostered by individual schools, universities and national commissions of experts that served as change leaders and agents for innovation. Insufficient attention to teacher training frequently impacts the investment, and the innovation processes are heavily influenced by the debate over the cultural value of ICT and the relationship between technology, learning, and professional development.

One of the most important initiatives is the National Digital School Plan (PNSD, Piano Nazionale Scuola Digitale) which is a part of the 2015 school reform. It has forced schools to focus all the collected funds on a single digital innovation project to cope with the severe economic crisis that has impacted Italy in recent years. The PNSD inspired the educators and policy makers and led to important initiatives including the "Classi 2.0 Project," which re-designed 400 classes with innovative technologies (Rivoltella et al. 2012); and the "Scuole 2.0", a project with 14 schools. In both projects, most resources were used to purchase hardware and software, rather than for teacher training. The schools in these projects covered the training needs on their own resources.

The PNSD set up the standard for a new type of school, which creates an open space for students to learn and to develop life skills. The PNSD addresses the challenges in interpreting and supporting life-long learning in either formal or non-formal learning contexts. The main actions of the plan included supporting broadband Internet access in schools, developing new learning environments, adopting a Bring Your Own Devices (BYOD) model, introducing digital skills, promoting Open Educational Resources (OER), increasing teacher training, and establishing an Innovation Team in each school. Moreover, in every school, a teacher assumes the role of a "Digital Animator," who supports the technological initiatives at the school.

Since 2017, the Italian MIUR has begun to implement an important curriculum of media education (Educazione Civica Digitale). This initiative responds to the need to prepare students for the profound changes brought by the ICTs and aims to help students develop the necessary competences of digital citizenship. In Italy, co-exist two different views on technology: The Technocentric (either critical or supportive) and the Sociotecnologic (Fishman and Dede 2016). The Technocentric approach affirms that the use of technologies has caused distraction and attention reduction in the new generation who were exposed to technologies since an early age. The Sociotecnologic approach highlights the importance of technology, the attention to infrastructure, and teacher training. It also acknowledges the challenges and the lack of leadership and support (Garavaglia 2015; Rivoltella 2018; Rossi 2017).

Among non-ministerial projects, the avant-garde educational project was promoted by the National Educational Research Center (INDIRE) to include networks of innovative schools. Another example was the EAS (Episodi di apprendimento situato), a teaching method based on microlearning that encourages students to create individual projects and connects formal and informal learning using technology (Rivoltella 2013). The Design for Personalization and Inclusion with the Technologies (DEPIT) project enabled educators to re-consider the instructional design using the DEPIT app, which allows them to share the design artifacts

among the students, following the established processes and objectives (Rossi 2017).

MOOCs in Italy

Many of the MOOCs in Italy are created for teachers who need flexibility for professional development, while others such as managers tend to enroll in MOOCs outside Italy such as Coursera (CRUI 2015). The most important MOOC platform in Italy is Eduopen, a network of universities with shared resources. Currently, Eduopen has 47,000 students. Despite these important initiatives, the phenomenon of MOOCs is not so widespread in Italy, and it is considered an economic risk (CRUI 2015).

Summary

Recent ministerial interventions and the leadership of many school networks have encouraged teaching innovations supported by technologies. There have been improvements in teaching and learning with positive impacts on schools. However, much more needs to be done to change the educational system in Italy.

Japan

Japan is third in the world's national GDP ranking (World Bank 2017) and is facing a long-term stagnant economic growth for over twenty years. Following a constitutional monarchy political system, the Japanese government leads a comprehensive and diversified educational system through its Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Central Education Council, and local governments (OECD 2018).

Currently, the elementary and lower secondary levels (nine years in total) of education are compulsory, and more than half of the students enroll in higher education in Japan. The use of ICT in education in Japan has not progressed successfully compared with other industrialized countries, especially in promoting ICT education (MEXT 2011). In recent years, active learning (including programming education), global education and re-structuring education are emerging topics with public attentions. Since MEXT believes that its utilization is the key in creating a school system suitable for the twenty-first century, ICT has become a supporting pillar in addressing such emergent national educational policy issues.

Compared with other countries, the rapidly declining birthrate, an aging society, and the reluctance to accept immigrants have been the major sociopolitical factors that influenced Japan's educational vision and policies. The government's visions for educational reform to address the aging Japanese society are reflected in the New Economic Policy Package (Cabinet Office of Japan 2017). It views the cultivation of human resources as serving an indispensable role to address the social issues in the forthcoming 100-year life era in education.

Trends and Perspectives

While life-long learning and continuing education are becoming urgent social needs, the entire Japanese school system is facing a major educational policy change in preparing younger generations for the future. In K-12 education, one big change to influence education at classroom-level is the revision of the New Course of Study and the College Admission Common Examination which is planned for its introduction in 2020. The latest revision of the New Course of Study includes the introduction of computational thinking and programming education as well as English language education in the elementary school curriculum (McMurray 2018). However, introduction of these new subjects creates serious challenges such as the lack of teachers with the adequate knowledge and skills to teach them. Investing in teacher training and supporting local teachers nationwide are pressing issues (MEXT 2015). It is imperative for educational technology researchers to assist those teachers and students in such programs. Besides the introduction of new subjects, emphasis on a fundamental shift of instruction, specifically from knowledge acquisition to knowledge utilization, is another major forward-looking educational reform in Japan. Furthermore, the needs to incorporate educational methods and tools to establish a learning environment for active, interactive, and deep learning persistently exist. Educators are becoming increasingly interested in educational technologies and instructional methods that enhance active learning (MEXT 2013).

In higher education, promoting globalization is one major change in educational policy that notably affects the learning environment. The Japanese government encourages the globalization of higher education by actively funding universities to increase the ratio of international students and faculty, increase the number of courses in English, and sponsor Japanese students to study abroad (MEXT 2014). Japan's MEXT initiated a national-grant project, Top Global Universities, which selects Japanese universities that are driving internationalization and offers prioritized support to their reform efforts.

MOOCs in Japan

The University of Tokyo joined Coursera and edX; Kyoto University, Osaka University, Tokyo Tech and Waseda University joined edX; and Keio University joined FutureLearn to offer MOOCs globally. While MOOCs are not yet a common means of learning in Japan, top universities are making use of MOOCs for global outreach (Fujimoto et al. 2018). Along with MOOCs, online educational tools to enhance international education such as video conferencing

software, video streaming services, and open education platforms are becoming part of the educational infrastructure for promoting globalization in higher education.

Summary

Japan's educational system is facing a radical change in its educational policies to address urgent socio-political situations caused by a rapidly aging society. A significant transition in its educational system is challenged by limited financial resources for education due to the drastic increase of social security costs. While advances in technology influence the educational system, rigorous research will be required to provide policy makers with substantial evidence to support better decisions.

The United States

The United States (U.S.) is first in the world's national GDP ranking (World Bank 2017). Under the federal republic political system, the U.S. educational system has distributed responsibilities among the Department of Education (DE) at the federal and state levels and local districts. Since the turn of the century, the No Child Left Behind Act of 2001 (NCLB) has been the most influential movement for rigorous educational testing and specific technology mandates until it was replaced by the new Every Student Succeeds Act (ESSA) in 2015 (Sheninger and Murray 2017). Ensuring equity in education is one of the core values built into ESSA along with many grant programs and initiatives. In line with the equity focus in the educational and political environments, innovative changes and grant-funded programs have been developed to deal with educational issues related to gender, socioeconomic conditions, ethnicity groups, and access to technology.

Trends and Perspectives

In the past two decades, K-12 school initiatives and state technology policies and programs have shown a gradual transition from a resource-focused technology integration phase to a design-for-learning-focused phase (Mao 2017). There has been much emphasis on 1:1 computing, personalized learning, and teacher professional development. Other technology-supported pedagogical approaches implemented in K-12 education include inquiry-based learning, game-based learning, online and blended learning, flipped learning, and maker education (Ottenbreit-Leftwich and Brush 2018). While digital tools and resources are available for technology integration in K-12 settings, educators are facing challenges from critical issues such as conflicts between technology policies, the digital divide and affordance and design issues. The issue of the digital divide has become a paradoxical concern when the technologies that are intended to minimize inequality among students and families from different socioeconomic backgrounds have led to more disparity or even larger divide in the fast-changing new media-supported world. Research has shown clear evidence for the evolving complexities and issues in the digital divide and technology integration patterns in K-12 education (Dolan 2016; Hohlfeld et al. 2017).

Over the past twenty years, higher education has gone through huge changes because of the Internet and computer technologies, and the corresponding changes in pedagogical perspectives, learning theories, and operation of the higher education systems in the U.S. These changes have become the representative research areas and site of policy changes, primarily because of the intense competition in the global higher education market and the hopes of finding a panacea for reducing costs of higher education.

The U.S. Office of Educational Technology (2017) has recognized that the global and socioeconomic trends in recent years have led to a rapid increase of the "new normal," non-traditional students, and it has called for a transformation of higher education teaching, learning, and assessing using technology. Reiser and Dempsey (2018) discussed many new trends such as learning analytics, informal learning, social media, MOOCs, open educational resources, and many other trends in the U.S. The most recent EDUCAUSE Review (EDUCAUSE 2018) has summarized the significant developments of higher education instructional technology in the past twenty years since its establishment in 1998. It found the following: (1) the Internet is considered the fundamental development; (2) analytics, cloud computing, cyber risks/security/privacy and mobile and online learning belong to the second level development; (3) collaboration, learning management systems, open technology/open educational resources, social media/networking, wireless and student-centered approaches become the third development; and (4) artificial intelligence, machine learning, eXtended reality (XR) and immersive learning will become the biggest development in the upcoming years. A number of nonprofit organizations continue to explore the newest changes and innovations, distribute and lead the trends in technology adoption, influence technology choices, and lead research on innovative practices and their impact on teaching, learning, and the educational systems of all levels. These organizations and resources have been influencing the trends globally.

MOOCs in the U.S.

Udacity, MITx (later edX) and Coursera were the first MOOCs platforms established by top universities including Standford University, Massachusetts Institute of Technology, and Harvard University. The number of MOOCs platforms has been increasing and the types of partnerships range from collaboration between universities, nonprofit organizations, corporations, museums, and the U.S. government. Educators

and researchers are aware of the challenges for MOOCs regarding course quality, assessments, and dropout rates. More research is needed to explore the pedagogical design, accreditation, and new business models for MOOCs in the U.S.

Summary

Many of the trends and perspectives on educational technology in the U.S. have had significant influence on the trends globally. Technology has greatly impacted the educational systems in the U.S.; and although there has been passionate support for technology adoption and innovations, many educational issues still need further exploration and research.

Discussion

The brief accounts above from five countries shows that national policies directly and greatly influence educational technology, regardless of the educational or political systems. National policies determine the expenditure on education and the distribution of resources by a country. While some countries have a below-average education expenditure, expenditure on research and development is increasing. When governments provide most or all of the grants and resources for research, research directions would be highly influenced by national policies, especially under centralized educational systems as in China or Italy. For example, educators and researchers in Beijing, one of the four cities receiving the most education funds in China (OECD 2016), have more opportunities to participate in or lead innovative educational technology projects tasked by MOE than those from other parts of China. Spector et al. (2014) emphasized the impact of funding agencies and national goals on design and development. To make such impact positive and meaningful, collaboration among all stakeholders is necessary in managing complex innovation and change.

Next, the adoption of innovation and change in education and research on educational technology are limited by the local STEEP elements of culture. The status of MOOCs in each country shows that although MOOCs may change the higher education landscape worldwide, not every country shares the same amount of interest and research attention as in the U.S. The culture of openness and sharing, an established tradition of examination and priority, and goals for education perceived by different stakeholders are some of the local factors that decide the success of any educational technology adoption. Experts recognized that the adoption of technology and innovation is "hindered by both local and systemic challenges, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches" (Johnson et al. 2016, p. 3). Considering local situations, customizing technologies and educational practices are critical for realizing the potential revolution brought about by educational technologies (Ren 2014).

The policy changes and technology initiatives implemented in the five countries indicate that the impact of technological changes on all aspects of society inevitably challenges the traditional educational practices. There are many strategies adopted in transforming education for the next generation; for example: the dual-teacher model in China, the technology projects improving student media literacy in Germany, the digital media curricula and projects in Italy, the reform of the college admission examination in Japan or *gaokao* in China, and the student-centered, personalized learning and computational thinking emphasis in the U.S. These strategies and reforms hopefully will prepare the next generation to be creative problem solvers for the constantly changing, globalized twenty-first century.

Concluding Remarks

The effectiveness of educational technology in improving teaching and learning remains the focus of research on educational technology for years. Although it is still being questioned globally, every country has developed national policies, acknowledging the need to support the innovation and change brought by various technologies. As Spector (2018) recommends, although evidence for the effectiveness of many proposed changes in learning design has yet to be accumulated, it is important to recognize the changes and learn from past efforts. Therefore, future research following this work may include an investigation of the new levels of the digital divide resulting from the socioeconomic and geographical division of a country and their relationship with the technology adoption rate. It may be meaningful to look into different design and business models for MOOCs and their relationship with practical local needs. Finally, more research is needed in exploring the contextual factors in educational technology design like the systems characteristics and policy limitations in different social, cultural, and political contexts. Using a design-based approach with a focus on problem-solving in educational technology (Reeves and Oh 2017) may be the right way to explore the contextual factors and local needs in different countries or regions.

Compliance with Ethical Standards

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest The authors declare that they have no conflict of interest.

References

Baartmann, L. K. J., Bastiaens, T. J., Kirschner, P. A., & van der Vleuten, C. P. M. (2007). Evaluating assessment quality in competence-based education: A qualitative comparison of two frameworks. *Educational Research Review, 2*, 114–129.

Banathy, B. H., & Jenlink, P. M. (2004). Systems inquiry and its application in education. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (2nd ed., pp. 37–57). New York: Macmillan Library Reference.

Bellin-Mularski, N., Mah, D.-K., & Ifenthaler, D. (2016). Pre-service teachers' perceptions of school development. In J. M. Spector, D. Ifenthaler, D. G. Sampson, & P. Isaias (Eds.), *Competencies in teaching, learning and educational leadership in the digital age* (pp. 57–76). New York: Springer.

Cabinet Office of Japan. (2017) New economic policy package. Retrieved from http://www5.cao.go.jp/keizai1/package/20171208_package_en.pdf.

Chen, L., Li, L., Zou, D., & Wang, A. (2013). Reflections on education and technological development in China. Deloitte China Education Industry. Retrieved from https://www2.deloitte.com/cn/en/pages/technology-media-and-telecommunications/articles/reflections-education-technological-development-china2013.html.

Cronje, J. C. (2016). The future of our field—A steep perspective. *TechTrends, 60*(1), 5–10. https://doi.org/10.1007/s11528-015-0009-0.

CRUI. (2015). *MOOCs massive open on-line courses. Prospettive e Opportunità per l'Università italiana*. Roma: Fondazione CRUI.

Delcker, J., & Ifenthaler, D. (2017). Computational thinking as an interdisciplinary approach to computer science school curricula: A German perspective. In P. J. Rich & C. Hodges (Eds.), *Emerging research, practice, and policy on computational thinking* (pp. 49–62). New York: Springer.

Dolan, J. E. (2016). Splicing the divide: A review of research on the evolving digital divide among k–12 students. *Journal of Research on Technology in Education, 48*(1), 16–37.

EDUCAUSE. (2018). Twenty years: EDUCAUSE and higher education IT. Retrieved from https://er.educause.edu/~/media/files/articles/2018/7/er184100.pdf.

Egloffstein, M., & Ifenthaler, D. (2017). Employee perspectives on MOOCs for workplace learning. *TechTrends, 61*(1), 65–70. https://doi.org/10.1007/s11528-016-0127-3.

Fishman, B., & Dede, C. (2016). Teaching and technology: New tools for new times. In D. H. Gitomer & C. A. Bell (Eds.), *Handbook of research on teaching* (pp. 1269–1334). American Educational Research Association. https://doi.org/10.3102/978-0-935302-48-6_21.

Fujimoto, T., Takahama, A., Ara, Y., Isshiki, Y., Nakaya, K., & Yamauchi, Y. (2018). Designing a MOOC as an online community to encourage international students to study abroad. *Educational Media International*. https://doi.org/10.1080/09523987.2018.1547545.

Galley, K., & Mayrberger, K. (2018 i.E.). Tablets im Schulalltag: Potenziale und Herausforderungen bei der Integration von mobilen Endgeräten an beruflichen Gymnasien. Erste Ergebnisse des Projekts, tabletBS'. *MedienPädagogik: Zeitschrift für Theorie und Praxis der Medienbildung*.

Garavaglia, A. (2015). Dispositivos móveis na escola: redefinição de ambientes e métodos de aprendizagem no contexto italiano. *PERSPECTIVA, 33*(2), 573–588.

Hohlfeld, T. N., Ritzhaupt, A. D., Dawson, K., & Wilson, M. L. (2017). An examination of seven years of technology integration in Florida schools: Through the lens of the levels of digital divide in schools. *Computers & Education, 113*, 135–161.

Huang, R., Yu, L., & Yang, J. (2014). The evolution of university open courses in transforming learning: Experiences from mainland China. In D. G. Sampson, D. Ifenthaler, P. Isaias, & J. M. Spector (Eds.), *Digital systems for open access to formal and informal learning* (pp. 25–39). Switzerland: Springer International Publishing.

Huang, R., Liu, J., Jiao, Y., Li, J., Zeng, H., Zhuang, G., et al. (2017). *The 2017 Research report on the internet education service industry*. Beijing: The Smart Learning Institute.

Ifenthaler, D. (2017). Are higher education institutions prepared for learning analytics? *TechTrends, 61*(4), 366–371. https://doi.org/10.1007/s11528-016-0154-0.

Ifenthaler, D. (2018). How we learn at the digital workplace. In D. Ifenthaler (Ed.), *Digital workplace learning. Bridging formal and informal learning with digital technologies* (pp. 3–8). New York: Springer.

Ifenthaler, D., Bellin-Mularski, N., & Mah, D.-K. (Eds.). (2016). *Foundations of digital badges and micro-credentials*. New York: Springer.

Ifenthaler, D., Gibson, D. C., & Dobozy, E. (2018). Informing learning design through analytics: *Applying* network graph analysis. *Australasian Journal of Educational Technology, 34*(2), 117–132. https://doi.org/10.14742/ajet.3767.

Johnson, L., Liu, D., Huang, R., Adams Becker, S., Gao, Y., Cummins, M., et al. (2016). *2016 NMC technology outlook for Chinese k-12 education: A horizon project regional report*. Austin: The New Media Consortium.

Lai, F. Q. (2017). Chinese scholars' perspectives regarding educational technology. In F.-Q. Lai & J. D. Lehman (Eds.), *Learning and knowledge analytics in open education: Selected readings from the AECT-LKAOE 2015 summer international research symposium* (pp. 205–221). Switzerland: Springer International Publishing.

Li, B., Zhang, J., Chen, H., Huang, W., & Wang, C. X. (2017). Education reform in the era of "internet plus": The 21st global Chinese conference on computers in education. *TechTrends, 61*(6), 520–523.

Mao, J. (2017). New technologies and old professional development: A reflection on emerging approaches. In W. W. K. Ma, C. K. A. Chan, K.-w. Tong, H. Fung, & C. W. R. Fong (Eds.), *New ecology for education: Communication x learning* (pp. 67–77). Singapore: Springer Nature Pte Ltd..

McMurray, D. (2018). MEXT's new course of study guidelines to rely on active learning. *The Language Teacher, 42*(3) Retrieved from: https://jalt-publications.org/articles/24329-mext%E2%80%99s-new-course-study-guidelines-rely-active-learning.

MEXT. (2013) The second basic plan for the promotion of education (Provisional translation) Retrieved from: http://www.mext.go.jp/en/policy/education/lawandplan/title01/detail01/1373796.htm.

MEXT. (2014) The Top Global University Project. Retrieved from: http://www.mext.go.jp/en/policy/education/highered/title02/detail02/1373875.htm.

MEXT. (2015) Improvement of the quality of teachers. Retrieved from: http://www.mext.go.jp/en/policy/education/elsec/title02/detail02/1373865.htm.

MEXT (Ministry of Education of Japan). (2011). The vision for ICT in education: toward the creation of a learning system and schools suitable for the 21st century. Retrieved from: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2017/06/26/1305484_14_1.pdf.

OECD. (2016). Education in China: A snapshot. Retrieved from https://www.oecd.org/china/Education-in-China-a-snapshot.pdf.

OECD. (2018). Education at a glance 2018: OECD indicators. https://doi.org/10.1787/eag-2018-en.

Office of Educational Technology. (2017). Reimagining the role of technology in higher education: A supplement to the National Education Technology Plan. U.S. Department of Education, Washington, D.C.

Ottenbreit-Leftwich, A., & Brush, T. (2018). Integrating technology into K-12 education. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and*

issues in instructional design and technology (4th ed., pp. 176–184). New York: Pearson.

Reeves, T. C., & Oh, E. G. (2017). The goals and methods of educational technology research over a quarter century (1989-2014). *Educational Technology Research & Development, 65*, 325–339.

Reiser, R. A., & Dempsey, J. V. (2018). *Trends and issues in instructional design and technology*. Boston: Pearson.

Ren, Y. (2014). Foreword. In J. M. Spector, M. D. Merrill, M. J. Elen, & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (4th ed., pp. vii–vxi). New York: Springer. https://doi.org/10.1007/978-1-4614-3185-5.

Ritchie, H., & Roser, M. (2018). Technology adoption. Retrieved from https://ourworldindata.org/technology-adoption#internet-access-technology.

Rivoltella, P. C. (2013). *Fare didattica con gli EAS. Episodi di Apprendimento Situato*. Brescia: La Scuola.

Rivoltella, P. C. (2018). *Un'idea di scuola*. Brescia: Morcelliana.

Rivoltella, P. C., Garavaglia, A., Ferrari, S., & Ferri, P. (2012). Could technology encourage innovation in school? An overview of "Classi 2.0" project in Lombardia (Italy). *REM Research on Education and Media, 4*(2), 253–264.

Rossi, P. G. (2017). Dall'uso del digitale nella didattica alla didattica digitale. In P. Limone & D. Parmigiani (Eds.), *Modelli pedagogici e pratiche didattiche per la formazione iniziale e in servizio degli insegnanti*. Bari: Progedit.

Sheninger, E. C., & Murray, T. C. (2017). *Learning transformed: 8 keys to designing tomorrow's schools, today*. Alexandria: ASCD.

Spector, J. M. (2016). *Foundations of educational technology: Integrative approaches and interdisciplinary perspectives*. New York: Routledge.

Spector, J. M. (2018). Future trends of designing learning in the global context. In T.-W. Chang, R. Huang, & Kinshuk (Eds.), *Authentic learning through advances in technologies* (pp. 205–216). Singapore: Springer.

Spector, J. M., Johnson, T. E., & Young, P. A. (2014). An editorial on research and development in and with educational technology. *Educational Technology Research and Development, 62*, 1–12. https://doi.org/10.1007/s11423-014-9331-z.

Watson, S. L., Watson. W., & Reigeluth, C. M. (2008). Systems design for change in education and training. In J. M. Spector, M. D. Merrill, J. van Merri˜enboer, & M. P. Driscoll (Eds.), *Handbook of research for educational communications and technology* (3rd ed.). New York: Routledge/Lawrence Erlbaum Associates.

World Bank. (2017). Gross domestic product 2017. *World Development Indicators*. Retrieved from http://databank.worldbank.org/data/download/gdp.pdf.

Wozniak, K. (2018). STEEP analysis. Retrieved from https://ceopedia.org/index.php/STEEP_analysis.

Xinhua News Agency. (2018). "E-book bag:" Worry addition or burden reduction? Retrieved from http://www.xinhuanet.com/local/2018-09/23/c_129959440.htm.

Zheng, Y., & Yang, R. Y. (2017). The rise of MOOCs: The literature review of research progress and hot spots of MOOCs education in mainland China. *EURASIA Journal of Mathematics Science and Technology Education, 13*(9), 6165–6174. https://doi.org/10.12973/eurasia.2017.01056a.