EDUCATIONAL TECHNOLOGY AS A KEY ENABLER FOR ACHIEVING THE SUSTAINABLE DEVELOPMENT GOAL 4

By

CHI, Younsuh

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Submitted to

KDI School of Public Policy and Management

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ABSTRACT

EDUCATIONAL TECHNOLOGY AS A KEY ENABLER FOR ACHIEVING THE SUSTAINABLE DEVELOPMENT GOAL 4

By

Younsuh Chi

In 2016, the world has embarked on a new journey for sustainable development, simultaneously entering the era of the 4th Industrial Revolution that accompanies huge advancement of technologies. Now that human beings are facing with daunting challenges of sustainability, the newly upcoming era is promising for far more opportunities of innovation than never before. Technology is deemed as what will be a driving force for sustainable development, and its benefits are expected to contribute to the achievement of post-2015 education goal, SDG 4, as well.

In this sense, this paper first delves into the SDG 4, the Education 2030 Agenda, focusing on the main obstacles in its achievement- i) financing and ii) low quality of education. Then by looking into the overall concept of educational technology, it further explores how advancement of technologies such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), and Learning Analytics, can contribute to overcome such challenges by enabling various effective learning methods- Blended

Learning (Flipped Learning), Massive Open Online Courses (MOOCs), Adaptive Learning, and G-Learning and Gamification. Case studies have already shown the benefits of educational technology to reduce the cost of education by allowing for the teachers to cover larger number of students at one time, as they are no longer restrained at one location thanks to the internet environment, and by letting schools to lower the tuition while saving additional cost on maintenance of the school facilities. In the meantime, quality of education can be enhanced as customized learning becomes available for every single student. Students can enjoy learning as entertaining factors are reinforced by VR/AR and gamification, and develop themselves by complementing what they are lack of, following the guidance of AI and Learning Analytics.

Indeed, experts analyze that BAU (Business as Usual) approach, to stick to the conventional way of educational development of simply increasing supplies of teachers and classrooms, will no longer a solution for sustainable educational development. Despite the potential benefits of technologies, however, still only a half of the world population is online, without being prepared at all for further development and aid to education is not reflecting such current circumstantial changes. This paper argues that, thus, digital equity and digital literacy should be redressed while enhancing teacher training, and reconsideration on the priorities of aid to education needs to be preceded for educational technology to function as a true enabler for the achievement of SDG4.

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I. INTRODUCTION

As the year 2016 begins, the world embarked on a journey of sustainable development, ending the era of the Millennium Development Goal. The world leaders have pledged to leave no one behind and shared a view that every country is a developing one in a sense that all share same challenges and burdens to carry on what is required to make the world sustainable. Despite the remarkable progress on the MDGs for the past 15 years, the existent problems are still daunting and new types of challenges have appeared, while population continues to grow and limited resources are being gradually exhausted. Education is of no exception, in terms of financial shortage and low quality. It is analyzed that far more financing is required to achieve post-2015 education goals (UNESCO, 2015a), and quality of education is not high enough to ensure that schooling results in actual learning (World Bank 2015).

That said, looking on the bright side, the world has simultaneously entered to the era of the 4th Industrial Revolution, in which sophisticated technologies are offering far more opportunities of innovation and development, that would enable sustainable development, than never before. Despite the concerns of numerous people on the potential harm of technologies to the lives of human beings, when properly and ethically well leveraged, technologies can be a major driving force for meaningful changes and outcomes.

Indeed, advancement of technology has already been rendering positive changes in light of education, bringing innovations in how people learn. Educational technology, shortened to edtech nowadays, is now enhancing the effectiveness of learning, while alleviating its costs.

Among many, what came to the forefront was a concept of *blended learning,* which was enabled by combining online education with face-to-face instruction in classroom, based on Information and Communication Technology (ICT), along with the *flipped learning* as one kind. Then the appearance of Massive Open Online Courses, MOOCs, has widened accessibility of education to anyone in any location. Furthermore, the development of Artificial Intelligence (AI) and Big Data has been allowing for *adaptive learning*, which is deemed as the most effective pedagogy (Hong, 2017), and other technologies such as Virtual/Augmented Reality are facilitating even more effective learning. Plus, *gamification*, which refers to the use of elements of game and play in education, has been developed in unprecedentedly entertaining and motivating features, in a way that teachers and students are supported in their teaching and learning.

Throughout the world, edtech is being considered as what can contribute to the achievement of SDGs. International institutions have already recognized its cost-cutting aspect (Earth Institute& Ericsson, 2016), and case studies have proven the effectiveness of harnessing education technologies in universities (ASU & BGC, 2018). Despite the empirical evidence is quite lacked for it was not recently that edtech started to be highlighted as an enabler for quality education, or sustainable development at large, few would disagree that edtech has large potential to function as a key in implementation of SDG 4.

One of the biggest challenges now is that many parts of the countries are not even connected to the internet. Only half of the world is online, and 30% of the youth are being unprivileged (ITU, 2017). Not to mention the needs of proper infrastructure and facilities, ensuring digital equity and literacy should be enhanced. Also, teachers need to be trained so that their teaching outcome can be maximized by proper pedagogy with proper pedagogy they choose to utilize. And those challenges indicate the way aid to education in developing countries should be directed, which is that more financial resources should go to the infrastructure and teacher training sector. Indeed, the pilot projects of digital learning classrooms in six universities in the United States have revealed that the reduced cost in the elements like instructional delivery or operations and maintenance tradeoff that of online operations (ASU & BCG, 2018).

II. SUSTAINABLE DEVELOPMENT GOAL 4

2.1. Sustainable Development Goals

2.1.1. Background

The discussion on the issue of sustainability within the global society is not a recent trend. Concerns over sustainability were first officially raised back in 1972, when the first UN Conference on the Human Environment was held in Stockholm, and global efforts to maintain economic growth while sustaining the environment have been being continued

ever since. Summits have taken place, and agreements have been reached to make collective actions. Then in 2012, when the era of MDG was coming to an end, at the UN Conference on Sustainable Development held in Rio de Janeiro, what leaders of the world recognized was the still unsolved problems of development and especially the environmental sustainability (Sachs, 2015). And it is when the world had reached an agreement to pledge their commitment to sustainable development through its outcome document *The Future We Want*. The document mandated composition of an Open Working Group (OWG) for setting goals for sustainable development, and it submitted the *Proposal of the Open Working Group for Sustainable Development Goals* to the United Nations General Assembly.

As a result of tremendous worldwide efforts for 15 years, rate of extreme poverty in developing countries declined from 47% in 1990 to 14% in 2015. Primary school enrollment rate increased, health-related issues were alleviated, and improvements were visible for other goals as well (UNESCO, 2015b). Then the adoption of the Sustainable Development Goals, that would replace the Millennium Development Goals, took place at the UN Summit in 2015, via its outcome document *Transforming Our World: the 2030 Agenda for Sustainable Development*, as a result of the collaboration among varied participants to set the goals for a number of years. There are 17 goals and 169 targets that the global society had pledged to implement to let "no one left behind", eradicating poverty as the foremost priority to achieve. Governments set their own national policy to support the movement, in principle, and High-Level Policy Forum takes place every year to review and follow up on the progress.

2.1.2. Definition of the SDGs

Today, the world is facing various problems from inequality to environment destruction. While population is steadily increasing, expected to have 9 billion people by 2040s (Sachs, 2015), challenges and threats of the post-2015 era became different from those of the MDG period, as reported by the Leadership Council of SDSN. Although chances are now very high to end extreme poverty thanks to the achievements of the MDGs, the problems of inequality and global governance are being deepened, and scale of growth of both population and economy are exceeding the capacity of the Earth system. Above all, it is expected that the challenges and threats are not going to be easily relieved if the governments continue to take Business as Usual (BAU) trajectory, and it is the point where pursuit of sustainable development is called for (EI & Ericsson, 2016).

Although definitions vary the world over, the most universally known meaning of sustainable development is appeared on *Our Common Future* (1987), defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987: 41). In a response to the request of the upcoming era with a rife of serious challenges, it is to balance three dimensions - economic development, social inclusion and environmental sustainability - that are required for sustainability (UN, 2015c). After all, it is a "normative outlook on the world", as Jeffrey Sachs (2015: 3) expressed, which functions as a policy guidance to all nations.

The outcome document of the UN Summit in 2015 that officially adopted the SDGs listed people, planet, prosperity, peace, and partnerships as the main five themes that action will be taken upon, and set 17 goals that address broad range of challenges ahead (Figure 1).

Goal 1.	End poverty in all its forms everywhere
Goal 2.	End hunger achieve food security and improved nutrition and promote sustainable agriculture
Goal 3.	Ensure healthy lives and promote well-being for all at all ages
Goal 4.	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5.	Achieve gender equality and empower all women and girls
Goal 6.	Ensure availability and sustainable management of water and sanitation for all
Goal 7.	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8.	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9.	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10.	Reduce inequality within and among countries
Goal 11.	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12.	Ensure sustainable consumption and production patterns
Goal 13.	Take urgent action to combat climate change and its impacts
Goal 14.	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15.	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16.	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17.	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Source: UN. (2015c).

<Figure 1. Sustainable Development Goals>

2.2. SDG 4: Education 2030 Agenda

2.2.1. EFA and MDGs (2000~2015)

The world level discussion on education as a development goal dates back to 1990, when the World Conference on Education for All was held in Jomtien, Thailand. After the fall of the Berlin Wall, the conference was the first one among a series of World Conferences on various subjects in the 1990s (Kenneth, 2007). Recognizing the harsh realities of educational inequality despite the Universal Declaration of Human Rights that claimed that education is a right for everyone, it highlighted the importance of basic education, promoting equity and enhancing partnership and international solidarity (WCEFA, 1990). After a decade, world leaders gathered again at the World Education Forum in Dakar, Senegal, and total six goals were set by the adoption of *Dakar Framework for Action, Education for All: Meeting our Collective Commitments* (WEF, 2000).

Shortly after the announcement of EFA goals, another goal for educational purpose was set as a part of the Millennium Declaration where the world leaders affirmed their collective responsibility to support the universal value of human dignity and equality (UN, 2000). Among 8 Millennium Development Goals (MDGs), MDG 2 (achieve universal primary education) and MDG 3 (promote gender equality and empower women) were as to the education. After all, having two pillars of education agenda until 2015, it was perceived that achievement of goals of EFA positively affect that of the MDGs (UNESCO Bangkok & UNICEF, 2013).

EFA	
EFA 1	Expanding and improving comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children
EFA 2	Ensuring that by 2015 all children, particularly girls, children in difficult circumstances and those belonging to ethnic minorities, have access to a complete free and compulsory primary education of good quality
EFA 3	Ensuring that the learning needs of all young people and adults are met through equitable access to appropriate learning and life skills programmes
EFA 4	Achieving a 50 per cent improvement in levels of adult literacy by 2015, especially for women, and equitable access to basic and continuing education for all adults
EFA 5	Eliminating gender disparities in primary and secondary education by 2005, and achieving gender equality in education by 2015, with a focus on ensuring girls' full and equal access to and achievement in basic education of good quality
EFA 6	Improving all aspects of the quality of education, and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy, and essential life skills

Source: UNESCO

<Table 1. Education for All goals>

As a result of the vigorous efforts on both MDGs and EFA goals, positive outcomes had been yielded as a result of tremendous efforts of the global society within the two pillars of education. The number of out-of-school children reduced from 100 million in 2000 to 57 million in 2015, net-enrollment rate in primary education increased to 91% in developing countries, and gender gap had been narrowed, according to the *Millennium Development Goals Report 2015* (UN, 2015b). In addition, increased enrollment rate of primary and secondary education had contributed to increase literacy rate among youth. The report also recognizes the challenges ahead, including the unsolved issues of inequality and needs for quality education and financing sources.

EFA movement is also assessed as a "qualified success" despite most of the targets had not been achieved (UNESCO, 2015: 43). The World Education Forum held in Incheon

in 2015 was where the achievements were reviewed and Incheon Declaration that renewed the global education agenda in a support of implementing SDGs (WEF, 2015).

2.2.2. SDG 4 (2016~2030)

As the era of MDG coming to an end, as aforementioned, OWG, which was mandated to set the SDGs, proposed the 17 goals and 169 targets, and the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development in September 2015. Education-related goal was set as the fourth one, that is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN, 2015c). Then the Framework For Action that was guided by EFA Steering committee was adopted in the same year in November, and it outlines necessary guidance to implement SDG 4.

As shown in <Table 2>, SDG 4 consists of 7 targets and 3 Means of Implementation (MoI). One of the key features is that it is a universal agenda that all targets are relevant to all countries worldwide, not limited to the developing countries as EFA and MDGs were to. Its aim reaches to more than primary education, to the extent of lifelong education, and neither to children or youth. Rather, ensuring broad range of education for children, youth and adults is what SDG 4 aims for. In addition, the goal pursues gender equality and effective learning, newly paying attention to the learning on sustainable development (UNESCO, 2015b).

	SDG 4: Quality Education	
Targets	4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes
	4.2	By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education
	4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
	4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
	4.5	By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations
	4.6	By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
	4.7	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development
MoI	4.a	Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environ
	4.b	By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries
	4.c	By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States

Source: Sustainable Development Knowledge Platform

<Table 2. Sustainable Development Goal 4>

2.2.3. Special features of SDG 4

Scope, Geographical Coverage, and policy focus

After delving into the features of SDG 4, its differences from MDG 2 and EFA are worth noting in three different aspects, to further the understanding of the context that SDG 4 is implemented. First, while MDG 2 aimed at specific scope, primary education, the goal of EFA was to ensure basic education for children, youth and adults. As much as the basic education was left unsolved after the completion of EFA, the scope of SDG 4 is same with it, yet it further pursues life long education. On the other hand, while MDG 2 and EFA mostly focused on the low-income regions, SDG 4 is applied to all the regions. In the meantime, the three are common in policy focus as they tried and try to ensure access to whatever kind of education it pursues (UNESCO, 2016).

Pursuit of Education for Sustainable Development (ESD)

As aforementioned, the issue of sustainability is not a recently prevalent one, and the world leaders and policy makers had already heightened global attention from more than a decade ago. In 2005, the United Nations, having UNESCO to take the leading role, declared a 10 year of period up until 2014 as the *Decade of Education for Sustainable Development* (DESD), and recognized the significant role of education in sustainable development stating as follows: "The United Nations Decade of Education for Sustainable Development(2005–2014) aimed at integrating the principles and practices of sustainable development into all aspects of education and learning, to encourage changes

in knowledge, values and attitudes with the vision of enabling a more sustainable and just society for all" (UNESCO, 2014: 5).

When assessed in 2014 through the final report *Shaping the Future We want*, achievements were visible and education policies around the world were recognizing and reflecting the need of promoting ESD. When reaching to the end of the Decade, the Rio+20 Summit resolved again to further promote ESD in 2012 (UN, 2012). So, as a follow-up of the DESD, the Global Action Programme (GAP) on Education for Sustainable Development was launched and, in addition, Higher Education Sustainability Initiative (HESI) was also created to support ESD.

2.3. Major Challenges in Achieving SDG 4

Now that education goal aims for broader range of beneficiaries and types of education to be promoted, there is growing need for more and better resources. Among many, the most prominent challenges are the shortage of financial resources and low quality of education.

2.3.1. Financing

In a policy paper that UNESCO had published as to the financial requirement to cover the required cost of achieving SDG 4, it provides an account on its seriousness by stating that "the average annual financing gap remaining across all low and lower middle income countries between 2015 and 2030 is estimated at US$39 billion. … This financing gap is equivalent to 1.6% of GDP across all countries. (UNESCO, 2015: 6)" (Figure 2).

	Low income countries	Lower middle income countries	Low and lower middle income countries
Total cost, 2012	14.4	134.2	148.6
Total cost, 2015–2030 (average)	50.5	289.4	339.9
Increase in total cost	36.1	155.1	191.2
Financing gap, 2015–2030 (average)	21.0	18.4	39.5

Source: UNESCO(2015a)

<Figure 2. Financing gap, US $ billion>

It provides two factors that are expected to increase the estimated cost of implementing SDG4: increasing enrollment rate and expenditure per student. Given the expected growth of population, having progress in implementing SDG 4 would mean that enrollment rate increases as more children go to school. For the second factor, it assumes that emphasis on improvement of quality would render higher expenditure that is consumed by a student, specifically due to the decreased pupil/teacher ratio. And this challenge is expected to be more serious in low-income countries, as it is where 20% of the children of school-age will be living in (Education Commission, 2017). To fulfill the pledge of the global society to leave no one behind, it shows that increasing investment and good allocation of financial resources would be essential.

In fact, such imperativeness of financing issue has already been recognized through many reports and resolutions of international conferences. First, the Millennium

Development Goals Report pointed out that securing source of funding will be essential for the post-2015 era (UN, 2015b). The Oslo Summit on Education Development, through which the issue of financing gap on education was discussed, recognized that financing gap still exists even after GDP spending ratio of 4-6% on education is fulfilled. Against the underfunding issue, the Commission on the Financing of Global Education Opportunities was established as a result of the Summit, and its report published in 2017 mainly states that spending should be more effective and efficient to ensure learning that students need (Education Commission, 2017). At the International Conference on Financing for Development that was held six days later in Addis Ababa, the world leaders resolved to increase investments on education and relevant facilities (UN. 2015a).

2.3.2. Quality of education

Progress towards the Sustainable Development Goals 2018, the most recent report to the Secretary General of the United Nations on the achievements and challenges ahead on the SDGs, based on the available data, points out that the quality of education is one of the most imperative issues to be dealt with enormous efforts. According to the report, 58 percent of students in the early stage of education are still lack of proficiency in reading and mathematics. Also, the inequality by location and wealth is still rampant, and the least developing countries are not provided with enough basic infrastructures for education. Furthermore, as same as the report of 2017 highlighted, increasing the number of trained teachers, which are lack in the numerous numbers of schools despite its significance as a factor for quality education, are considered crucial (UN, 2017 & 2018).

As pointed out by the progress report, despite the considerable progress in quantitative education, providing most of the school-age children with opportunities to be educated at school, their actual performance in learning basic skills is still questionable. The World Bank (2018) has expressed this phenomenon as “learning crisis”, stating that “schooling is not learning” on their World Development Report published in 2018 with a theme on education. It diagnoses that millions of children who completed primary education do not acquire enough reading and mathematics skills, and thus lack of competencies to take a next step of learning. The problem is worse for the students in the lower income countries where economic status of family is one of the critical factors. And it further reports that the causes are rooted to various factors in education; learners, teachers, school inputs and management. It is because students are in a bad condition of health, teachers are untrained and less motivated, and schools are lack of management skills and out of enough inputs including education facilities (World Bank, 2018).

After all, it is irrefutable that having insufficient financial resources is linked to the aforementioned causes for learning crisis. Children with no efficiency in learning would be in a better condition if he or she is not nutritiously deficient, and teachers might be more zealous and put more efforts to develop themselves if they are financially supported more from the schools, which could be more efficiently managed with more investment. Thus, more funding and investment need to be input in education sector. At the same time, it should also be noted that resources are limited and thus efficient use of what are given is very important (UNESCO, 2016), as much as the reason the world is now in pursuit of sustainability lies in such context. In the era of the Fourth Industrialization, thankfully, however, human beings are equipped with one of the most powerful means that generates ceaseless innovation, technology. Development that is boosted by

technology accompanies efficiency and effectiveness, not to mention the high return of investment.

Utilization of technology in education sector has already long history, yet the current advancement presents more possibilities and opportunities for better future than never before. Educational technology, which can contribute to the cost-effectiveness and better quality of education, will be introduced in this sense as a key in implementing the SDG 4 in next chapter, by showing how financial challenges and quality issue in education can be overcome.

III. Educational technology

The idea of utilizing technology in education is not a newly borne concept that appeared in a recent period. Technology was used to facilitate education from the early 1920s, when testing machine enabled students to test themselves (Gagos, 2013). Radio was an effective means of education to impart knowledge towards a massive audience, and television programs produced for educational purpose have provided people of all age group with opportunities of learning with low cost. Ever since the computer brought Computer Assisted Instruction (CAI) into being, learning modality has been continuously evolving, enabling Web Based Instruction (WBI), which is based on the internet, Mobile Learning, and Ubiquitous Learning, which became possible by the invention of Cloud system (Hong, 2017).

Now, as the world enters the era of the 4th Industrial Revolution, more technologies are available and limitless potential of application of those are promising more possibilities and opportunities than never before. To the world that is currently facing multifaceted challenges of environmental sustainability, social inclusion, and economic growth, such advancement of technologies is of an advantage. When it comes to education, far more sophisticated technologies than radio or television transmission are leading the paradigm shift, bringing positive changes to the learning modalities and pedagogies. It is another type of transformation that is absolutely different from when the internet first appeared, in that utilization of the advanced technologies allow better quality of education by allowing learning efficiency for the learners in a lower cost. In this sense, this chapter will look into how technologies for education, what is called Educational technology, or edtech, can take a pivotal role in implementation of SDG 4.

3.1. Definition of Educational technology

To simply put, Educational Technology is as to the utilization of technology in education. The basic idea is that technology complements teaching and learning, bolstering the positive effect from those activities. As much as technology has been advanced as time goes by, definition of educational technology has also evolved. And thus the current definition will only last for a certain period of time and be redefined when another changes occur (Januszewski & Molenda, 2008: 1).

In 1972, the Association for the Educational Communications and Technology defined educational technology in its book, *The field of educational technology: a statement of definition. Audio-visual Instruction,* as "a field involved in the facilitation of

human learning through systematic identification, development, organization and utilization of a full-range of learning resources and through the management of these processes" (AECT, 1972: 36). Then in 2004, the Definition and Terminology Committee define it as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (AECT, 2004).

When comparing the two definitions in different era that would have had been in different stage of technological advancement, what is recognizable is that the aspect of technology as a resource to improve performance had been newly underscored in the later definition, while both recognizes its function as a facilitator for education.

One of the most recent report on educational technology published in the United Kingdom, of which educational technology industry is taking the lead throughout the world, defines educational technology as the "effective use of technological tools for learning" that involves a variety of arenas (Edtech UK, London & Partners & Mayor of London, 2017: 5). What should be noted here is that educational technology does not refer to technology itself. Rather, it is as to the effective use of the resources.

From time to time, e-learning is confused with educational technology. As edtech is different from e-learning in a number of important aspects, distinguishing the two is important. The term e-learning refers to delivering information or instruction through computer network

technology, mostly Internet (Welsh, Wanberg, & Marcia, 2003), and it has been acknowledged as what brought innovative changes in education, not to mention the enormous positive benefits that had not been possible without the internet. While e-learning is an identical realization of the content of offline education, edtech is utilization

of various technologies from Artificial Intelligence (AI) to Internet of Things (IoT). Consequently, lecturers are the only factor that determines the quality of E-learning, that of edtech depends on a number of steps of learning as it offers more activities than just learning- reviewing, sharing results with others, rewarding, and so forth. Above all, edtech enables personalized, or customized, learning while E-learning is a unilateral provision of content (Hong, 2017).

AECT, 1972	**AECT, 2004**	**Edtech, 2017**
"A field involved in the facilitation of human learning through systematic identification, development, organization and utilization of a full-range of learning resources and through the management of these processes"	*"The study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources"*	*"Effective uses of technological tools for learning"*

<Table 3. Definitions of Educational technology>

In sum, edtech is an effective use of technologies, industry of its practices, and a distinguished concept from e-learning. Various innovative pedagogies are available now thanks to the development of edtech, including blended learning, adaptive learning and gamification, and impacts of such teaching methods are being proven by various pilot projects and case studies. Also, it is now brining a number of changes in education industry. Jungmin Hong, the author of Educational technology (2017), analyzes that it is

not only blurring the border between suppliers and consumers of education, but also "unbundling" the complex functions of learning institutions. As consumers are now looking for better educational service throughout the world via internet, the stakeholders in the whole industry are now competing at the global level (Hong, 2017: 218-221).

3.2. Technologies that are transforming education

Among many, Artificial Intelligence (AI), Virtual/Augmented Reality (VR/AR), and Learning Analytics are considered as the major technologies that will bolster the effect of learning. These technologies provide essential yet basic functions, and boundless possibilities of application are being expected.

3.2.1. Artificial Intelligence (AI)

Artificial Intelligence is a technology that can demonstrate human intelligence when embedded to a machine or device such as robot. As it can implement what has been done by a human being, a large number of vocations are expected to be replaced by utilizing this technology.

In education sector, it is being spotlighted as a potential tutor. What is deemed especial is its capacity to understand needs of the students and respond to it (NMC, 2017). As its function is not limited to the delivery of information or instruction, learners can communicate with AI tutor, making questions and receiving feedbacks. Chatbot tutor, a representative type of intelligent tutor using the AI technology, are now reaching out to numerous students, enhancing their learning outcome. Duolingo, a language learning app

by which people can learn languages with chatbots, is a good example of the chatbot tutor. The strength of this app is that students can improve themselves by solving problems that are suggested by AI according to the personal performance, and the availability of personalized learning has attracted more than 100 million students to download the app (Hong, 2017). Here, what should be noted is that AI develop itself by what is called *machine learning*. Whenever the bots are said new things, they save it as a data, and accumulation of such information make them expand their knowledge. Through machine learning, the AI tutors are expected to become exactly alike the human tutors by 2020 (Metarri, 2018). Moreover, when established with proper algorithm and combined with Big Data, AI tutors can receive all information as to the learners on their past study history and performance, and it enables what is called *adaptive learning*, which is deemed as one of the most effective pedagogies (Hong, 2017).

3.2.2. Virtual Reality (VR) and Augmented Reality (AR)

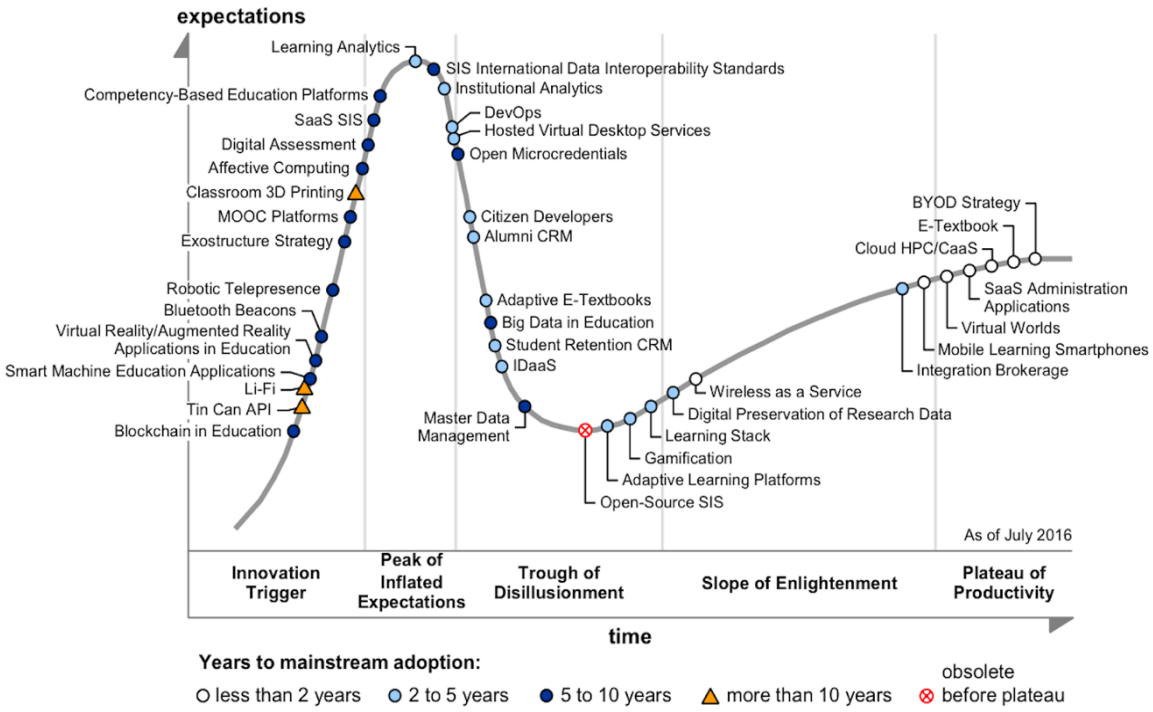
Virtual Reality (VR) refers to a technology that generates an environment exactly same as it exists in a real world, making he or she immersed in the artificially made environment. On the other hand, Augmented Reality (AR) is to embed a virtual object into the real world, and it is perceived as the more advanced technology than VR (Hong, 2017).

The main advantage of the VR and AR would be the rendered excitement and motivation. Also, indirect experience is possible without moving to other places, as a program named Expedia Pioneer of Google allows people to travel various locations through environment generated by VR technology (Hong, 2017). The program is being

widely used in the K-12 classrooms of the United States, and VR goggle named Google Cardboard, which is available in a low cost, is also utilized to provide them with a variety of experience that are controlled by teachers from a tablet (OET, 2017). Moreover, AR allows for what would be costly or dangerous to simulate in reality. For instance, a program called VFrog provides students with chances to dissect frog as many times as they want. It is beneficial not only in that it is cost-saving, while offering numerous opportunities for practice, but also it ensures safety (Zahira et al, 2014).

3.2.3. Learning Analytics

In the 1st International Conference of Learning Analytics and Knowledge, the term learning Analytics was defined as "the measurement, collection, analysis and reporting of data about learners and their context, for purposes of understanding and optimizing learning and the environments in which it occurs" (Melanie, 2012). It helps students to track their problems while learning, by analyzing data pulled from the Student Information System (SIS) and Learning Management System (LMS) (Gartner 2016). When looking into the Hype Cycle of Education that was suggested by Gartner in 2016, Learning Analytics was at the Peak of inflated Expectations phase and expected that it will reach to the point of Plateau of Productivity in 2 to 5 years. It analyzed that it can yield significant changes in learning as students can be greatly improved when individual challenges are well addressed through the technology (Gartner, 2016).



Source: Gartner (2016)

<Figure 3. Hype Cycle of Education>

3.3. Changes brought by technologies

When technologies mentioned above are applied, various types of learning become possible. While one type of learning itself has an impact on the outcomes, two or three types of learning can be combined as well (e.g. Blended Adaptive Learning, Flipped MOOCs).

3.3.1. Blended Learning (Flipped Learning)

Blended learning was what appeared along with the advent of e-learning, based on the development of Internet (Hong, 2017). Used interchangeably with the term *hybrid instruction*, it refers to a pedagogy that involves both online learning and face-to-face instruction which is conducted in classroom (Means et al, 2013). When conducting blended learning, students can get individual mentoring as more teachers can spend more time on interaction with students rather than giving lectures (Paniagua & Istance, 2018).

Flipped learning, which is a subset of blended learning, is a concept to literally flip the traditional way of learning. In flipped classroom, students study online for what is planned to learn in next class and discuss and practice what they have prepared in their classroom (Hong, 2017). Like the e-learning and edtech, there are occasional confusion between the concept of flipped learning and blended learning. What flipped learning is different from blended learning is the initial purpose. In addition, while the initial aim of the blended learning was to benefit from the cost-saving aspect of online learning, flipped learning was developed for the purpose of maximizing the effectiveness of learning (Hong, 2017).

As the concept does not have a long history, there are few studies on the impact of blended learning, including flipped learning. However, cases in which flipped learning resulted in positive outcomes are continuously being reported (Paniagua & Istance, 2018). As the number of applicable technologies for education increases, options for student and teachers for the way they learn and teach are becoming broader.

3.3.2. Massive Open Online Courses (MOOCs)

The first appearance of Massive Open Online Course was in 2008, being a part of open educational resources movement (UNESCO IITE, 2013). MOOCs refer to the online courses that are accessible to anyone at any place where Internet is available, with no cost or entry qualification (UNESCO & COL, 2016). Coursera, edX, and Udacity are leading the wave, making lectures of professors from top tier universities in the world available for anyone. When a year had passed after Coursera, a startup company that provides the largest number of courses, started its service, over 3 million students were being benefitted from the open accessibility (Hong, 2017).

As the use of MOOCs rapidly grows, a new approach named *Flipped MOOC* has been also introduced. As the name indicates, it is to study with MOOC before a class and have discussion or practice at classroom with a teacher. Now numerous universities are taking this approach worldwide (Hong, 2017).

3.3.3. Adaptive Learning

Adaptive learning, also named as personalized learning, is an opposite approach of the one-size-fits-all, through which individual knowledge level and further needs for learning are specifically considered and customized to the learners (Alli, Rajan, & Ratliff, 2016). By harnessing AI and Big Data, student progress can be monitored, and instruction method can be modified according to one's performance (NMC, 2017).

Nowadays, numerous mobile applications are being launched for K-12 curricula, and universities are providing digital courses through which students can learn online

and personalized academic management. Though it will be discussed in the later chapter, it is analyzed as what can be a solution to the problem of maintaining cost-effectiveness while retaining the quality of education (Gartner, 2016).

3.3.4. G-Learning and Gamification

Despite the intuitive perception on a play as a negative effect on study, it has always been what triggers the interest in learning. For educational purpose to be achieved when applying such entertaining element to education, it is said that engagement of a learner is a prerequisite, and in that sense, game, which is a type of playing that comprises rules and competition, is the most effective method (Hong, 2017). G-learning, which is to apply such method, refers to the cases that game itself becomes an education. It is used not only for education for basic skills from languages to mathematics, but also for human resource training for leadership or project management (Hong, 2017).

Meanwhile, gamification is to promote learning by using the entertaining elements of game, such as competition, reward, and penalty (Metarri. 2018). The effectiveness of gamification has been proved by a number of recent academic research (Paniagua & Istance, 2018). *Teachers as Designers of Learning Environment: The Importance of Innovative Pedagogies*, a work by Alejandro Paniagua and David Istancd, has recognized gamification, along with other five including blended learning, as an innovative pedagogy that can improve teaching (2018).

3.4. Educational technology industry

Educational technology has been listed as one of the leading industries for the future, and it is rapidly growing. Following this trend, many countries are establishing policies to foster the edtech industry, among which UK and USA are leading the way.

3.4.1. United Kingdom

The edtech industry of the United Kingdom is the largest in the world, having 1000 companies throughout the country, and prospected to become a value of $220 billion in two years (Edtech UK, 2017). In the wake of success to foster ICT and Fintech industry in the U.K., the government is reinforcing its efforts to promote the Edtech industry, establishing an organization named Edtech UK (Hong, 2017). A report on the industry, *Edtech: London Capital for Learning Technology (2017)*, which was released at a summit where the launching of Edtech UK took place, appeals London as the best place to base related companies for a number of reasons. First, more than $1.1 billion per year is spent by schools in London on educational technology. It is being a hub of top tier world class universities, and more than 70 thousand developers are located in the region. What is more, its tax rate is the lowest among the G20 countries.

The UK government is promoting the industry by supporting various stakeholders in a variety of ways. Schools are being equipped with proper technologies in need. Indeed, the UK Digital Strategy 2017 states that it will give schools “a series of aggregated procurement opportunities for tablet, desktop and laptop devices” (Department for Digital, Culture, Media & Sport, 2017: 2). In addition, $8.9 million has been input to the

Mayor of London Digital Talent Fund, which was launched in 2016, to support the youth to develop their career in digital industry.

Efforts have also been put on the impact evaluation of edtech. According to the *Edtech vision 2020*, which was published by Edtech UK 2017, the Education Foundations is conducting various trials, including launch of Best of British Edtech"badge for startups and development of a website with evidences. Also, EDUCATE, in which University of College London, Edtech UK and Nesta are making collaboration, brings researchers and entrepreneurs together for the purpose of knowledge sharing (Edtech, 2017).

3.4.2. United States

Since the legislation of the No Child Left Behind Act of 2001, the United States has been putting much efforts to solve the problems of its public education system. The country started to promote the use of technology from 2010 when the first National Educational technology Plan (NETP) was developed by the U.S. Department of Education Office of Educational Technology (OET), and the most recent publication, *Reimagining the Role of Technology in Education* has been published in 2017. It reviews that significant progress has been made throughout the country to leverage technology in education, and its goal is focused on provision of equity and accessibility. It further states that whether to use technology in learning is no longer a topic of discussion, and classrooms are now equipped with high-speed infrastructure in every school. Through what is named ConnectED programme, high speed broadband has been set in 99% schools and colleges. Furthermore, digital devices became inexpensive and interactive tools and apps for education are widely available (OET, 2017). In the meantime, the

government has put $4.9 billion for purchasing devices such as Tablet PC, Laptop, Desktop for secondary schools in 2015, providing schools with approximately 10 million devices for teaching and learning (Han, 2016).

The market size for educational technology is approximately $12 billion, showing a fast growth (Hong, 2017). The site for MOOCs, including Coursera, edX and Udacity, are transforming the way people learn, and IT leaders are backing up the industry by putting enormous amount of investment. For example, Google is supporting numerous classrooms in which Google Classroom service is used, by providing apps and tools for effective learning.

What is notable is the use of Openly Licensed Educational Resources, which contributes to the provision of digital learning content, throughout the country. The Department of Education is conducting Regulation on Open Licensing Requirement for Competitive Grant Programs, which is to require grantees that are being benefitted by the funds from the department to openly license resources of which creations were possible by the fund (OET, 2017-website).

3.4.3. Republic of Korea

Although Korea was the first to legislate a law for the development of e-learning industry, its start to promote edtech industry has been delayed due to low utilization rate of educational content (Cho et al, 2017). The size of e-learning industry was estimated to be a value of $3.4 billion, and that of edtech is prospected to become a value of $10 billion. Now National IT Promotion Agency, NIPA, is conducting research on the strategy for promoting edtech industry (Yoon, 2017).

In Korea, the development of edtech industry was not initiated by government but by the educational content or publication company in private sector. Anyhow, now more than 30 startups out of 50 existing ones are getting investment, and approximately $4 billion is being invested to the business related to adaptive learning (Cho et al, 2017).

On the other hand, Korean government was the one that actively responded when MOOCs appeared. The Ministry of Education started to run K-MOOC in 2015, gathering universities to open courses to learners. A number of universities are issuing certificate and giving academic credit to the participants who complete a course via K-MOOC site (YOO, 2016).

3.4.4. China

In China, educational technology industry market is expected to be enlarged by a value of $39.2 billion in 2019, having 160 million users of e-learning education (Kim et al, 2017). Discussion on the application of AI in education started in 2001(Cho et al, 2017), and the government is continuously promoting the industry by establishing policy to promote digital education (Yoon, 2017). What is more, the growth of the industry is being enhanced by investment from the major companies such as Alibaba, Baidu and Tencent (Yoon, 2017).

IV. Implication of Educational technology on Achievement of SDG 4

As aforementioned, it can be thought that the world is now at the optimal point of timing for pursuing sustainable development, inspite of numerous challenges and threats. The era of the 2030 Agenda for Sustainable Development, that ceaseless worldwide efforts are required to be put to the implementation of the 17 goals and 169 targets, overlaps with that of the 4th Industrial Revolution, the era that advancement of technology is expected to benefit human beings and promote innumerable innovations and creations. Despite the potential downside of the new era, it is time to make the best use of what are given.

What are distinct in the 4IR is the ubiquitousness and mobility of the internet (Schwab, 2016). While the advent of cyber world characterized the 3rd Industrial Revolution, the fusion of the real world and the cyber one is what is now specific about the next era (Hong, 2017). Based on the more sophisticated digital technologies, societies and global economy are being transformed (Schwab, 2016).

Among many shifts that the 4IR brings, education is expected to go through enormous changes by the advanced technology in addition to ICT. It was prospected that ubiquitous computing will have positive impact on access to education according to the survey *Deep Shift - Technology Tipping Points and Social Impact*, which was conducted 2015 (Schwab, 2016). The specific role of ICT in implementation of SDG 4, in the similar context, has already been widely recognized by the international institutions, being highlighted for its cost-saving yet access-broadening aspect (EI & Ericsson, 2016).

However, ICT related elements are included in only 6% of the contents of SDGs, and such lack of mention of ICT on the SDGs had been a disappointment to many (Unwin,

2015). Against this, stakeholders are saying that BAU (Business as Usual) approach, to take conventional way of educational development only by increasing supplies of teachers and classrooms, will not work to achieve SDGs (EI & Ericsson, 2016).

4.1. Addressing financial challenges

The cost-cutting benefit of technologies in education is a well-known fact. When harnessing ICT, delivery cost is reduced, and that of maintenance is alleviated as well by cloud-based systems (EI & Ericsson, 2016). Recalling from the estimation of the financial gap that UNESO presented at its Education for All Global Monitoring Report, what would increase the costs is the effort of quality improvement to decrease the pupil/teacher ratio and increase salaries for the teachers. After all, it is prospected that more teachers need to be hired due to the continuously growing number of students, and salaries have to be increased for better motivation for the teachers. And it is based on the supposition that teacher is the only enabler for learning of in classrooms. Yet, what if taking edtech into account?

In a traditional way, every class is counted as an opportunity cost. Physical space is needed, and teachers have to spend their time in a specific space instructing a limited number of students. Every single student is required to purchase their textbooks and stationeries and wait for his or her turn to make a question to the teacher. By contrast, once an infrastructure is established and a classroom is equipped with digital devices, features of a classroom become different by the changes that currently advanced technologies for education bring for. First, textbooks or materials for experiments are no longer needed to be purchased. Open resources, including digital textbooks, and MOOCs

allow for students to participate in a class by spending no or less money, and VR and AR software provides unlimited number of students with chances to repeat experiments or exploration as many times as they wish without additional cost. Furthermore, teachers can cover larger number of students as they can be assisted by AI, MOOCs, or Learning Analytics which can give guidance to students on their learning methods.

Such benefits have actually been proven in higher education in the United States. According to the case study conducted by ASU and BCG, higher student-to-instructor ratio had contributed to reduce instructional cost for the factor of restraint of location was removed as digital learning took place. While students could receive an individual instruction, the number of students covered by one teacher increased than usual as he or she can be located in various online classroom at one time. Indeed, schools did not need to put extra expenditure on adding classrooms or study space nor on maintenance of the facilities. Despite online course operation requires expenditure at first, it turned out that the saved cost was enough to offset the initial cost (ASU & BCG, 2018).

Likewise, the cost-saving benefit of edtech will contribute to reduce the financial gap for the achievement of SDG 4. Not only for the developing countries, edtech is a way to step forward also for the rest of the countries to the sustainable development. To make the best use of edtech, most importantly, investment should be made in a long-term perspective, considering the benefit that would eventually exceed the initial cost.

4.2. Enhancing quality of education

Edtech can also increase the quality of education, tiding over the learning crisis. As the existent pedagogies are enhanced thanks to the development of newly rising technologies, its effectiveness on learning outcome has been newly explored.

In fact, the impact of flipped learning has already been theoretically proven far long ago. According to one research done by NTL, the National Training Laboratory, of the United States, learning impact is maximized when students discuss about learning content and practice in person (Hong, 2017). In the meantime, when it comes to adaptive learning, as a student can get an individual analysis on their strength and weakness, improvement is possible by complementing what he or she lacks. As much as sophistication of technologies sheds a new light on adaptive learning, it is deemed as a key to solve the educational iron triangle, which comprises quality, cost, and access (Murray &Pérez, 2015). Indeed, the case studies of six universities, that was conducted by Arizona State University and Boston Consulting Group, well showed that access and learning outcomes were improved, and cost of education was reduced by adopting courseware that enabled adaptive learning.

Likewise, effectiveness of using technologies in education **is** being proven thesedays, and further researches are ongoing. Given that combination of more than one technology is limitless, potential of edtech will be much more than expected. And here are some evidences that have revealed the positive outcomes by the level of education.

K-12 Education

In UAE, a company named Alef launched a platform that sixth grades students can learn by interacting with AI and analyzed a group of students' performances for a year. As a result, students showed 27% higher scoring in English and 78% in Math right after about a half a year passed (Metaari, 2018).

Higher Education

In case of Arizona State University, by the use of courseware that enabled adaptive learning in Biology class, students showed 94% of success rate, approximately 18% of increase compared to the past semester without such learning available. In the meantime, dropout rate had shown large decrease from 15% to 1.5% (Cogbooks, 2016).

Technical and Vocational Education and Training (TVET)

Technologies can be a useful tool in TVET as well. Metaari had provided an explanation, in a similar context, on the benefit of using technology in education in its White Paper on the Learning Technology Industry in 2018, that the products of the learning technologies achieve both knowledge transfer and learning transfer at the same time in vocational training. As the terminology indicates by themselves, knowledge transfer refers to when information is delivered to the learner, and learning transfer occurs when the learner completes a mastery (Metaari, 2018). And one example was when Boeing conducted an experiment to estimate the effect of AR training. The result

indicated that training time was reduced by 75%. In a similar internal study of GE that used AR in MRI manufacturing facility, the company witnessed 34% of improvement in productivity.

V. Policy Recommendations

To make the full use of the opportunities presented by the timing that effective learning through technologies is being enabled, both learners and teachers should be well prepared, and aid to education should be allocated in the right direction. Digital equity should be ensured, and improvement of digital literacy is in need for high preparedness of the potential beneficiaries of edtech. Meanwhile, integration of up-to-date technologies in education requires teachers to be trained, equipped with proper pedagogies. And for the low-income countries, priorities of aid sector allocation in education should be rearranged, so that resources can be put on infrastructures and facilities in a way that digital learning is enabled for as many students as possible.

5.1. Prepare Learners: Digital Equity and Digital Literacy

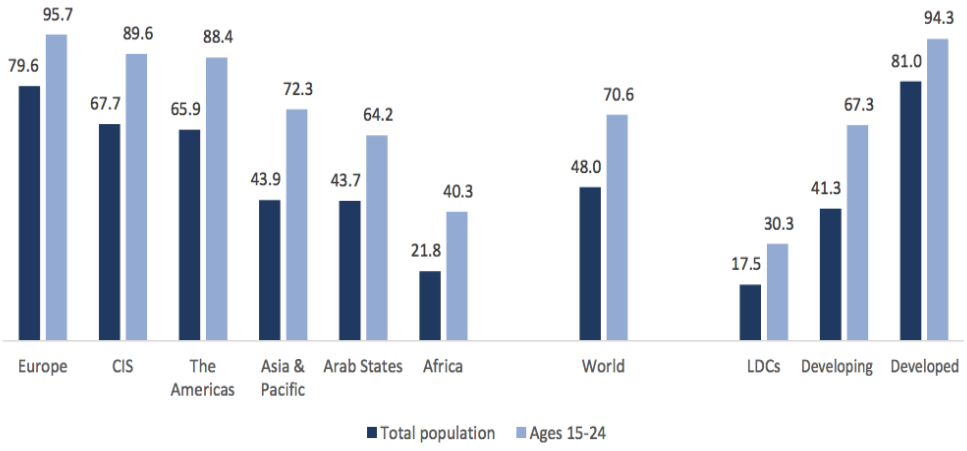
5.1.1. Digital Equity

Technology has evolved to the extent that its utilization is unthinkable without existence of high-speed internet. When it comes to education, now few would refute that

access to the internet is a key enabler for cost-saving yet quality digital learning. The world leaders have recognized the significance of ICT in the implementation of SDG 4 through the Incheon Declaration (2016), and UNESCO has underscored that education is what matters the most for achievement of all Sustainable Development Goals (EI & Ericsson, 2016). Furthermore, it is deemed as an international human right that is directly related to the right to education (UNICEF, 2017).

However, the issue of digital equity is still lingering the world over. Digital equity is as to the "unequal access to technology, particularly broadband internet" (NMC, 2017: 30). As shown on the *ICT Facts and Figures 2017* published by ITU, only 48% of the world population is online, and 30% of the youth in the world are not.

What is more, on the contrary to the common belief that internet access is only a problem in a few countries, high-speed internet is not being guaranteed for more than 30 million people in America (NMC, 2017).



Source: ITU (2017)

<Figure 4. Proportion of individuals using the Internet, by age>

The biggest issue that accelerates the problem of digital equity is high cost of connectivity. According to the *Affordability Report 2017* by the Alliance for Affordable Internet, cost of purchasing 1GB of data is about 18% of a person's monthly income in Africa region. While price of broadband has been lowered, it is still not enough to be considered affordable (A4AI, 2017). While it is a matter of national infrastructure, however, which means that government should take a pivotal role in addressing this issue, what has been observed indicates that there are far more to go. Among 58 developing countries that were studied by the Alliance, only a half are supporting access by concrete policies, and national broadband plans, the efforts of the governments to ensure universal access to internet, are "badly out of date, or have never been developed" in 23 countries (A4AI, 2017: 7).

Now that traditional feature of school is expected to largely disappear in a near future, having internet access will become more and more significant for one's decent life. Given the timing that education can offer, when equipped with internet access, greater opportunities to anyone than ever before, governments should establish policies, legislate laws, make investments and provide subsidies to the stakeholders to ensure better connectivity. In doing so, 5P, Political will, People, Pedagogy, Partnerships and Process, is highlighted (UNESCO, 2017)

5.1.2. Digital Literacy

Once people are equipped with proper infrastructure to be benefitted from what advancement of technology offer for their educational development, they also need to be capable of using devices and surfing internet, developing digital literacy. UNESCO has

defined that digital literacy is a life skill, and describes its components as "accessing, managing, evaluating, integrating, creating and communicating information individually or collaboratively in a networked, computer-supported, and web-based environment for learning, working or leisure" (UNESCO, 2011: 4). To assess digital literacy is thus important, as the "percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills" has been set as one of the indicators of SDG 4, and UNESCO is now conducting the Digital Literacy Global Framework (DLGF) project to address this need (Law, Woo, Torre, & Wong, 2018).

To improve digital literacy, governments as well as ICT companies should take the lead. For example, Microsoft has been assisting people to develop their digital skills through what is called Microsoft Digital Literacy Curriculum, and Google is helping students and teachers through its free online course.

5.2. Prepare Teachers: Teacher Training

For edtech to fully function as a means to achieve SDG 4, teacher training, with especial focus on technology, is extremely important. Teachers can have unlimited chances to improve students' learning impact by selecting technologies and applying them in various ways that meet individual need of their student (OET, 2017). However, as much as the technology itself is not directly connected to the positive outcome unless it is harnessed with proper pedagogy, ICT should be well integrated with pedagogical strategies (OECD, 2018).

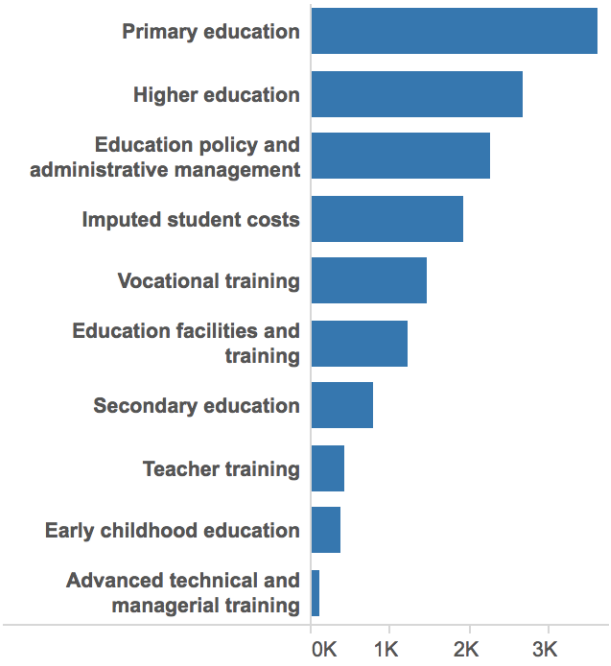
Teacher training is an imperative issue in a broader sense, given the increasing population. As population growth continues, teachers will be more in need. In an

estimation that such demand will increase by 25%, the Education Workforce Initiative (EWI) has been launched by the Education Commission. Complementing the UNESCO International Task Force on Teachers for 2030, the EWI has been working on education workforce reform, figuring out changes in role of teachers and seeking for ways to enhance the teaching personnel.

The need for teacher training is directly highlighted by SDG target 4.a, requiring for increase in the "supply of qualified teachers". As traditional pedagogies are being challenged, teacher training focused on integration of technology should be prioritized.

5.3. Aid to Educational technology

While governments and private sector take actions on the issues of digital equity and digital literacy, along with teacher training, it is worth reconsider the aspect of aid to education. Above all, the biggest challenge is that the current aid is not enough to fill the financing gap. According to the EFA Global Monitoring Report, the gap can be filled if amount of aid is driven from 0.7% of both DAC and non-DAC members and 10% of it is allocated to education sector (UNESCO, 2015a). And it is analyzed that more aid should be allocated to basic and secondary education, and targeting low-income countries is a key to lower the financial shortage (UNESCO, 2018b).



Source: OECD (2018)

<Figure 5. Education-related Aid, by Sector, USD million>

Indeed, donor countries are allocating their aid the most to primary and higher education (Figure 5). On the other hand, aid to the education facilities, which would include those required for digital learning, and teacher training and advanced technical training are less prioritized in aid to education, and amount of aid to education facilities and training is less than one third of that of primary education. It does not reflect the needs that international institutions have been urged as necessary- to increase utilization of ICT in achieving equality and quality in education. No evidence would be needed to aver that students in lower income countries will be left far behind from benefitting what advancement of technology offers if aid allocation continues to be in this feature. It is rather an easy calculation that return of investment will be high, despite the initial cost, given a simple fact that students/digital devices ratio does not have to be low. If

investment is allocated to build up a classroom for digital learning, its effect is applied to the whole school. Hence, in the long term perspective, now is the time to put more resources to the infrastructure and facilities for digital learning, of which effectiveness is far higher than the learning in traditional classrooms.

VI. Conclusion

The essential competencies in the 21th century are somewhat different from those in the past days. Rather than memorizing what a lecturer unilaterally provides, students are now required to foster 4C skills, which are communication, collaboration, critical thinking, and creativity. Above all, ability to "learn to learn", and creating what is value-adding are important to be well-prepared for the era of 4th Industrial Revolution (Lee, 2018).

When Klaus Schwab declared the new era, he pointed out that one of the prominent changes that occurred by the revolution is the diffusion of technologies and innovation at unprecedentedly faster and wider level (Schwab, 2016). In fact, the advancement of technology comes with both harms and benefits. While it poses a threat to replace a large number of occupations of human beings, it promises innumerable positive changes that will contribute to a more convenient and decent lives. However, in terms of sustainable development, it seems that there are more benefits that technology can offer than harms cause by its advancement. And the education is one of the major potential beneficiaries of digital revolution.

When it comes to the harnessing technology in education, Korea had built a successful case to reduce cost in education and enhance equality by providing CSAT, the college entrance examination of Korea, courses through Korea Educational Broadcasting System (EBS). In the midst of the Korean War, radio was first utilized as a complementary means to deliver education to a broad range of students. From 1970, broadcasting became one of the means of education, and internet enabled provision on lecture online from 2001. Then Korean government introduced a policy to deliver CSAT courses via EBS TV channel and online platform from 2004, and the examination has been covered by its educational content for 70% ever since (Koh, Shin & Lee, 2011). As the lectures are on air and available online, cost of education alleviated much, and demand for private tutoring, one of the biggest problems in education of Korea, largely reduced (Lee, Jung, & Song2018).

The case of EBS would be just one of thousands of cases that broadened access to education and realized cost-cutting benefit of technologies. Now far more sophisticated technologies are empowering education, and its advantages are continuously proven by researches and pilot projects. Above all, the boundless possibilities of innovation are implying that there is a room for the world to deal with the financial challenges and issue of learning crisis in a more efficient and effective way.

As discussed in the earlier chapter, edtech does not refer to the technological options only. It is to combine those in the most effective way and to practice them in teaching and learning, while it also indicates the related industry from time to time. AI, VR/AR and Learning Analytics have immense potential to enhance learning outcomes of the students, and impact of the advanced types of learning, such as blended learning, flipped learning as one subset, MOOCs, adaptive learning, and gamification, can be maximized when combined with those technologies. Edtech not only improve quality of

education likewise, it also reduces cost for both schools and students. Case studies conducted by Arizona State University and Boston Consulting Group (2018) have proven the cost-saving benefit of the edtech.

Meanwhile, what many leaders and experts emphasize is the technology itself can never become a solution. For edtech to function as an enabler for the achievement of SDG 4, learners as well as teachers should be prepared, by enhancing digital equity and literacy and increasing the chances for teachers to be trained. Also, governments should take a pivotal role to create an enabling environment for the outcome of utilization of technologies reach its peak. Mostly importantly, there should be shared awareness that building up one more classroom in a developing country is no longer an answer for ensuring better accessibility of education. Establishing more infrastructure and ICT facilities is more likely to be a better solution in a long-term perspective. To translate such need into the real requirement that is enough to promote governments to take actions, in addition, more and better qualified data should be accumulated.

In a recent report on the global education, UNESCO (2017) has shed new light on education as a shared responsibility, emphasizing that all countries should take part in as a whole while reinforcing the international cooperation. In the meantime, all countries are in the same status in that they are all the developing ones in terms of educational technology. It is new to every single country, and knowledge sharing and cooperation are essential. Given the fact that technology of nowadays is based on the internet without an exception, location constraint is no longer obstructing the way for better cooperation. As long as all share awareness on the potential of the educational technology as a key enabler in ensuring equal opportunities for quality education, achievement of the SDG 4 is possible. Education for education to promote such awareness would be another key, and

equipping all countries with proper infrastructure should be a priority in development cooperation.

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