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Research Paper

Effects of Covid 19 on Digital Transformation. Evolving Educational Technologies in a Post-pandemic Context

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Abstract
The COVID-19 pandemic became a catalyst to rethink education that will lead to innovation and a paradigm shift. The educational institutions are forced to adopt virtual learning and digital transformation is a necessity. Online learning turns out to be almost as effective as learning that is the "new common". Technology has become the glue of a modern society, and is viewed as an efficient tool for developing skills. Without internet access, individuals can be said to be living in poverty, and are being made to sufer from social deprivation. Further, unequal access exacerbates educational inequalities that internet access is an essential social good. Although crises tend to reshape society, it is uncertain how the global COVID-19 pandemic will transform our lives, and the global pandemic is accelerating innovation, especially in the digital sphere. This paper aims to answer the primary research question: how can the educators enable the new common through information? This paper reviews the digital transformation in education, including discussions on technology-enhanced learning, educational inequality by digital divide, online learning and EdTech, and distance education. Then, this paper introduces the situation in the local, Taiwan and anticipates how the education service will be after the COVID-19. Lastly, this paper concludes with the future of the education service and the author's insight. This study made use of a qualitative research methodology through a systematic literature review.
Keywords: *COVID-19 Pandemic Digital Transformation Crisis-Resistant Education System Technology-Enhanced Learning New Common Through Information*

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I. Introduction

1.1 Internet Access as Essential Social Good

Investments in high-quality education is the key to knowledge-driven digital economy（Fung, Taal & Sim, 2021:195）. Education is flourished by technology that both are complementary with each other（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:40; Stuart, Phillips & David, 2021:312）. COVID-19 caused a global pandemic that presents challenges to our society and education. Schools are forced to transfer their programs online by using e-learning or blended learning modes, using open educational resources, digital tools and online platforms etc.（Jimoyiannis, Koukis & Tsiotakis, 2021:330; Tsigaros & Fesakis, 2021:313; Vladova, Ullrich, Bender & Gronau, 2021:232; Murillo, 2021:63-64）. Digital transformation is changing social attitudes that artificial intelligence, virtual and augmented reality, and other emerging technologies, are creating opportunities（Canina & Bruno, 2021: 27-28; Kift, Tomas & Shah, 2021:295; Hädrich, 2021:12; Kővári & Bak, 2021:159; Ahmad, Kharki & Berrada, 2021:200）. In spite of students being dispersed, their social connections are soaring over distance—thanks to Zoom and Teams（Groenleer & Bertram, 2021: 92-93）. COVID-19 enabled digital innovation, and it accelerated the transition to what will be our adaptation to a new normal（Hovestadt, Recker, Richter & Werder, 2021b:145-146）. It was imperative to shift from in-person classes to online classes so that it needs to examine how the new normal due to the effects of Covid-19（Martins, 2021:246; Dias, Hadjileontiadou, Diniz & Leontios, 2021:250）.

Technology, including its artificial intelligence and smart applications, has entered human life（Alkhaffaf & Almomani, 2021:3-4）. The phrase "information saves lives" uttered in crisis responses that information plays an important role in reducing uncertainty in a crisis（Meesters, 2021:153-154）. The need for internet access to participate in social life during lockdown is a reason to think that internet access is an essential

social good（Archer & Wildman, 2021: 31-32）. The COVID-19 pandemic shows the importance of digital transformation, big data, artificial intelligence, and especially the lockdown, has made it clear that internet access is a necessary good for our life（Archer & Wildman, 2021:29; Ahmad, Alshurideh, Al Kurdi & Salloum, 2021:96; Lee & Han, 2021:2）. Due to the pandemic, millions of students had to be taught differently than before. Given these advantages of online education, should online education become the new common（Louwerse, Postma, Horden & Sluijtman, 2021:137-138）? Although crises tend to reshape society, it is still uncertain how the global COVID-19 pandemic will transform our lives and how the digital transformation will reshape the education service（Kang, 2021:16-17; Ewing, 2021:38）.

1.2 New Learning Architecture for Powering Learning Societies

To cope with the COVID-19 crisis, schools are forced to adopt virtual learning that digital transformation is no longer a luxury, but a necessity（Leo, Alsharari, Abbas & Alshurideh, 2021:204; Aljumah, Nuseir & Alshurideh, 2021:370）. Digital technologies are opening up a new world of possibilities（Lee & Han, 2021:2; Singh, Venkataramani & Ambarkhane, 2021:202; August & Tsaima, 2021:79）. New technologies have generated a revolution, which affects not only the industry but also the education（Cóndor-Herrera, Bolaños-Pasquel & Ramos-Galarza, 2021:331; Bouchey, Castek & Thygeson, 2021:35; Lee, 2021:260）. ICT possesses a great educational potential through making teachers updated and enriching students' educational experience（Tkachuk, Yechkalo, Semerikov, Kislova & Hladyr, 2021:48; Alam & Hoon, 2021:380）. This paper highlights the opportunities and challenges of online learning and suggests a solution by incorporating the advantages of e-learning（Leo, Alsharari, Abbas & Alshurideh, 2021:206; Darawsheh, 2021:191）. Technological advances call for exploring new directions for multimodal teaching and learning（Bouchey, Castek & Thygeson, 2021:36; Berrada, Ahmad, Margoum, Kharki, Machwate, Bendaoud & Burgos, 2021:192-193）. Digital technologies help people to mitigate the consequences of the crisis. Zoom, video conferencing services and digital technologies help schools to facilitate remote collaboration and virtual education to mitigate social disconnect during lockdowns（Hovestadt, Recker, Richter & Werder, 2021a:3）. The author explores the opportunities and challenges through the lens of uncovering the practices in the emerging trends and pedagogies（August & Tsaima, 2021:88）.

Education is expected to build students' capabilities to anticipate sustainability challenges in achieving sustainable development goals (SDGs)（Kalsoom & Shah, 2021:427）. But the transition from face-to-face classrooms to online learning systems has shown the effects of socio-economic inequality that have termed as "digidemic"（Alam & Hoon, 2021:378）. There are key visions for how digital technologies can revolutionize the provision of educational services（Stuart, Phillips & David, 2021:317）. This global crisis caused by COVID-19 pandemic has crystalized the need for policies that support access to learning resources. The use of open pedagogical practices and resources achieves inclusive education which learners have equal opportunities in accessing learning resources. Technological innovation extends learning opportunities depending on the use of the learning environment, such as e-learning, m-learning, massive open online courses (MOOCs) and Coursera, social networking and cloud computing services. This new situation has generated challenges for schools that teachers need to integrate their educational design knowledge to integrate digital technologies in their instruction（Ossiannilsson, 2021:105; Lands & Pasha, 2021:281; Jimoyiannis, Koukis & Tsiotakis, 2021:330-331; Andres, Dobrovská, Hrmo & Vaněček, 2021:186）. The Taiwan education policy initiatives have reflected the learning and teaching practices in schools. The author develops a vision of what future learning for the students might look like, note learning is understood as a "cluster of new ideas, knowledge and practices"（Lourie, 2021:81）.

1.3 Crisis-Resistant Education System

With the advancement in technology, online course has become the primary format of distance education nowadays, and is focused on technology and educational design methodologies that effectively impart education to students（Xu & Xu, 2020:352-353; Ntaba & Jantjies, 2021:183）. This shift is full of challenges and opportunities that the educators have to rethink the schools' infrastructure and pedagogical resources（Affouneh & Burgos, 2021:11-12; Cucco, Gavosto & Romano, 2021:24; Denden, Tlili, Burgos, Jemni, Huang, Essalmi & Chang, 2021:148; Banchio, Cervella, Galaverna & Giordano, 2021:275）. Technology has become the glue of a modern society, and allows us to stay up-to-date with advances. Yet education is hesitant to enact further change to embrace this that books are being left behind（Patel & Brown, 2021:141-142）. By moving online, teachers are forced to deliver educational content through the use of social connection platforms, such as Zoom, Meet, Teams, etc.（Caridà, Colurcio, Altimari & Melia, 2021:288; Davidovitch & Wadmany, 2021:456）. Understanding the factors that explain how students perceive online courses is critical to improving support for

students who are forced to take distance learning（Caridà, Colurcio, Altimari & Melia, 2021:290）. Because learning processes are influenced by the use of technologies, it is important to investigate what is the influence of digital devices in the pedagogical strategies of teaching and learning. COVID-19 became a catalyst to rethink education that will lead to innovation and a paradigm shift. Aligned with UNESCO's Sustainability Goals for Education (SDG4) to ensure inclusive and equitable education and promote lifelong opportunities, the pandemic has highlighted the need for a crisis-resistant education system（Ossiannilsson, 2021: 99-101; Othman & Al-Sinani, 2021:225-226）. Hopefully, this is just the beginning of larger reforms（Patel & Brown, 2021:136）. COVID-19 has forced schools to adapt to changes by moving from face-to-face (F2F) to online teaching. It has accelerated the digitalization and transformed teaching practices in education (Caridà, Colurcio, Altimari & Melia, 2021:287-288; Monzón, Jadán-Guerrero, Almeida & Valdivieso, 2021:324）.

1.4 Related Researches

Scholars do researches into the theme "COVID-19 Pandemic and Digital Technology", and come to the conclusions as described below: (1) COVID-19 has expedited digital technology adoption（Lee & Han, 2021:1）, (2) COVID-19 pandemic is accelerating digital transformation in education. The distance education is becoming a new normal in the education service（Kang, 2021: 15-16）, (3) A schoo's lockdown forced by pandemics or environmental disasters could have on students: it contributes to a learning loss（Cucco, Gavosto & Romano, 2021:23）, (4) As the COVID-19 pandemic continued to escalate, educators had been encouraged to move to online and distance learning（Ossiannilsson, 2021:99）, (5) Due to the COVID-19 pandemic, universities have decided to apply remote teaching（Denden, Tlili, Burgos, Jemni, Huang, Essalmi & Chang, 2021:147）, (6) Lessons learned from the COVID-19 pandemic will help stakeholders to start thinking the future of education（Berrada, Ahmad, Margoum, Kharki, Machwate, Bendaoud & Burgos, 2021:191）, (7) higher education institutions were compelled to embrace E-Learning that use the Zoom platform, as well as others: Weber, MS Teams, etc（Davidovitch & Wadmany, 2021: 453-454）, (8) The outbreak of COVID-19 pandemic caused closures of universities. All the teaching has been taking place remotely/online（Prikhodko & Polyakova, 2021:36）, (9) Online teaching, open online courses, and higher education form a close union of elements（Bruschi, Marchisio & Sacchet, 2021:187）, (10) To drive the digital transformation has become a mission for design education（Canina & Bruno, 2021:27）, (11) Virtual learning has been widely adopted in higher education institutes during the COVID19 pandemic（Yuan & Garaudy, 2021:299）, (12) The pandemic of COVID-19 forced schools to transfer their educational programs from in-person instruction to remote online teaching（Jimoyiannis, Koukis & Tsiotakis, 2021:330）, (13) As digital age learning is comprehensible through mobile phones, future 5G technology will enable mobile device to access digital platform（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:39）.

II. Theoretical Foundations

2.1 Digital Innovations

1) Digital Transformation in Education

Technology is an enabler, and using technology and e-learning in innovative ways could make education more accessible to schools and students (Holt, 2021:84; Patel & Brown, 2021:138-139; Ahmad, Alshurideh, Al Kurdi & Salloum, 2021:98）. The recent trends in digital transformation during the COVID-19 pandemic are the expansion of distance education and the increasing innovations in educational technologies（Kang, 2021:17）. The COVID-19 pandemic presents the education system with a renewed opportunity to embrace new EdTechs. Home-schooling is the obvious option for parents because learning content is accessible remotely and EdTechs are developed to assist learning（Kang, 2021:20; Higueras, Tounsi & Burgos, 2021:297; Dolezal, Roschger, Hahnenkamp, Mairinger, Zimmermann, Satek, Koppensteiner & Motschnig, 2021:414）. Modern technology is virtual and augmented reality (AR) that will have a considerable effect on distance learning that involves the use of a range of instructional methods such as print, video, and multi way communication systems（Ntaba & Jantjies, 2021:186-188）. Interactive online learning has become a trend in education that is made possible by the expansion of the Massive Open Online Course (MOOC)（Kang, 2021:18-20）. The pandemic has forced global experimentation with remote teaching that demand for online learning has skyrocketed—with Coursera（Ewing, 2021:39）.

2) Technology-Enhanced Learning

Cross Reality (XR) refers to technologies and applications that involve combinations of mixed reality

(MR), augmented reality (AR), virtual reality (VR), virtual worlds (VWs), and the use of 3D models/simulations. These are technologies that connect computer technology to the physical world for the purposes of augmenting or extending experiences. Cross Reality is becoming ubiquitous, and presents an opportunity for a new approach to learning design that can leverage the transmedia learning（Ziker, Truman & Dodds, 2021:56-59; Tropschuh, Dillinger, Gärtner, Korder, Bauer & Kagerer, 2021:5）. These scenarios are designed to illustrate what lies ahead in education, as these technologies become more ubiquitous, allowing students to move seamlessly within the reality-virtuality continuum（Ziker, Truman & Dodds, 2021:55; August & Tsaima, 2021:81-82; Nielsen & Brandt, 2021:279; Peterson, Bogosian, Tubella & Vassigh, 2021:13）. A "one size fts all" curriculum may not fulfill everyone's needs（Ragan & Villarin, 2021:109）. Multimodal learning environments can address diversity issues. The richness of content digitally accessible is more likely to be integrated into the learning materials. Immersive learning environments such as those made possible through virtual worlds simulations can enhance participants' experiences（Ragan & Villarin, 2021:111-113; Stuart, Phillips & David, 2021:313）. Further research is asked for to expand the knowledge about how meaningful learning can be mediated with XR （Nielsen & Brandt, 2021:280）. Immersive technologies, comprising VR, AR and MR, tries to imitate the real world though the use of a digital or computer-generated world that display prospects of possibly aiding in the challenges experienced by the DL learners（Ntaba & Jantjies, 2021:188-190）. Online learning and teaching have been practiced in many rural regions that the advantage is the expanding educational access. The second important advantage is further learning opportunities. Opportunities for social and emotional learning normally arise from interpersonal contact in the classroom, yet these are unavailable in an online classroom（Murillo, 2021:65）.

3) Educational Inequality by Digital Divide

A finding from the 2015 PISA report indicates that there is no difference in reading, mathematics, or science skills between students in the countries that had invested heavily in information and communications technology (ICT) for education（Kang, 2021:24; Fung, Taal & Sim, 2021:197）. Schools with good ICT infrastructure will improve their education services faster than those with poor ICT infrastructure. The wider the digital divide, the wider the educational opportunity gaps（Kang, 2021:25）. Technology and internet affect the way we think and communicate that is referred as "digital culture"（Fazzolari, Fabbri, Matteucci, Petrocchi & Vaccarelli, 2021:271）. The rapid evolution of internet technologies enables e-learning to provide media-rich content and just-in-time delivery where students can take ownership of their learning（Taylor, Yeung & Bashet, 2021:20）. Immersive technologies, simulation, visualization, and geospatial datasets are ideal tools to enhance learning（Peterson, Bogosian, Tubella Vassigh, 2021:15）. In the current situation caused by the COVID-19 pandemic, students need to participate effectively in digital media. It is a challenge at all levels of education to ensure that students can effectively develop their digital literacy that can be defined as the ability to use information in different formats（Kővári & Bak, 2021:160-161）.

2.2 Online Learning and EdTech

E-learning is defined as the use of the internet and digital technology to create an experience and educate learners. This method provides the advantage of easy access regardless of time or place where students use information and communication technology (ICT)（Darawsheh, 2021:191; Cóndor-Herrera, Bolaños-Pasquel & Ramos-Galarza, 2021:332-333; Holt, 2021:80）. The appearance of smartphones enabled mobile access to virtual learning environments giving rise to mobile learning（m-learning）（Cóndor-Herrera, Bolaños-Pasquel & Ramos-Galarza, 2021:333）. In Covid-19 pandemic situation, schools were following the online teaching-learning platform for interactive classes. Blended learning is a new technology of remote education learning where the conventional (blackboard, canvas, D2L) and nonconventional (Zoom, Google Meet, etc.) platforms will provide a combination of face-to-face interaction with virtual mode（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:50, 52-53; Pannen, 2021:131; Darawsheh, 2021:192）. Covid-19 has caused a global shift in the livelihood of life that people are faced with no choice but to turn towards technology and conform to virtual assistance to continue functioning（Leo, Alsharari, Abbas & Alshurideh, 2021:206）.

2.3 Distance Education

The emergency remote teaching refers to "a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances". Distance learning refers to "education is delivered to students in remote locations"（Hodges, Moore, Lockee, Bond & Jewett, 2021:38-39; García-Peñalvo, Corell, Abella-García & Grande-de-Prado, 2021:85-86; Denden, Tlili, Burgos, Jemni, Huang, Essalmi & Chang, 2021:148）. Given the circumstances of the COVID-19 pandemic, schools decide to apply remote teaching. These challenges can be

categorized into four categories. Firstly, technical challenges: effective use of ICT can help teachers in providing distance courses. Secondly, psychological and emotional challenges: depression and anxiety become more common. Thirdly, social challenges: online learning can reduce social interaction. Fourthly, pedagogical challenges: teachers have become obligated to prepare learning content（Denden, Tlili, Burgos, Jemni, Huang, Essalmi & Chang, 2021:148-151; Wang, Bajwa, Tong & Kelly, 2021:178）. The distance learning became a necessity, rather than an option, during the pandemic（Noorashid, Ha, Alas & Yabit, 2021:358-359）. It is becoming pivotal to use ICT in teaching and learning processes by implementing digital learning tools, such as computers, laptops, tablets, and mobiles, to expand course curricula, and to make teaching and learning more meaningful and fun. The logic of MOOC, e-learning, and m-learning, shows us the central role of the technological device in education（Berrada, Ahmad, Margoum, Kharki, Machwate, Bendaoud & Burgos, 2021:195）.

2.4 Enabling New Common Through Information

When the COVID-19 pandemic hit societies, on-site lectures transformed into on-line interactions. Online education seems to be a substitute for on-site education, and online learning turns out to be as effective as learning. It would be wise to invest in online lectures, MOOCs, and online learning platforms（Louwerse, Postma, Horden & Sluijtman, 2021:140）. Given that teaching online requires some tools that are different from face-to-face instruction, transitioning from in-person to online teaching would require a reconsideration of the course and assessment（Wang, Bajwa, Tong & Kelly, 2021:180; Meesters, 2021:158）. Assumptions regarding quality, excellence and competitiveness must be questioned, and new normality must be articulated（Ossiannilsson, 2021:101-103）. Learners in rural regions may not have decent access to the internet and this may lead to inequalities based on the geographical location and economic situation（Corbi & Burgos, 2021:116; Kalsoom & Shah, 2021:432）. Thanks to online tools and a hyper-connected network, this proactive approach is more available than ever that students can find courses, video lectures, mobile apps and software applications of any kind to support learning（Affouneh & Burgos, 2021:13）. Technological innovations enabled education to spread faster and wider, and technology can play a role in making education nonrivalrous（Aneja & Lalvani, 2021:297）. Education in situations of crisis becomes an asset for progress, so that people could think that internet access is an essential social good that it is essential for exercising certain human rights（Archer & Wildman, 2021:30-31）.

III. Aims, Underlying Assumptions & Method

This study aims to provide a brief explanation through a qualitative lens to the COVID-19 pandemic and its causes as well as challenges. Specifically, the author will delve into the digital innovations and enable the new common through information. Due to the pandemic changes had to be adapted to the educational system, this included digitalization, online learning and educational technologies (EdTechs) and distance education. The author will look into how changes are made to emerging trends and pedagogies and digital innovation, how it has rethought education in a crisis: how new is a new common really? and how it has developed to the digital innovation. As the COVID19 pandemic continues to grow, technology continues to improve and leads to different pathways. Schools look to employ technology tools that will further stimulate active learner engagement with academic content. Technology tools (which involve the use of gaming, simulations and XR, AR, VR, VWs and MR) have largely been used in education to provide immersive learning experiences.

This paper aims to answer the primary research question: How can the educators enable the new common through information? The rapid proliferation of information technologies has made it easier for us to obtain information that technology has played a powerful role. Students can gain information; education not only from the classroom, but from all manner of news, media, and social platforms. Education has become a matter of urgency, and educational technologies have been positioned as a frontline emergency service. In this time of crisis, the question is more about how academic institutions will be able to adopt e-learning on such a massive scale. This paper reviews the digital transformation in education, including discussions on technology-enhanced learning, educational inequality by digital divide, online learning and EdTech, and distance education. Then, this paper introduces the situation in Taiwan and anticipates how the education service will be after the COVID-19. Lastly, this paper concludes with the future of the education service and the author's insight, which is shown in Figure 1. These objectives were classifed as digital innovations and transformation in education, online learning and EdTech, and distance learning challenges. A systematic literature review will be employed to address these objectives. Then, the author discusses the recommendations formulated to enable the new common through EdTechs. In addition, a future digital model is proposeds, to reduce the adverse effect of a pandemic. At last, the author concludes the summary. This study made use of a qualitative research methodology through a systematic literature review.

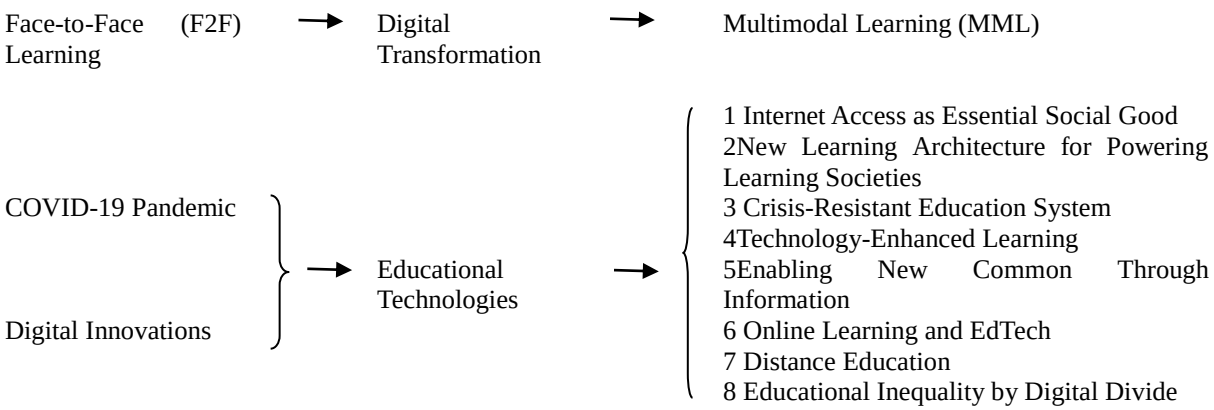

Figure 1. Research Framework

IV. Results

4.1 Digital Innovations

1) High-Tech Knowledge-Intensive Services

According to gross domestic product by kind of activity, the amount (Million N.T.$) of information and communication develops from 34,377 in 1981 to 639,103 in 2021, and its % of GDP develops from .0190 in 1981 to .0294 in 2021; the amount of ICT industry develops from 76,106 in 1981 to 4,584,775 in 2021, and its % of GDP develops from .0422 in 1981 to .2109 in 2021, which is shown in Table 1. Taiwan has a revealed comparative advantage in the product groups: high skill and technology-intensive manufactures and high-tech knowledge-intensive services. By major activities, the amount of agriculture develops from 132,689 in 1981 to 310,846 in 2021, and its % of GDP develops from .0735 in 1981 to .0143 in 2021; the amount of industry develops from 791,098 in 1981 to 8,440,496 in 2021, and its % of GDP develops from .4383 in 1981 to .3883 in 2021; the amount of services develops from 881,256 in 1981 to 13,024,794 in 2021, and its % of GDP develops from .4882 in 1981 to .5991 in 2021, which is shown in Table 1. The industrial sector has played a major role in the transformation of the economy, with growth in manufacturing value of .3406 (% of GDP) in 2021.

After the downturn of the 2000s, Taiwan economy underwent significant changes that half of the workforce were employed in the services sector. Because a concern with the need for Taiwan workforce to be able to respond to rapid technological change, Taiwan needs a work-force which is highly skilled and adaptable; Taiwan economy needs workers with specific technological skills to enable innovation and support the infrastructure. The ICT industry faces challenges recruiting people with the skills to drive digital innovation and strengthen Taiwan potential for economic growth. Interactive and adaptive learning is a popular area of investment focused on designing digitized learning activities. The MOOC launched in Taiwan in 2013 when University joined Coursera and edX that National Taiwan University was invited by Coursera. NTU MOOC has launched courses with NTU's unique features. Universities in Taiwan offer interactive online courses. Coursera sought to apply online reskilling as a tool for the economic development and workforce transformation. Coursera models the values of a learning society to extend education beyond the classroom, supporting both lifelong learning and workforce development.

Table 1. Gross Domestic Product by Kind of Activity in Taiwan, End of 1981—2021

	Gross Domestic Product_Current Price(Million N.T.$)					
	1981		2010		2021	
	data	% of GDP	data	% of GDP	data	% of GDP
A. Agriculture, Forestry, Fishing and Animal Husbandry	132,689	.0735	224,828	.0159	310,846	.0143
B. Mining and Quarrying	13,798	.0076	19,008	.0013	12,076	.0006
C. Manufacturing	589,905	.3268	4,090,594	.2897	7,405,251	.3406
D. Electricity and Gas Supply	75,725	.0420	182,902	.0130	238,827	.0110
E. Water Supply and Remediation Services	13,380	.0074	94,504	.0067	120,973	.0056
F. Construction	98,290	.0545	367,044	.0260	663,369	.0305
G. Wholesale and Retail Trade	226,275	.1254	2,367,946	.1677	3,373,250	.1552
H. Transportation and Storage	77,212	.0428	427,866	.0303	833,008	.0383
I. Accommodation and Food Services	15,548	.0086	293,073	.0208	430,977	.0198
J. Information and Communication	34,377	.0190	465,419	.0330	639,103	.0294
K. Finance and Insurance	68,995	.0382	871,705	.0617	1,464,369	.0674
L. Real Estate and Ownership of Dwellings	87,455	.0485	1,188,787	.0842	1,666,328	.0767
M. Professional, Scientific and Technical Services	19,733	.0109	307,743	.0218	481,437	.0221

N. Support Services	11,247	.0062	197,194	.0140	332,883	.0153
O. Public Administration and Defence¡FCompulsory Social	156,698	.0868	1,034,284	.0733	1,189,668	.0547
Security	48,103	.0266	654,422	.0463	748,277	.0344
P. Education	13,204	.0073	392,829	.0278	645,102	.0297
Q. Human Health and Social Work Services	9,042	.0050	120,299	.0085	127,649	.0059
R. Arts, Entertainment and Recreation	37,117	.0206	372,513	.0264	465,373	.0214
S. Other Services	1,728,793	.9578	13,672,960	.9684	21,148,766	.9728
Subtotal	76,250	.0422	152,107	.0108	224,580	.0103
Import Duties	1,805,043	1.0000	14,074,747	.9969	21,776,136	1.0017
Total (by production approach)	1,805,043	1.0000	14,119,213	1.0000	21,738,982	1.0000
GDP	132,689	.0735	224,828	.0159	310,846	.0143
By Major Activities : Agriculture	791,098	.4383	4,754,052	.3367	8,440,496	.3883
By Major Activities : Industry	881,256	.4882	9,095,867	.6442	13,024,794	.5991
By Major Activities : Services	76,106	.0422	2,111,024	.1495	4,584,775	.2109
ICT Industry						

Source: Directorate General of Budget, Accounting and Statistics (DGBAS) of Executive Yuan, R.O.C. (Taiwan)
Unit:Million N.T.$

2) Technology-Enhanced Learning

A technology can be used to settle a certain societal problem, for instance, the COVID-19 contact-tracing app is promoted as a way to quickly inform people who might be at risk of having caught the virus. Many rural students were able to complete the semester with smart phone and mobile data. Indeed, mobile devices could become "must-have", which could increase access to and participation in educationy. The COVID-19 outbreak has shown the importance of the ability to stay connected by digital means. During these crisis situations, the digital divide increases even further. Schools have sped up the selection of online solutions, trying to deliver some of their classes through Skype, ZOOM, Meet, Webex, or some other solutions at hand. Online learning, in the form of MOOCs, remain an innovative method for learning due to their incorporation of new technologies. Course content can be presented and delivered in multiple modes, such as 3D printing, AR and VR, virtual assistants, auditory productions, and multimedia. The use of multimodal learning (MML) in education creates a foundation for fexible multidirectional interaction and discussions. Educators are looking for ways to leverage existing technologies to create meaningful interactions.

3) Educational Inequality by Digital Divide

Technology promotes equal access and has the potential to bring remote learners into mainstream learning. Technological innovations also help students with special learning needs. It is perhaps timely to consider a policy framework that targets the worsened digital divide due to COVID-19 to ensure equitable access to the benefits or technology in education. During periods of lockdown, the majority of educational activities moved online. But unequal access to the internet runs the risk of making educational inequalities worse. Students must be given good quality internet access, then, to help prevent the widening of these educational inequalities. Educational systems were set in place to serve all children, and with the digital technologies, inclusive systems may become a reality. The digital transformation has been recognized more during, and it is recommended that digital tools be user-friendly. Investment in ICT infrastructure is necessary to minimize the digital divide in education. To prevent technology from exacerbating inequalities, governments must ensure its spread in a sustainable and inclusive manner.

4.2 Online Learning and EdTech

On February 2020, Covid19 was spread in Taiwan and further measures were introduced that the public and private educational sectors were closed. In particular, schools managed to complete the semester, by shifting amidst the Covid-19 outbreak, to online learning solutions. Students and teachers use mobile technologies for a wide range of teaching and learning purposes. Online infrastructure refers to how teachers and students access blended learning materials. It adjusts instruction and course material delivery in ways that accommodate for Wi-Fi access on campus and in remote areas. Virtual learning has opened new methods to the educational sphere. This is an advantage to the educational field as we have many types of elearning such as distance learning and blended learning. One of the important problems is the problems and how to communicate with students, which is disrupted the traditional learning to be replaced by e-learning. Schools has had to go online and help students continue their education so as to not hinder their development during this time of crisis. Some popular tools used these days are Google classroom, Blackboard Learn, Ultra Collaborative, GoToMeeting, WebEx, Zoom, and many more.

4.3 Distance Education

The COVID-19 epidemic forced schools to shut down on February, 2020 tthat schools were compelled to provide online teaching to students, despite having little previous experience with it. Ministry of Education

recommended using distance-learning technologies and open educational applications and planforms to reach learners remotely. It was possible to use various software: Zoom, Skype, Microsoft Teams, and Google Hangouts as communication tools. The Taiwan experience suggests that the negative effects of home-schooling can take place. First, there is a learning loss for students, who are experiencing a reduced amount of instruction and no social interplay. Such a loss in human capital may potentially lead to an economic loss of Taiwan's annual GDP. Second, the shutdown of schools is particularly problematic for categories of students coming from low socio-economic backgrounds and students with special needs. Students maybe experience emotional distress from the pandemic. The teaching has been taking place remotely/online. During the pandemic, distance learning became a new normal in education. Many EdTechs have been developed in Taiwan that students use laptops and tablets to access digital educational materials and EdTechs. Due to the COVID-19 emergency, educational systems have been forced to rethink traditional learning models and to rapidly adapt to a completely different reality. Whether students had sufficient internet environments to support distance learning increased the difficulty of accessing distance education?

4.4 Enabling New Common Through Information

Taiwan has experienced an educational experiment for the nationwide implementation of online learning as formal education. While many issues and obstacles were revealed, Taiwan might find new opportunities from this massive experiment. Ministry of Education and policymakers could revise the guidelines for online education in preparation for such a crisis in the future. Teachers should embrace innovative teaching and learning methods through online education and seek ways to realize learner-centered pedagogical approaches. Taiwan education policy and initiatives include goal statements about achieving socially just outcomes for all students. Social distancing and physical distancing will become a way of life. Further, health and hygiene will assume more importance where wearing masks will become a necessity across all strata of society. This 'new normal' will throw up new requirements that the government and its people must together address. It is expected that the after-Covid environment will encourage educational institutions to leverage technology, such that it will impact the lives of people. This will require enhancement of IT infrastructure that will become a powerful mode to deliver services. Educational institutions starting from schools will have to adopt information technology to facilitate on line and blended learning. With the IT infrastructure in place, one could expect significant expansion in reach and access to education. The new normal will witness massive expansion of information technology infrastructure. The employability of the workforce depends more heavily on the ability to acquire new skills throughout life. The education emphasis needs to shift to nurturing the propensity to acquire new knowledge and skills.

V. Discussion

5.1 Challenge of Information and Communication Technology

The digital technology such as cloud computing, internet of things (IOT) and bigdata analytics are available（Lee & Han, 2021:8）. EdTech is the method where education is integrated with technology to facilitate learning. Using different video conferencing platforms like Google Meet, Zoom, and Webex, schools hope that no student is deprived of knowledge irrespective of nationwide lockdown. The locals should spend money in developing the learning applications by using emerging technologies（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:41,44-46）. Technology to accelerate learning as a life skill is reflected in SDG Indicator: Proportion of youth/adults with ICT skills. The innovative initiatives and proliferation of learning apps, and MOOCs have influenced the local's efforts to meet the workforce and continuous learning needs (Jamil, Ahmed & Pudasaini, 2021:1184-1185）. The augmentation of virtuality in education must be viewed as a tool to enrich teaching and learning（Ntaba & Jantjies, 2021:194-195）. Our younger generations are growing up as digital natives. To acquire and use the skills in life and learning, young people have to form an understanding of the digital environment（Jamil, Ahmed & Pudasaini, 2021:1185）.

5.2 Covid-19 and E-Learning Implications

The closure of educational organizations to combat Covid-19, forced schools to provide education through distance learning or blended learning to ensure students continuous access to learning（Leo, Alsharari, Abbas & Alshurideh, 2021: 212）. The smart education system ensures to create skilled students with technology （Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:41）. Schools introduce Zoom, Blackboard Collaborate, WebEx, Google meet and other such online platforms to conduct classes and have students participate in online classes（Leo, Alsharari, Abbas & Alshurideh, 2021:210-211）. The pandemic has shown that schools have the competence to change rapidly and agilely, and teachers are encouraged to develop digital competences （Ossiannilsson, 2021:107-108）. In times of emergency such as the COVID-19 crisis, the use of digital learning makes it possible for learners to maintain a study continuity and to reduce the disruption of their study routine

（Davidovitch & Wadmany, 2021:458）.

5.3 Embracing Opportunity in Pedagogy : Online Teaching and Social Distancing

Quarantine and closing schools intensify the existing gaps and inequality in the educational system, and students from disadvantaged populations are particularly vulnerable to the consequences of the crisis. Moreover, many students describe a sense of loneliness and social disconnection when learning in an online environment（Davidovitch & Wadmany, 2021:460）. While educators observe the expansion of the use of technologies and online learning platforms as a direction for education, people urge all levels of education to reflect on the effects of transitioning to more digital initiatives. Using online platforms have now become 'the new normal'; also teaching remotely and online conferences are commonly done with people（Noorashid, Ha, Alas & Yabit, 2021:366,368）.

5.4 Powering a Learning Society and Infusing Educational Technology

A major pillar of Education 4.0 will be the technology-driven devices used by students to acquire knowledge（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:44-50）. Technological advancements facilitates the need for a more structural approach to information management（Meesters, 2021:155-156）. Students have been identified with favorable responses regarding the use of technology to increase willingness to perform learning activities（Cóndor-Herrera, Bolaños-Pasquel & Ramos-Galarza, 2021:335）. Nowadays, access to the internet in education is vital for student academic success（Waghid, Waghid, Terblanche & Waghid, 2021:27,51）. Technology is not only changing landscapes concerning the economic activities; it is also influencing the nature by which education is provided that there will be a new normal with transformative features（Ra, Jagannathan & Maclean, 2021:7-8）.

VI. Conclusions and Suggestions

6.1 Challenges and Issues

1) Digital Innovations

i) How the COVID-19 Pandemic Is Reshaping the Education Service

The COVID-19 pandemic is accelerating digital transformation, and enables opportunities for change around teaching/learning innovation. Educational technologies will enable students to take ownership of their learning that we can expect improvements such as enhanced online-teaching tools, digital fluency and engaging lessons（Kang, 2021:33; Ewing, 2021:50; Stuart, Phillips & David, 2021:319）. Digital skills are needed by our students, given the fundamental aspect of digital technologies（Murillo, 2021:70）.

ii) Technology-Enhanced Learning

In Covid-19 pandemic situation, education has been improved with technology; technology has become the glue for developing skills. In future, education cannot be sustained without technology（Pradhan, Mitra, Chowdhuri, Neogi & Ghosh, 2021:64）. Future work includes the development of educational design patterns and software services supporting students to give schools useful tools to adopt to the new challenges（Dolezal, Roschger, Hahnenkamp, Mairinger, Zimmermann, Satek, Koppensteiner & Motschnig, 2021:423）. It presents a number of challenges that teachers and schools need to address for an adaptive learning implementation（Taylor, Yeung & Bashet, 2021:31）Optimizing the use of XR in education requires the support and resources of committed professionals from education, government, and industry（Ziker, Truman & Dodds, 2021:74）.

iii) Educational Inequality by Digital Divide

Future plans will achieve digital literacy, reflecting on exiting pedagogy to enhance students' skills needed for future jobs（Affouneh & Burgos, 2021:19）. The digital transformation, and digital literacy and competences have become important. The technology and devices are not equally accessible to all; therefore, online learning is a challenge for some learners. A social safety net must be provided for the vulnerable to ensure that they have easy access to education（Ossiannilsson, 2021:109）. There is a need to understand how the learning experience can be facilitated for learners in online and video-centric environments（Kővári & Bak, 2021:165）.

2) Online Learning and EdTech

Technologies continue to provide new approaches to assist online teaching（Wang, Bajwa, Tong & Kelly, 2021:186）. Innovative ideas have emerged, including some rethinking of the goals of education（Soriano, Cardona & Corpas, 2021:271）. It is necessary to boost the pedagogical aspects of the new technological tools（Davidovitch & Wadmany, 2021:477）. There is a need for the integration of technologies and online learning platforms in the education system that fulfills the aspiration to embrace the emphasises on the incorporation of media and info-technology advancement（Noorashid, Ha, Alas & Yabit, 2021:371）. The pandemic situation suggests that sustainability teaching should build students' capacities to anticipate the uncertain future（Kalsoom

& Shah, 2021:436; Wang, Bajwa, Tong & Kelly, 2021:182）. This is what we need to focus our attention for our young people to be prepared for this new world of work（Patel & Brown, 2021:142-143）.

3) Distance Education

School closures has a big impact on students' and teachers' motivation as well as on family engagement（Cucco, Gavosto & Romano, 2021:33-34）. The COVID-19 pandemic has cast a cloud of uncertainty over education that is an opportunity for the local to rethink education. Lessons learned from the pandemic crisis should bring answers to the future of education and respond to the challenges of opportunities, as well as how to maintain quality of education（Berrada, Ahmad, Margoum, Kharki, Machwate, Bendaoud & Burgos, 2021:202; Banchio, Cervella, Galaverna & Giordano, 2021:279）.

4) A Digitalized Learning Society Today for the Society of Tomorrow

Without suitable internet access, individuals can be said to be living in poverty, and are being made to sufer from social deprivation. Further, unequal access exacerbates educational inequalities. These reasons make a case for thinking that internet access is an essential social good. The government should have a clear responsibility to ensure that students have suitable access（Archer & Wildman, 2021:32）. What the future needs is how TVET stakeholders can contribute to the design of tomorrow's society by being aware that tomorrow's society is in today's curricula（Crisonà, 2021:255-256）.

6.2 Limitations and Implications

1) Rethinking Education

The COVID-19 pandemic has hit all aspects of society, and it has provided us with an opportunity to rethink education（Louwerse, Postma, Horden & Sluijtman, 2021:142）. A learning society must not limit learning to just schools; and it is likely that learning will move into homes, workplaces, and other part of life（Aneja & Lalvani, 2021:295）. With students facing a lot of academic constraints in online education, only quality online courses can compensate the situation（Pannen, 2021:132）.

2) Powering a Learning Society During an Age of Disruption

In an age of disruption, a learning society can help economies, societies and individuals to successfully navigate transformational changes（Ra, Jagannathan & Maclean, 2021:10-11）. It is more urgent to rethink principles of what should be a good standard of work and living for all（Maclean & Wheeler, 2021:20）. With lifelong learning becoming a necessity in a digital world where skills-in-demand continually evolve, the need for skills upgrading is becoming a "must have" to live well in technology-enabled societies. In moving toward positioning lifelong learning as a public good, governments need to rethink the principles relating to education（Fung, Taal & Sim, 2021:204-205）.

3) Remodeling Classroom

A challenge of integrating these innovative learning environments is that the physical space is set up for a traditional study area, but many academic activities require group work. This necessitates a rearrangement or remodeling of the classroom. Proponents of new education technology must appreciate how it fits into physical structures and campus cultures（Ryoo & Winkelmann, 2021:12-13）.

4) Limitations

The local, Taiwan started the "Disrupted Education, Undisrupted Learning" initiative by providing flexible and remote teaching to students from their homes. However, teachers have faced several challenges during this period of remote teaching. This study has several limitations that should be acknowledged. For instance, the number of teachers participating in this experiment was limited due to time (teachers are generally overloaded during the crisis) and context (pandemic) constraints. Future research could focus on collecting and comparing the different emergency policies and strategies taken by the local during the COVID-19 pandemic to create universal education response policies in crises（Denden, Tlili, Burgos, Jemni, Huang, Essalmi & Chang, 2021:155-157）.

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