Digital Literacy:
A Review of Literature

Pritika Reddy, Fiji National University, Fiji

(iD) https://orcid.org/0000-0003-4088-1706

Bibhya Sharma, USP, Fiji

Kaylash Chaudhary, USP, Fiji

(iD) https://orcid.org/0000-0002-2378-7745

ABSTRACT

Information and communication technologies (ICT) along with the internet have fueled advancements and growth in banking, transportation, economics, and most of all in education in the 21st century. The 21st century citizens are provided with new opportunities that have been created with the advancement of ICT. Hence, individuals need a wide range of abilities, competencies, and skills to adapt to the technological era. This paper provides a literature review of the growing importance of ICT, its wide array of usage, and its influence on various facets of people's daily lives. In addition, the emerging concept of digital literacy through ICT developments, contribution of digital literacy towards the achievement of sustainable development goals, contribution of ICT towards the development of various sectors particularly the education sector, and the work done in this area of digital literacy are summarised. The paper concludes with three new models of digital literacy: four gear model, model for flexible learning, and a model showing the impact of ICT on the learning process.

KEYWORDS

Digital Literacy, Distance Flexible Learning, ICT, ICT and Learning, Literature Review, Technoethics

INTRODUCTION

Information and Communication Technology (ICT) has undergone a significant transformation which has changed the way it is defined in the 21st Century. The term ICT can now be defined as the use of digital technologies to generate, distribute, collect and administer information and communicate in real-time (instant messaging, voice over IP (VOIP) and video conferencing) (techterms, 2018; Sarkar, 2012). ICT has become an integral part and an acceptable norm of our livelihood, mainly due to the fact that these modern technologies are playing an important role in improving the quality of living.

Although ICT has been responsible for digital divide from the beginning of 1990 (Sarkar, 2012), it has stimulated educational growth and variablilty, provided new opportunites in developing countries, introduced digital libraries and created new dynamics in research (Sharma, et al., 2019). Sarkar (2012) mentioned that ICT could play an important role in skills development and this concept has also been mentioned in Information and Communication Technologies for Development (ICT4D). The ICT4D refers to the use of ICT for international development, particularly reframing the poor by providing new opportunities for working (Walsham, 2017; Andersson & Hatakka, 2013; Heeks, 2008). According to researchers, ICT has made potential contributions in the fields of banking,

health, education, transportation, poverty alleviation programmes and e-governance (Reddy et al., 2020;Nand & Sharma, 2019; Sharma et al., 2019; Reddy at al., 2017;Pojani & Stead, 2015; Sharma et al., 2015; UNDP, 2008).

From the fields mentioned above, major discussions in this paper revolve around the transformations in the education sector because of new technologies and their adoption and adaptation that have has changed the entire education paradigm.According to (Tondeur et al., 2017; Kurtz & Peled, 2016; Perdana et al., 2016) education plays a vital role in any countries development; therefore, this paper reflects on how education has transformed through the inclusion, leaverage and integration of ICT. The development of other sectors through ICT is also discussed in this paper.

ICT and the plethora of developments through ICT have led to a new revolution – the Digital Revolution, which has re-engineered societies and hence reshaped how one lives in them (Lopez, 2009). New concepts and ideologies like e-permeated society (digital society) and digital tools and technologies like mobile devices, computer-aided manufacturing tools, communication tools, smart learning cities etc. have emerged. The literature suggests that the rapid and continuous growth in the digital technology requires individuals to have the necessary skills and competencies to perform tasks and solve problems in digital environments (Fu, 2013; Sarkar, 2012; Martin & Grudziecki, 2006). This set of skills is now defined as digital literacy skills. According to Fu (2013) digital literacy is a set of skills required by 21st Century individuals to use digital tools to support the achievement of goals in their life situations. A broader discussion on this emerging concept appears later in this paper.

Researchers and scholars in their own ways have pointed out the varied developments in ICT, its importance and the potential it has brought with it. This paper undertakes a comprehensive review of this field and discusses a series of examples on how ICTs are benefitting in the various broad facets of our daily living. The paper also presents the evolution of digital literacy through the eyes of ICT, with particular emphasis to developing countries since the developing countries are still emerging with the use of ICT when compared to the developed countries who are maximizing the full potential of ICT. For the developing countries, exploring the use of ICTs suggests new research directions. While the concept of digital literacy is new in the developing countries, it is as important as in the developed countries. This is because if individuals of a country are digitally literate, they will be able to effectively and efficiently use ICT to perform tasks and achieve goals hence contributing to the economic development of their country (Aleke et al., 2011). The impact of ICT and the evolution of digital literacy are discussed as follows:

1. Impact of ICT in various fields in developed and developing countries are discussed under Importance of ICT.
2. The uses of ICT and how it has impacted the area of health, governance, banking and industries and education are discussed under Usage of ICT.
3. The emergence of new tools and technologies through the advent of modern ICT tools are discussed under Emerging tool and Concepts.
4. The influence of ICT in higher education and the way it has changed the education paradigm are discussed under Influence of ICT in Higher Education.
5. The discussions on the concept of digital literacy are under the heading Digital Literacy.

RESEARCH QUESTIONS

1. How did the term digital literacy evolve?
2. Are the developments in ICT responsible for the evolution of digital literacy?
3. Is digital literacy part of ICT enabled education?

METHODOLOGY

For this study, an integrative literature review methodology has been used. An integrative literature review is one which intends to address mature or emerging concepts with the overview of the knowledge view, reconceptualization and expands on the theoretical foundation of the specific topic (Snyder, 2019). The emerging concept in this reseach study is digital literacy, and the theoretical foundation that sets the stage for digital literacy is the adoption and adaptation of ICT in education over time.

IMPORTANCE OF ICT

The 21st Century has witnessed the proliferation of ICT in improving efficiency, decision making, and administering progress in various fields (Din et al., 2017). ICT is playing an important role in economic development (Reddy, et al., 2017;Farhadi, Ismail & Fooladi, 2012), enhancing quality of and access to education (Nand & Sharma, 2018;Sharma et al., 2019; Reddy et al., 2017; Gonel & Akinci, 2018; Sapkota, 2018), significantly contributing to the health sector (Haluza & Jungwirth, 2018; Hossain, 2011), and social and political progress (March, 2018; Lee, 2018).
In 2002, Oliver, in his paper quotes:

ICTs have impacted the educational practices to date in quite small ways but the impact will grow considerably in years to come and that ICT will become a strong agent for change among many educational practices.

The impact of ICT and its role has in the recent past been extended to the developing countries. According to (Cunningham, 2019), a developed country is one that is more industrialised and have higher per capita level whereas a developing country is one that is less industrialised with lower per capita levels. Surbhi (2019) has differentiated developed countries and developing countries as summarised in Table 1 according to employment rates, living conditions, income, etc.
ICTs can promote development in many dimensions and has the tremendous potential to overcome the varied challenges faced by developing countries such as illiteracy, poverty, hunger, elimination of high child mortality rate and poor maternal health (United Nations, 2018; Segura & Pena, 2017).

Table 1. Difference between developed and developing countries

Factors	Developed Countries	Developing Countries
Unemployment and Poverty	Low	High
Birth, Death and Infant Mortality rates	Infant mortality rate, death rate and birth rate is low while the life expectancy rate is high.	High infant mortality rate, death rate and birth rate, along with low life expectancy rate.
Living conditions	Good	Moderate
Revenue Generation	Industrial sector	Service sector
Growth	High industrial growth.	Rely on the developed countries for their growth.
Standard of living	High	Low
Distribution of Income	Equal	Unequal
Few Examples	United States, Australia, Germany, France, Spain, South Korea, Spain, Taiwan, New Zealand	China, Malaysia, Fiji, Tuvalu, South Africa, Argentina, Solomon Island, India

Studies have shown that ICT, when used effectively, can help organisations to optimize the use of resources and become more competitive and productive. The developed countries have utilized ICT for various purposes,while in developing countries the use of ICT is an emerging concept since issues such as poor infrastructure, high cost and lack of support from stakeholders still exist (Nand & Sharma, 2019; Sharma et al., 2019; Gatautis et al., 2015). According to (Delponte et al., 2015) the uptake of technology in developing countries is low because the individuals lack technical, structural and strategic skills to fully utilise ICT for apparent benefits. The authors mentioned above also add that human capital and well trained IT labor attract more foreign investments that can be used for the economic and infrastructure development of any country. Another contributing factor that was hindering the proliferation of ICT in developing countries is that the individuals are not educated enough or lack competencies and confidence to participate in the economic development of a country through the effective use of ICT (Reddy et al., 2020; Sharma et al., 2018; Reddy et al., 2016). If the individuals do not possess relevant skills, they will not be able to use ICT and in many cases the population from low income countries or developing countries face this situation due to the fact that the stakeholders do not provide development investments to conquer these issues (Delponte et al., 2015; Aleke et al., 2011). To add on to this, digital divide which exists in the developing countries is another internal factor that makes the acceptane of ICTs more difficult (Reddy & Sharma, 2016; Delponte et al., 2015).

Notwithstanding these challenges, the following are successful examples selected from developing countries:

1. *Africa* ICT is used to create trading networks that connect local crafts people directly with their customers (Ponelis & Holmner, 2015). The use of mobile payments and Internet banking (Mishra & Tiwary, 2011).
2. *Kenya*- the advancements in ICT has enabled the use of mobiles as a payment option through M-Pesa, mChek systems (Mishra & Tiwary, 2011).
3. *Nigeria*- the use of ICT by small scaled agribusiness (Akele et al., 2011).
4. *India*, the State Wide Area Networks (SWAN) project facilitates the electronic access of the state and district administration services to the citizens in villages such as the land records of the farmers (Mukherjee, 2011)
5. *Malaysia*, community kiosks in the rural areas have been established under programmes like the Rural Internet Centre (Internet Desa) and Community Communication Development Programme which help to connect rural communities to the K-community (Kakroo, 2007)
6. *Fiji, Vanuatu and the Solomon Islands*, the Asian Development Bank (ADB) financed a technical assistance project which assisted in addressing poverty and improving the quality of life in the Pacific through enhanced government decentralization, financial control, project control and monitoring, community engagement, disaster mitigation, and improved provision of health and education services (Asian Development Bank, 2019).

Many researchers have related ICT and its potential to development that is "ICT – the Enabler of Development" and the key attributes of ICT that have led to this include (Bull, 2015; Hameed, 2006):

1. **Knowledge Management:** ICT helps people to collect, manage, store, retrieve knowledge quickly, use it effectively and distribute knowledge to the right people rapidly and inexpensively.
2. **Efficiency:** ICT enables private and public enterprises of developing countries to operate more productively at a reduced cost. Also, it opens up more opportunities for Small and Medium Enterprises (SMEs) to exploit their strengths in the market.
3. **Network:** ICT provides the people to connect and gain effectively equivalent access to information, resources, distribution mechanisms, and potential customers as users and firms.

4. **Multipurpose:** Due to the rapid change and development in technology ICT products and services are equally effective when applied to developing countries' problems.

The innovations of ICT have brought about major revolution in the following areas:

1. **Health Care:** To deliver health care services especially to remote areas where the health services are scarce. Also, the advances in ICT in the last century has led to more accurately profile individual health risks, to better understand basic physiologic and pathologic processes, and to revolutionize diagnosis through new imaging and scanning technologies and smart health care services (McNamara, 2007; Panir, 2011).
2. **Education:** To enhance the teaching and learning pedagogies due to the vast amount of data available at a low cost. It has introduced anew method of learning that is eLearning and mLearning which has enabled distance education for students in remote areas, has developed student's and facilitators research skills (Sharma et al., 2019; Reddy et al., 2017; Sharma et al., 2015; Balanskat et al., 2006).
3. **Environmental Sustainability:** To tackle the everyday environmental issues such as the problems caused by climate change (Gonel & Akinci, 2018). The new ICT technology has introduced the concept of 'green ICT' or 'ICT for green' which aims to reduce CO_2 by 15% (Higon et al., 2017). The concept "ICT for green" has been defined as the use of techniques that aim to optimize environment governance in the interest of the natural environment and natural resources, that maintains sustainable environment (Andreopoulou, 2012), ICT techniques that are designed to reduce negative effects of human activity on the environment (Greenit, 2019; Kasemsap, 2018).
4. **Employment:** To create new jobs, change the structure of jobs and the career development processes. According to (Amiri & Woodside, 2017; Gatautis et al., 2015) ICT integrated employment brings out more efficiencies, increase in productivity, development of new good and services, introduction to new market opportunities, provides flexibility of labor market, establishment of new financial systems, reduction in poverty and overall development of the country.

Moreover, ICT has been denoted as a catalyst or the key driver for achieving Sustainable Development Goals (SDGs) (ITU, 2016; Atikson, 2017). The SDG's are a blueprint for addressing the global challenges like poverty, inequality, climate, environmental degradation, prosperity, peace and justice and achieving a better sustainable future (United Nations, 2018). According to (ITU, 2016) ICT accelerates human progress and develops knowledge societies. The aforementioned powerful attributes of ICT can be harnessed to accelerate the process of achieving all the 17 SDGs goals by 2030. Figure 1 depicts the SDG goals that will transform the world and enable in the achievement of a better and sustainable future. For the purpose of this study, a gear model which has been adopted from (Sharma, et al., 2018) has been proposed. Figure 1 shows the model which depicts the importance of ICT in order to achieve the SDG goals. The proliferation of ICT has brought in new tools and technologies; therefore to use these new tools and technologies, one needs to be digitally literate. Once individuals have the relevant skills, then they can successfully use these tools and technologies to achieve the SDG goals. The three-gear conceptual framework from Sharma et al. (2018) has been modified to establish the four-gear model illustrated in Figure 1. On a similar understanding as that of the three-gear framework it can be seen that digital literacy forms the nucleus of the overall machinery in addressing the SDGs through education and ICTs. Just as an increased number of rotations of the inner gears would increase the rotations of the outer gears, a wide proliferation of ICTs through mandatory education will ensure greater numbers of digitally literate individuals who would ensure successful attainment of the SDGs through an array of ICT leveraged means and ways.

Figure 1. The four-gear model connecting ICT to the Sustainable Development Goals
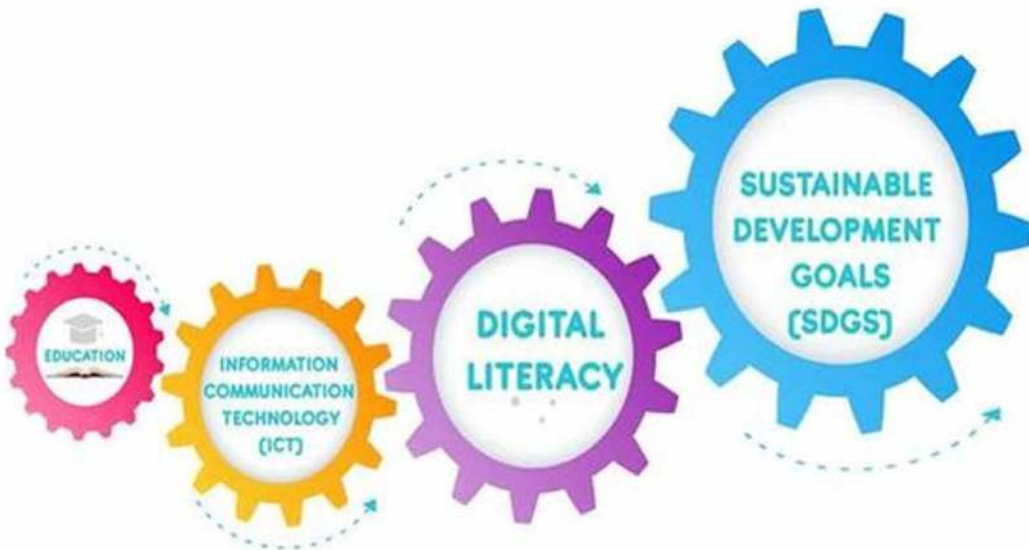
USAGE OF ICT

An amicable integration of ICT tools with progressive technologies has significantly contributed to innovations, inventions, interventions and improvements of people's daily lives. According to literature, the developing nations have been asked to leverage on ICT as a strategy to accelerate their economic growth and development (Niebel, 2018; Hinostroza, 2017). This paper will reflect the impact of ICT in the areas of health, governance, banking and industries and education.

Health

Over the years, ICT has made significant contributions in the health sector. According to the World Health Organisation (Farahat et al., 2018; WHO,2004), technologies have always been the backbone of the health sector that provided services to prevent, diagnose, treat illness and disease. However, according to (McNamara, 2007), poor health and inequity of access to essential health services particularly in rural areas have always been an issue in the developing countries (Ruxwana et al., 2010; McNamara, 2007; Pattichis et al., 2002). With the proliferation of new ICT technologies and its inclusion in the health sector has reformed the quality of health services provided whilst containing the costs (Arvnaitis &Loukis,2016; Zekmer et al., 2016). The potential usage of ICT in health sector are;

1. *Maintaining patient records*, tracking of disease prevalence, monitoring drug supplies, maintaining ordering system for supplies and billing procedures. For example in Africa- the South African Department of Health has developed a National Health Care Management Information System (NHC/MIS) to cover medical records, patient registration, billing and scheduling modules in selected hospitals in all the 9 provinces (Marutha & Ngoepe, 2017). In Bangladesh, a similar project with different scale was developed to register, schedule and track immunization of children (Bangladesh Development Research Center- BDRC, 2015). In Fiji, 36 out of 200 health centers use PATIS (Patient Information Systems) patient's medical history, prescriptions, history of previous visits and relevant information pertaining to the patients (Ravindra et al., 2015).

2. *Enhanced health care* service delivery through improving access to basic services, development of new technologies and products in health care, e-health and telemedicine (Ruxwana et al., 2010; McNamara, 2007). Telemedicine refers to the delivery of health care and the sharing of medical knowledge over a distance using telecommunication means (Pattichis et al., 2002). In the Republic of the Marshall Islands, the TAMC Telemedicine Program was originally developed to support the hospital services (Mukaida, 1996), In Fiji, the Telemedicine center in Nadi uses telecommunications and mobile technology to consult doctors in Australia, New Zealand, India and the US to provide health care support for the poor patients in its Western division (Matheswell, 2008) .

3. *Collection and management of health data* so that health outcomes in PIC's can be improved (Cullen, 2017; Cullen & Hasall, 2016), using ICT to enable health workers to address life-threatening birth 2017; complications in PNG through the Childbirth Emergency Phone Project (Watson et al., 2015).

4. *Other health services* that have improved due to ICT includes implementation of eMental Health for mood disorders, improving quality of life through early detection of chronic diseases, enable smart medical treatment which are based on cloud, use of blockchain technology to improve quality of service provided to patients and safety of patients (Cisotto & Pupolin,2018; Vis et al., 2018; Wong et al., 2018; Paul & Das, 2017).

Governance

ICT is playing a major role in interlinking the development interventions and outcomes of the government as well. The proliferation of ICT in the use of government development is now referred to as e-governance. E-Governance is regarded as the ICT enabled route to increase efficiency in government operations, strengthen democracy, enhance transparency and provide better service to the citizen Din et al., 2017. For example,

1. *Cambodia*, the villagers send emails regarding their problems to the governor through Wi-Fi access point as shown in Figure 2, which are mounted on motorbikes (Wescott, 2015).

2. *India*, the government has computerized 20 million records of land ownership of 6.7 million farmers, and makes them available at 168 kiosks throughout the state and in Bangladesh, an online system registers births and links to a database that can be shared with other public agencies (Wescott, 2015)

3. *Uganda*, the government has established over 20 eGovernment systems including the integration of national systems and databases, electronic single window, eProcurement, eVisa, standardisation of government websites (Ministry of ICT & National Guidance, 2018).

Recent studies have also shown that e-governance has improved citizen empowerment, accountability, and transparency and enhanced the productivity of the public sector (Niebel, 2018; Cullen, 2017; Sharma et al., 2014). However, according to (Rehman et al., 2012; Qaisar and Khan, 2010; Kayana et al., 2011), there are issues associated with e-governance like poor IT infrastructure, low rate of literacy which lead to slow development of eGovernment services and adaption, lack of trust by people on government and Internet facility, limited security and lack of IT policies.

Banking and Industries

In this 21ˢᵗ Century, the business environment has become very dynamic and competitive, therefore the use of ICT in business industries particularly in banking has changed the ways banks operate and maintain their relationship with customers (Vugec et al., 2017). ICT – being in the center of all organisations today acts as the business driver. According to (Ademola & kaka, 2011), ICT has affected all processes of banking, from the preparation of payroll and order entry to decision making

Figure 2. Image showing how Wi-Fi connects the villagers through motor bikes in Cambodia. Source: (Chyau & Raymond, 2005)
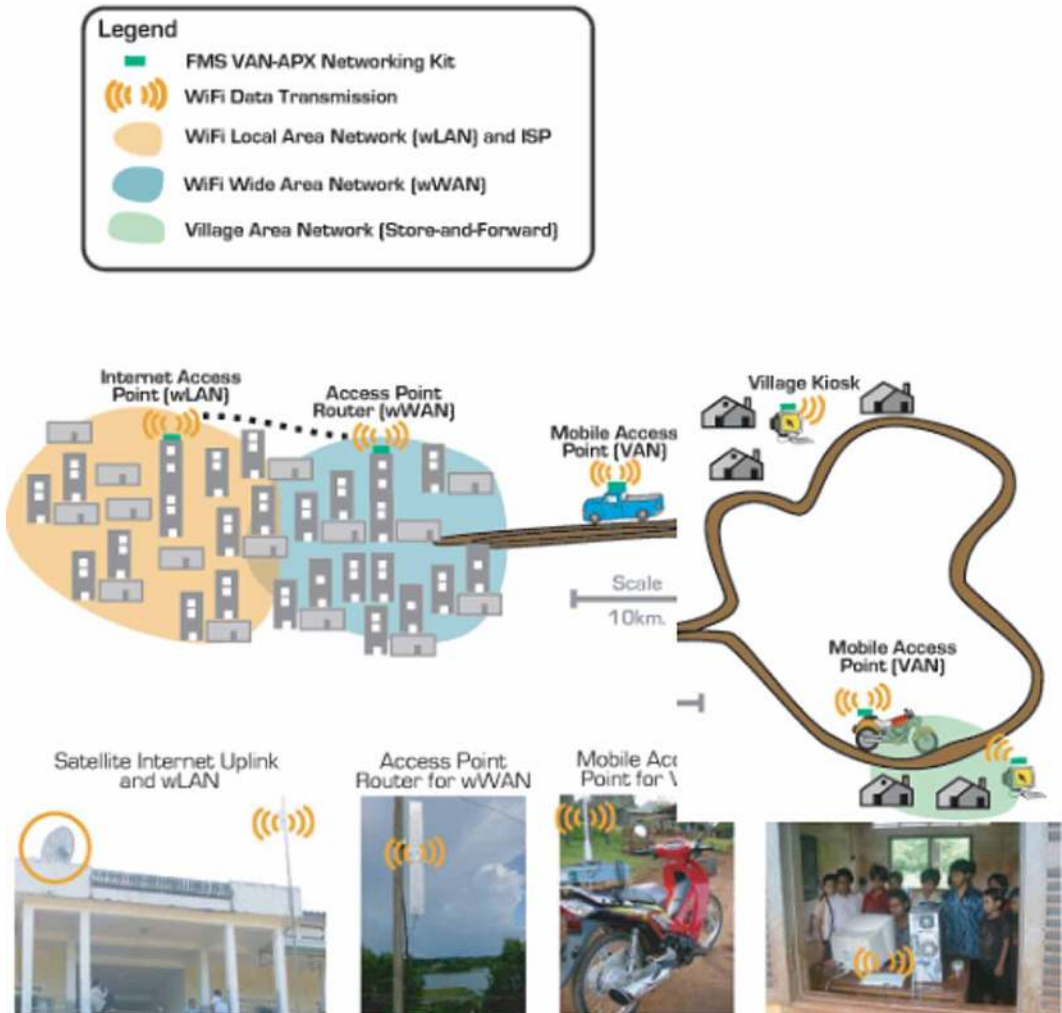
and strategic activities, from enhancing the speed and quality of service delivery to improving the competitive edge of banks in the markets.

In industries, ICT has been used to redesign manufacturing and supply chain processes and organizations in order to improve efficiency, quality, flexibility and environmental performance in a sustainable and resilient way (Aithal, 2016; Borena & Negash, 2016). Some new inventions include eManufacturing, eSupply chain, eProcurement and Smart Plants (Dipartimento di Ingegneria Gestionale, 2018; Vugec et al., 2017; Aithal, 2016).

Some of the ongoingg impacts of ICT on the industries in developing countries include;

1. Nigeria, the advancement in ICT has facilitated Internet banking, ATM Network and electronic transfer of funds (Luka & Frank, 2012)
2. Nepal, ICT has enabled banks to provide the latest banking services such as E-banking, SMS banking, m-banking and utility payments (Sapkota et al., 2018)
3. Thailand, ICT has been used to increase and improve employee productivity in firms (UNCTAD, 2008)

4. Zimbabwe, the e-Hurudza Programme (Electronic Farm Management Software Solution) provides agricultural information such as how to grow crops, planting methods and monitoring, that includes farm equipment, tools and inventory management system (Kundishora, 2016).

5. **Vanuatu:** the use of District Health Information System (DHIS) to improve communication in various health institutions. The mSupply application that monitors the distribution of medical supplies. The establishment of Financial ervices Bureau that enables timely flow of funds (PRIF, 2015).

6. **Vanuatu, Fiji, Samoa, Tonga and the Solomon Islands:** The use of mobile money service in for efficient and timely banking transactions (PRIF, 2015).

7. **Samoa:** the SchoolNet program which aims to incorporate eLearning in secondary schools (Sharma et al., 2018; PRIF,2015).

8. **Fiji:** introduction of e-services such as online birth certification registration and company registration to save time, etransportation service so that people don't have to carry money around, development of applications like MyKana to monitor people's health (The Fijian Government, 2019).

9. Fiji - eAgriculture initiatives such as (SMS mobile service, Apps like AgriTips, mPrices, m Collect, use of GIS technology, Agromet information and Online Assessment tools) which aims to educate the farmers for the enhancement of agriculture and the rural development (Gupta & Prakash, 2018). The Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) has introduced TraSeable Farms – which uses blockchain technology to solve the challenges faced in the fisheries and agriculture industry (CTA, 2019).

The application of ICTs has a fundamental importance in the commerce industry. However, lack of knowledge, literacy and inappropriate application of ICT tools and technologies can inhibit the full potential of ICT in their economic development (CTA, 2019; Gupta & Prakash, 2018; Sapkota et al., 2018).

Education

The use of ICTs in education or ICT enabled education has opened new opportunities to raise standards, widen participation in life-long learning and improve learning experiences (Sharma etal., 2018; Cullen, 2017; Alam, 2016; Sharma & Reddy, 2015; Shopova, 2012). The adoption of ICT in education also led to the paradigm shift from traditional instruction-based learning to virtual learning environments that changed the roles of both the facilitators and the learners (Sarkar, 2012). As King (1993) states, a facilitator's changed from *sage on the stage to guide on the guide* (King, 1993). According to (Sapkota et al., 2018; Englund et al., 2016; Fu, 2013) ICT has reformed and restructured the learning and teaching context to improve the quality of education in a number of ways such as augmenting students' efficacy to learn, providing essential tools and technology for accessing learning resources, enhancing professional development of teachers, improving efficiency of administration and accessibility of resources just-in-time, just-for-me and just-enough learning (Sharma et al., 2018; Kumar && Mohite, 2017;Reddy et al., 2016).

In education, ICT has proven to be a great support in the following ways as summarised in Table 2 from selected countries (Reddy et al., 2017; Bhattacharjee & Deb, 2016; Kaur, 2016; Juma et al., 2016; Oyedemi, 2015; Thakral, 2015; Gu et al., 2012; Unesco, 2011).

ICT has significantly impacted very facet of our living in both developed and developing countries, the education sector being the beneficiary of this technological permeation. ICT had the potential of promoting a revolutionary change in educational paradigm making learning more creative, experimental and interesting and mobilizing a societal change (Sharma et al., 2019; Reddy et al., 2017).

Table 2. Ways in which ICT has supported the main domains of education

Group	Impact	Example
Students	• assists the students in accessing digital information • fulfills the needs of learners by providing items and packages of higher standard and interest • supports self- paced learning • creates new and creative learning environments • promotes collaborative learning in distance-flexible learning • improves the quality of learning delivered to students	• Fiji, the adoption and adaptation of ICT tools and technologies has enabled the University of the South Pacific to deliver its distance-flexible learning programs to its enrolled students in the Pacific and abroad • India, The Symbiosis Centre for Distance Learning (SCDL) was set-up to provide distance education to over 13 campus students in central India.
Facilitators	• improves student attention that is through the use of ICT tools such as multi-media • makes learning more hands on and relate it to real world situations, improved facilitator- student communication • prepares teaching resources and delivery it to the students with minimal effort and time • provides constructive and timely feedback • accesses assessments of students in a more organised and critical manner • aids in routine administrative tasks • establishes a healthy and interactive relationship between teachers, schools, institutions, and universities • enables teachers to expertise rich resources in cyber space and improved the teaching skills as while preparation the facilitators also learn • ICT is also being used for Teacher development in many countries. This is to ensure that the facilitators are well trained and versed with the use of ICT tools and technologies so that they encourage their students to make use of technology effectively	• China and Sweden, the TETPD (Technology Enhanced Teacher Professional Development) project has been initiated to develop a strong technological infrastructure for teaching and learning
Administration	• assists in achieving the goals and the objectives of any educational institute • increases staff coordination, effective and quick decision making • developments of electronic applications for the management of administrative transactions and records • reductions in workload of staffs especially when analyzing student academic performance • manages student admission, student records and examination records • monitors and evaluation of staff curriculum and staff development • promotes financial management and the institute • enhances communication between stakeholders, students and the general public	• India, has computerised the registration of documents relating to immovable properties in transactions involving sale, mortgage, and lease. • use of MIS in many developed countries like UK, Canada, Australia and developing countries like Fiji, India and Malaysia. • use of ICT enabled systems at higher education institutes.

Emerging Tools and Concepts

The advancement of technology and the diffusion of Web 2.0 tools led to the maturity of learning at higher education in terms of increase in accessibility and availability of learning contents and resources, new formats of sharing knowledge and information and learning through multimedia which

created a more engaging learning environment. As such several concepts like internet-mediatedd communication, flexible and distance education, social learning, peer-to-peer learning emerged that were used to support the varied education-related purposes (Nashipudi, 2012; Veletsians, 2010; Anderson, 2007).The emergence of these new concepts provided new ways to carry out learning activities, new learning support services, and the possibility to use new types of contents (Atikson, 2017). According to literature, the emerging trends; Education 3.0, student/ skills 2.0, Web 3.0 and Web 4.0 tools and technologies and digital delivery have re-shaped the education sector. As technological advancements occur, the aforementioned technologies will continue to evolve in years to come, but for this study, we will elaborate on the evolution of Web technologies from Web 1.0 to Web 4.0.

Evolution of Web Tools and Technologies – Web 1.0 to Web 4.0

The birth of the Web technologies was with Web 1.0 starting as a read-only medium (Rajiv & Lal, 2011) which was a one-way process where students attended lectures and information was received in the form of printed handouts and textbooks or use of static pages, emails, websites and HTML pages (Aghaei et al., 2012; Lee et al., 2001). Web 1.0 was the first step to moving to digital content. The birth of Web 2.0 led to the motion of moving content online. The literature states that Web 2.0 led to the introduction of using social media for collaboration (kimbrell, 2013; Aghaei et al., 2012; Lee et al., 2001). Some examples of Web 2.0 tools are social media websites like Facebook, cloud computing, LMS, blogs, Really Simple Syndication (RSS), Wikis and Web mashups to list a few. According to (Nashipudi, 2012; Anderson, 2007) the key features of Web 2.0 include:

1. **Folksonomy:** Classifying digital content as a piece of information for example tagging of websites, images, videos or links.
2. **Rich User Experience:** More interactive, dynamic and pervasive applications which are responsive to user input, for example, a user can click on image or application to find more information.
3. **User Participation:** Information flowing in both ways that are from user to site owner or site owner to a user, for example, the user can evaluate, review and comment online.
4. **Software as a Service (SaaS):** Web 2.0 websites have APIs which allow automated usage such as creation of Wikis and mashup.
5. **Mass Participation:** Wider group of people participating using the web for different purposes.

The Web 2.0 also gave rise to the concept Student 2.0 which refers to 21st Century learners who were compilations, amalgams and a concatenation of web sites and spoke with texted and tweeted characters (AdvanceHE, 2018; Stommel, 2016).

Web 3.0, the third generation of the web, was released in 2006 (Nova, 2011). The purpose of Web 3.0 was to define structure data and link them to have effective discovery, automation and integration. In addition to this the Web 3.0 improved data management and accessibility, enhanced customer satisfaction and collaboration on social web and enabled reusing of applications through the use of artificial intelligence (Aghaei et al., 2012; Rajiv & Lal, 2011). The key features of the Web 3.0 are summarised by Rajiv and Lal (2011) as:

1. **Intelligence:** Applications work intelligently with the use of human-computer interaction.
2. **Personalisation:** Personal or individual preferences is considered during different activities such as information processing, search, the formation of personalised portal on the web.
3. **Interoperability:** Reuse, communication medium for knowledge and information exchange.
4. **Visualisation:** With the use of high-speed Internet bandwidths, high-end 3D graphics are created.

The trends associated with the Web 3.0 such as Semantic Web, the 3D Web, Social Web, Media Centric Web, Pervasive and Ubiquitous Web offer services that enhance and create effective learning environments (Aghaei et al., 2012; Nashipudi, 2012; Rajiv & Lal, 2011). Web 4.0, the fourth generation web is about creating symbiotic relationships between human and machines. According to (Solanki & Dongaonkar, 2016) Web 4.0 will have all data and operating system in the cloud and will connect all devices in real and virtual world in real-time. This is why Web 4.0 is also known as the Internet of Things (IoT). It is also stated that Web 4.0 will begin the new era of human social engagement.

Evolution of Web Tools and Technologies – Education 1.0 to Education 3.0

The evolution of the web from Web 1.0 to Web 3.0 has led to the evolution of education from Education 1.0 to Education 3.0. This was from learning through behaviorism- students taking notes and classrooms being teacher-oriented (Education 1.0) to learning through constructivism - interacting with the web content through communicating, contribution and collaboration via social networks, blogs, podcasts and related participation technologies (Education 2.0) to self-paced, self- determined, internet-based learning which is based on problem-solving, innovation and creativity (Education 3.0) (Gerstein, 2014). According to (Salmon, 2016; Gerstein, 2014) the shift in the education paradigm brought new tools and technologies for learning as well such as LMS, MOOCs which raised the potential of digital learning, the concept of flipped classrooms, ubiquitous learning and mobile learning. All these innovations enhanced learning and contributed to lifelong learning. Education 3.0 enabled self-directed learning, interest based learning where problem-solving, innovation and creativity are the drivers of education (techthought, 2018). Hence, concepts like SMART Education were developed to facilitate this impending 21st century learning. The concept of SMART Education aims to deliver Self-directed, Motivated, Adaptive, Resource-enriched, and Technology-embedded learning (Unesco, 2011).

Digital Delivery

The 21st Century learners no longer rely on textbooks as their source of learning, in fact leaners are sourcing to online to find reliable content such as Khan Academy, YouTube, TeacherTube's collection of content, TED Talks and other Open Educational Resources (OERs) website. According to (Lee, 2018) digital delivery involves staying connected to ubiquitous mobile devices, using social platforms as primary means of communication, using cloud computing which allows creation of new learning tools. A report by the 'Digital Education Advisory Group (2012) states that the 21st Century technologies can be used to support learning strategies and achieve high quality student outcomes. This was supported by Henderson et al., (2017) and Englund et al., (2016) who also stated that digital delivery supported students learning styles, gave timely access to resources, enhanced their learning through IoTs and Artificial Intelligence (AI) and enhanced real-time collaborations with their peers and facilitators. Table 3 summarises ways in which digital tools have improved student learning.

Since, the concept of digital delivery had apparent benefits, and the demand from the learners for a life- long and life-wide learning for this century was at its peak, the higher education institutes adopted and incorporated the digital tools in its teaching and learning processes. The learners needed to have the required skills, ability and knowledge to use these tools effectively for their learning processes (Nand & Bibhya, 2019;Gonel & Akinci, 2018; Oyedemi, 2015; Fu, 2013). They needed to be aware of the issues surrounding the use of digital technology and be more responsible towards using these tools. According to Dios et al. (2016) security skills or the ability to use digital technologies without risk and dangers need to be emphasized, meaning they need to be aware of the ethics surrounding the use of information. As digital netizens, one must know how to access information and know how to manage one's identity and privacy online. The authors, Kwon and Ahn (2017) add that most ethical considerations while using digital platforms and digital technologies are confined to personal information and copyright, however, more emphasis must be given towards ethical education to the digital netizens so that information retrieval and exchange occurs safely. The aforementioned ability

Table 3. Digital tools that support Learning strategies and Learning Outcomes. Adopted from (Digital Education Advisory Group, 2012).

Digital Tools	Learning Strategies	Learning Outcomes
OERs, Data capture technology, simulations	Cognitive theory activities	Solving problems which enables creation of new knowledge
Semantic Web	Problem solving activities	Finding new information through problem solving
Mobile devices, virtual tools, augmented reality tools, IoT	Scaffolded group activities, role plays and simulations	High level collaborative skills for knowledge building, experience and expertise.
Web Authoring tools, virtual learning environment tools	Meaningful and authentic activities	Cognitive skill of understanding
AR, VR, IoT, automation	Inquiry- Based learning Design thinking	Development of generic problem solving skills and strategies that can be applied in different contexts.
AR, VR, IoT, automation, Gamification, semantic web, AI	Self-directed Learning	Development of metacognitive skills.

is collectively termed as technoethics- understanding the moral and ethical aspects of a technological society, in this case, the digital society (Amrute, 2019; Luppicini, 2017).

The emphasis on this new emerging concept of technoethics needed focus as advances in ICT changed the pace and way information was transmitted and shared with the individuals of the digital society (Perdana et al., 2016). Although there were apparent benefits in the way information was being disseminated to people that is information about employees, companies production, number of social media users, business data or company assets, the issue of ethics still persists (Dios et al., 2016). The issue was also evident in the education sector, as the students are consistently using the web in their learning processes. Since, technology is being integrated as part of the education curriculum, and the students are using the digital platforms for their learning purposes (using various search engines, discussion forums, online blogs, and inclusion of social media in education platform), they need to be made aware about the ethics surroung the use of technology. The lack of knowledge on technoethics may lead the students to misuse technology and can be involved in or suffer from cyberbullying, depression, suicidal ideation, anxiety and exposure to explicit online materials (Luppicini, 2017; Dios et al., 2017, Perdana, 2016). The authors (Dios et al., 2017; Perdana et al., 2016) state that ethics and security is an essential component of digital literacy.

The above reinforced the need for digital literacy as it as a whole utilises technology as a tool and teaches one how to survive in this digital world (Hinostroza, 2017; Witt & Gloerfeld, 2017; Kastis & Carnero, 2009). Today, the concept of digital literacy has become utmost important for everyone around the globe.

INFLUENCE OF ICT IN HIGHER EDUCATION

Learning in higher education got more formalised with colonization, American Revolution and mass higher education era (Altbach et al., 2009). The advent of new ICT tools and technologies and their assimilation into the education system have now fostered many significant changes. As a consequence, there was a transformation of how learning and teaching took place, for example, new interactive and engaging learning environments evolved such as flexible learning and distance learning. The evolution of flexible learning and modes that are possible through the developments in ICT is reflected in Figure 3. In addition to these, quality content delivery, better access to educational

Figure 3. Conceptual framework of flexible learning
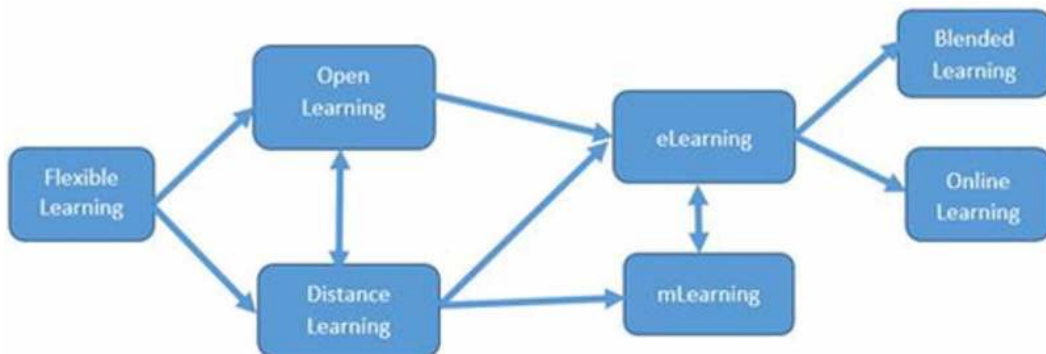
content, new assessment methods have evolved (Raturi, 2018;Sharma & Reddy, 2015; Buckingham, 2007; Majumdar, 2006; Mioduser et al., 2003).

Additionally, with the integration of the new ICT tools many universities around the globe have successfully brought positive changes in the organisation of classrooms becoming the new force and to some extent the prime assets which had enabled the higher education institutes to achieve their goals (Sharma & Reddy, 2015). However, higher education institutes faced many challenges such as increase in student enrollments, issues with traditional methods of facilitation particularly for the distance or flexible learners, lack of student motivation, student readiness and perception about mLearning, and student insecurities about learning (Sharma et al., 2018; Keegan, 2013; Rosenblit, 2011). The above mentioned issues were evident as there were a slow transition and adoption of ICT enabled learning from the traditional learning due to lack of trained facilitators, socio- economic factors, unfavorable organizational culture and poor attitude, lack of funding and lack of literacy and competency (Sharma et al., 2019; Arsharskiy, 2017; Budhedeo, 2016).

ICT and New Learning Environments

To address the aforementioned challenges, ICT was integrated into higher education learning to achieve a sustainable and lifelong learning eduscape hence transforming the traditional flexible and distance learning to real-time web facilitation. There has been a number of interventions such as smart and flipped classrooms, learning with mobile devices such as tablet learning and smartphones where students are taught using educational videos and audios, e-lectures and online classes (Reddy et al., 2020; Sharma et al., 2019; Sharma et al., 2019; Raturi, 2018; Kanvaria & Bisht, 2016).

According to (Sharma & Reddy, 2015; Wade et al., 2013; Shakeb, 2011; Altbach et al., 2009), the following methods of learning evolved under flexible and distance learning: eLearning, web-basedd education, Internet-mediatedd learning, telematics environment, digital education, advanced distributed learning off-site learning, mobile learning, open learning and so on. These new learning methods were adopted by many higher education providers to make teaching and learning more accessible for their students. Figure 3 describes the relationship between each learning method evolved. According to literature, flexible learning made open and distance learning possible and many researchers have integrated the three under flexible and open distance learning. Figure 3 shows that the modes of eLearning and mLearning came when mobile devices were integrated into the learning and teaching practices, and eventually eLearning gave rise to blended and online learning.

The concept of eLearning emerged as the most promising and distinct way of learning in flexible learning which promoted student-centredlearning and improved learning experiences (Reddy et al., 2017; Wade et al., 2013; Shopova, 2012). ELearning allowed instructional content to be updated

easily through the use of videos, audios, online quizzes, online discussion forums and web 2.0 tools (Sharma et al., 2019; Reddy et al., 2017). As the use of eLearning proliferated, it was realized that the traditional eLearning method faced challenges such as; it was long, dull and boring, the content was long and tedious hence disengaged learners, learners were isolated, lacked interaction and failed to engage (Growth Engineering, 2018; Elias et al., 2010). With the incoming of new ICT innovations, and the demand from the Net Generation learners the concept of eLearning was redefined and this method initiated newer learning methods that has been implemented or can be implemented for life-long learning in years to come. This includes (Arshavskiy, 2017; Reyna, 2012):

1. **Microlearning:** Learning content to be in short bursts and bit-sized.
2. **Social Learning:** Learning through social networking tools and approaches, using podcasts and RSS feeds.
3. **Adaptive Learning:** Using content that can be modified as per student's response and interactions.
4. **Virtual Reality (VR) and Augmented Reality (AR):** Using VR and AR environments to make the learning content more engaging.
5. **Cloud- Based LMS:** using cloud based LMS so that learners have access to the content anytime from anywhere using any device.

The penetration of the Internet, the use of Web tools and the rapid growth of ICT devices gave rise to more innovative methods of teaching and learning. The popularity of the use of mobile devices also increased and many students were seen to be using this in university campuses and beyond for formal and informal learning. According to Witt & Gloerfeld (2017), the ownership, affordance and usage of mobile devices have exploded and with mobile Internet as an add-on has further raised the potential of mobile devices for learning at higher education institutes. Mobile devices such as netbooks, tablets and smartphones have now become the new learning and personal communication and collaboration tool in education. This new medium allows learners to learn beyond the classroom and homes that is from remote places, having access from anywhere and at any time Krull & Duart, 2017; Klimova & Poulova, 2016). This new paradigm has been termed as mobile learning or mLearning and due to the fact that mobile learning is flexible, it is commonly used to facilitate distance learning, as shown in Figure 3.

Technology integrated learning brought in new modes of learning such as blended learning and online learning which allowed greater learner interactivity and efficiency, motivation, and cognitive effectiveness, combined collaborative learning with web-based technology to enhance student learning (Li et al., 2017; Kirkwood & Price, 2014).

ICT and Student Learning

Just as ICT technology is influencing and supporting various mediums of learning methods, it is also supporting varied learning styles of students. From the behaviorist theory (McLeod, 2017) in the early days of learning to cognitive theory of learning from 1909 – 1913 (Bredo, 1994) and the evolution of these two learning theories to constructivism was only possible due to the introduction of new ICT tools and digital media (Mechlova & Malčík, 2012) . According to Reddy & Sharma (2015); Buckingham (2007); Majumdar (2006) digital media allowed ubiquitous access to learning resources which enabled self-paced and self-directed learning for students. Learning became more inquiry and experimental based, which developed student's creative thinking skills. ICT combined with the new learning modes provided a number of benefits to the learners including improved completion and student retention rates, fostered deeper learning and understanding of high order thinking processes, improved student interaction in online discussion forums and activities and provided greater flexibility for students to get access to learning resources (Li et al., 2017; Kirkwood & Price, 2014). In 2002, Oliver elaborated on the impact of ICT on student learning in the following ways;

1. What is learnt, that is access to a number of resources in different forms and types, learning environments tailored to inquiry-based learning, teachers to be guides on the side instead of being content experts
2. How students learn, that is students to take responsibility for their learning, learning that is conducted to be based on the constructivism theory where students learn by doing experiments and solving problems rather than memorizing
3. When and where students learn, that is using ICT tools and technologies to provide flexible delivery through flexible and distance learning and getting access to the learning materials as well.

According to (Bhatt, 2015), each student has different learning style and it is important that learning for each student is fostered in a way that they are able to receive and process accordingly. Therefore, learning through ICT provides facilitators with versatile instruments that can be used to foster learning and meet each students learning style. Majumdar (2006) adds that the interactive multimedia based instructional materials gives learners the control to review the learning content at their own pace and according to their own interest, needs and cognitive processes. The learners always prefer learning that is flexible, that is in accordance with their pace and space and the content is favorable to them. Therefore, ICT tools are now being used to fulfil the needs of these 'Net Generation' users.

Although there are underlying issues such as cost of education and cost of ICT technologies, lack of support from administrators and stakeholders, the higher education institutes (HEI) continue to adopt these technologies to improve their teaching-learning processes to prepare their students for the job markets and support future educational developments.

ICT and Changing Role of Facilitators

The transition from traditional learning to ICT leveraged learning has not only changed the way students learn but has also changed the role of facilitators. With the new learning paradigm of constructivism, it has become important for facilitators to nurture their teaching strategies in a way that their learners are actively engaged (Alam, 2016). The learning environment must support multiple perspectives of reality, knowledge construction and lifelong learning. For this, Ilomaki (2008) states that *'teacher technology'* skills are important whereby a facilitator should be able to use the necessary digital skills to scaffold their learners to open learning environments. The teacher's role as described by Ilomaki (2008) is from the creator or advisor of knowledge to a learning coach.

ICT technology has enabled the facilitators to deliver quality learning materials to their learners, improved their productivity as technology skills are upgraded as part of their professional development, develop new learning environments, improve the communication between them and the learners, and enable them to manage the student administration (Alam, 2016; Kaur, 2016; Thakral, 2016; Ilomaki, 2008). Figure 4 shows how ICT tools have positively impacted facilitators' role at higher education by performing various tasks in everyday academic life. As per Figure 4, the use of ICT has enabled data to be produced in various formats, enhanced collaboration between the students and the facilitators, enhanced the learning environments and innovated tools that could be used by students for their learning processes (Ilomaki, 2008). Broadly, the ICT tools have opened by opportunities for learning by transforming the learning and teaching processes. As such ICT has enabled the facilitators to deliver 'just-in-time' learning, provide better learning materials by manipulating existing information, integrate new pedagogical strategies and deal with the different learning styles of students.

Figure 4. Impact of ICT on learning process. Model is adapted from theories explained by Ilomaki (2008)
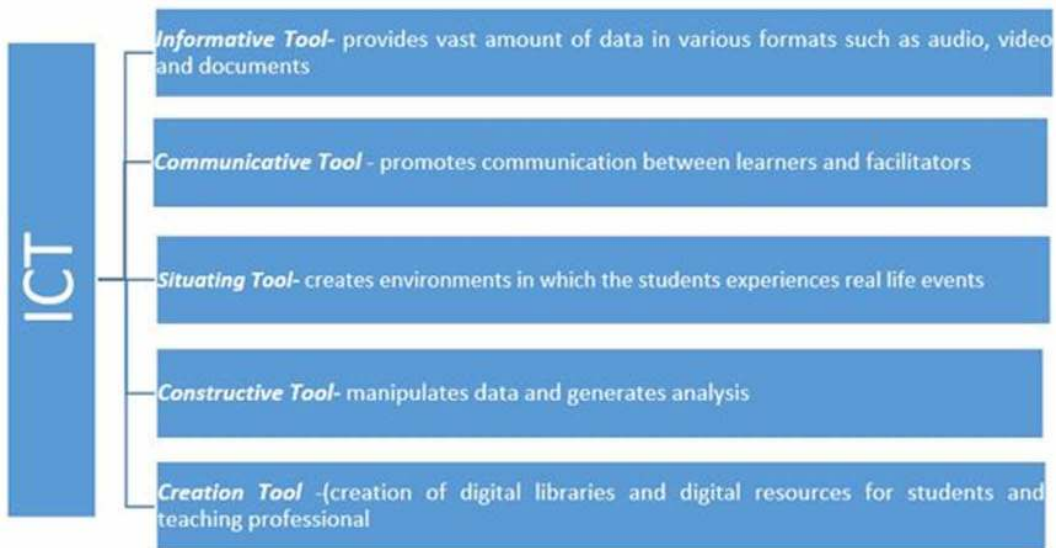
DIGITAL LITERACY

The term literacy can be defined as the mastery of simple and practical skills which bring a profound enrichment and transformation of human thinking capabilities (Belshaw, 2012). In the 21st Century, with the advent of new technologies and the Web tools the demand for learning by individuals, society and education authorities has become extremely complex due to the fact that new technological skills and knowledge are required in technology-oriented workplaces. New literacies have evolved or have been re-defined for a life- long learning perspective (Kastis & Carneiro, 2009). Technological innovations have transformed how learning is taking place and digital literacy has become one of the main competences in this era (Cisotto & Pupolin, Evolution of ICT for the improvement of quality of life, 2018).

The concept of digital literacy is dated back to 1960, and it has evolved with time due to the fact that the change in technology affected how the term was defined (Kastis & Carneiro, 2009). In the early days, literacy meant visually seeing, interpreting and communicating this information with others; therefore John Debes defined the concept as 'visual literacy' (Lankshear & Knobel, 2008). Considine (1986) defines visual literacy as the ability to comprehend (able to produce and interpret visual messages) and create images in a variety of media in order to communicate effectively. On the contrary, (Cassidy & Knowlton, 1983) and (Suhor & Little, 1988) argued that the term did not have enough explanatory power and was absurd hence from the 1970s, parallel to 'visual literacy', the term 'technological literacy' came into the picture. Technological literacy incorporated all the changes that were brought about by the technological innovations in the environment, therefore Martin (2006) defined 'technological literacy' as the ability to use the new technologies which were efficient and appropriate to produce information with new insights. In the 1980s, the term technological literacy was still popular with the growing use of computer-based and media technologies by young people. According to Gurak (2001), literacy meant the ability to perform something and the definition of 'technological literacy' was limited to knowing how to use a particular piece of technology. He argued that the element of 'literacy' and the ability to make meta-level decision judgements about

technology usage entirely absent from the definition of 1970s- 1980s. Eyman (2007) also argued that 'technological literacy' was a broad term and there was no functional distinction between print-based literacy (reading, writing and communication information through print mediums such as magazines, newspapers, etc.) and digital literacy.

With the development of Apple II in 1977, followed by IBM's first 'Personal Computer' (PC) in 1981, Graphical User Interfaces (GUIs) in the early 1980s and onwards, Apple's 'Finder' in 1984 followed by Microsoft's 'Windows' in 1985, there was a need to define the new competencies and literacies that came with these new innovations . Hunter (1984) and Scher (1984) defined 'computer literacy' as having the ability to understand the characteristics, capabilities and applications of a computer and implementing this knowledge to the productive use of computer applications. Till the late 1990s, the term 'computer literacy' continued to be used without any issues. It was in the late 1990s, when 'computer literacy' competencies were being measured due to the growing use of computers in education, work and leisure and it was during this time when 'new literacies' occurred . The term 'computer literacy' began to lose its credibility. According to, 'computer literacy' was about how to us the computer to access knowledge and media rather than using a computer to create knowledge and media. In addition, the encoding element of literacy was being lost therefore a new term 'ICT literacy' was introduced.

The conceptual definition of 'ICT literacy' is the use of digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge-basedd society (Lankshear & Knobel, 2008). Cook and Smith (2004) state that 'ICT literacy' is the use of ICT applications such as spreadsheets, word processors etc, engaging with online communities and in eLearning. The definition of 'ICT literacy' was more of conceptual rather than procedural and the term 'literacy' was seen to be reliant upon specific tools rather than involving a meta-level definition (Lankshear & knobel, 2008; Oliver &Towers, 2000). There have been varied definitions of 'ICT literacy' as it meant differently to different groups, for example, The European Commission, defines 'ICT literacy' as 'learning to operate technology' without it including any 'higher-order skills' (Coutinho, 2007). Town (2003) argues that the term 'ICT literacy' has implied the inclusion of information literacy and computer literacy, not realising that IT is a synonym for 'computer literacy' and 'information literacy' is a broad term on its own.

To embrace the growing use of digital technology, a much broader term was needed to define this usage. With the growth in Web technologies and access to digital technology and Internet, digital media was becoming the central aspect of the 'Net Generation' hence the most relevant term to describe this technological evolution was 'digital literacy'. Glister first used the term in 1997 who defined 'digital literacy' as the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers (Glister, 1997). Martin (2008) defines 'digital literacy' as a literacy which involves acquiring and using knowledge, techniques, attitudes and personal qualities and will include the ability to plan, execute and evaluate real-life situations. However, Martin's definition lacked the importance of creative activities in digital literacy (Lankshear & Knobel, 2008). The definition of digital literacy – "the ability to understand the communication media used in their society and the way they operate and to acquire skills in using these media to communicate with others" also lacked the creative element of digital literacy (Lankshear & Knobel, 2008). The European Commission defined digital literacy as the ability to use ICT and the Internet for creativity, innovation and entrepreneurship and acquiring the skills and knowledge necessary to live in the 21st Century (Martin & Grudziecki, 2015). In 2006, Martin and Grudziecki developed three levels of digital competence shown in Figure 5.

According to (Martin & Grudziecki, 2006), all the levels are linked to each other that is ; if we look at the model, at the foundation is digital competence which include the skills, knowledge, attitude and awareness about digital technology. Then at level 2 is digital usage which is dependent on the digital competence or digital literacy of individuals. This includes using the digital skills to use appropriate digital tools to find and process information and seek a solution to a problem. At the

Figure 5. Levels of digital literacy by Martin and Grudziecki, 2006
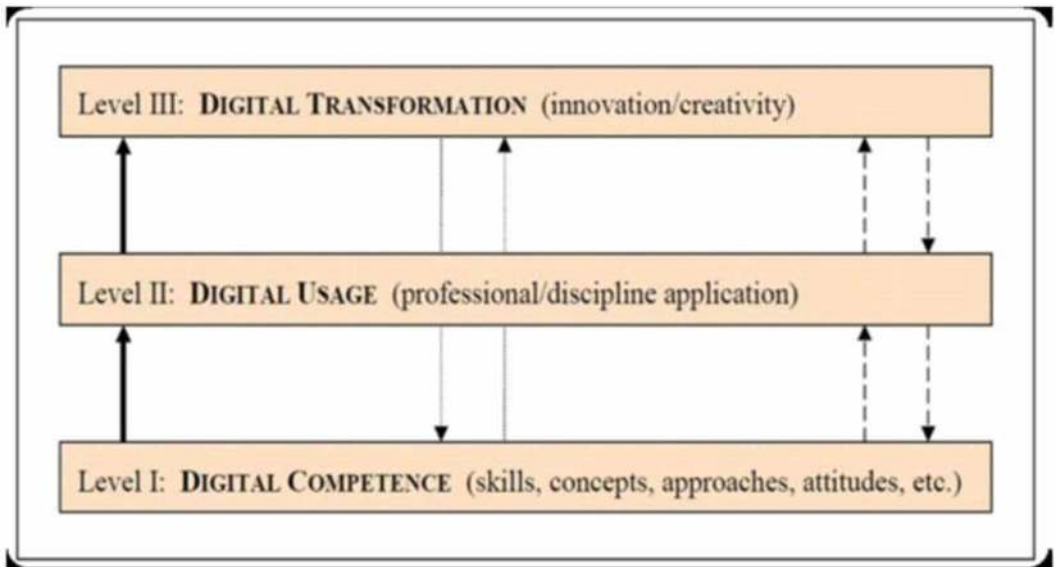
very top level is the digital transformation which is achieved through digital usage. The individuals make use of the digital tools to create new knowledge, activity or innovation. This model fulfilled the requirements of digital literacy.

Tabusum et al. (2014) defined digital literacy as the ability to locate, organize, understand, evaluate, and analyze information using digital technology. He states that it is not just being computer literate but using digital technologies to communicate information using digital platforms.

Walton (2016) in his article titled "Digital Literacy: Establishing the Boundaries and Identifying the Partners" has coined the definition of digital literacy as: the ability to find, evaluate, utilize, share, and create content using information technologies and the Internet. It is the confident and critical use of information and digital technologies to enhance academic, personal, and professional development. It is the ability to use digital technology, communication tools or networks to locate, evaluate, use and create information, understand it and use information in multiple formats from a wide range of sources via computers and perform tasks effectively in a digital environment.

The definition of digital literacy changes as per different authors due to the fact that new technologies and innovations change the way people utilise technologies and perform tasks. Also, each author or organization has agreed that the concept of 'digital literacy' is a multidimensional concept entailing a complex integration of technical skills, cognitive skills and meta-cognitive processes as well as civic engagement and ethical awareness (Rosenblit, 2011; Martin & Grudziecki, 2011). *For this study, the term digital literacy is defined as an individual's ability to find and evaluate information, use this information effectively, create new content using this information and share and communicate this newly created information using appropriate digital technologies. A digitally literate person should have the following abilities:*

1. *Possesses* comprehensive knowledge of ICT technologies and emerging ICT technology and their efficient and effective usage
2. *Possesses* a variety of skills (technical and cognitive) to disseminate, locate digital information using well-designed search strategies and critically evaluate it and judge the quality

3. *Understands* the relationship between technology and life- long journey, personal privacy, interact appropriately with other people via digital technologies (communicate and collaborate with peers, colleagues, family and on occasion general public)
4. *Participates* in civic society and contribute to a vibrant and informed society and has the self-motivation to seek, share information, learn new skills, evolve and transform lives
5. *Considers* the impact and longevity of digital information that they are considering to public and protect others.

According to (Covello, 2010) digital literacy is an umbrella for a number of complex and integrated sub-disciplines or "literacy's" such as 'Information Literacy', ' Computer Literacy', 'Media Literacy', 'Communication Literacy', 'Visual Literacy' and 'Technological Literacy'. Covello's work was used as a guideline for this study as his study had a similar setting to this study. The background for his research was an educational setting and educational testing service (ETS) was designed to measure digital literacy skills of the students'. However, this ETS was used to design various assessments which only focused on measuring the ICT skills of the students and did not consider other components of digital literacy. In this information age as new digital tools and technologies have evolved, Covello's definition of the six components lacked the necessary skills needed for an individual living in this age. For the purpose of this study, his guideline of the six components of digital literacy has been redefined to include the necessary digital skills needed by an individual for this age. Also, these six components have been used to design a digital literacy scale that will measure students' digital literacy skills. The items of each of the six components have also been identified for this study and as this was missing in the study done by Covello.

The definitions of the aforementioned literacy's have undergone transformation or expansion as innovation and research has redefined them. For this research, these six literacy disciplines are adopted and redefined as such:

1. **Information Literacy:** Using digital technology to find, locate, analyse and synthesise resources, evaluating the credibility of these resources appropriate citation techniques, abiding the legal and ethical issues surrounding the use of these resources and formulating research questions in an accurate, effective and efficient manner.
2. **Computer Literacy:** An understanding of how to use computers, digital technologies and their applications for practical use.
3. **Media Literacy:** Having the ability to use digital technologies to access, analyse, evaluate and communicate information in a variety of digital platforms.
4. **Communication Literacy:** Using digital technologies to communicate effectively as individuals and work collaboratively in groups, using publishing technologies, the Internet and Web 2.0 tools and technologies.
5. **Visual Literacy:** Having the ability to use digital technology to 'read,' interpret, and understand information presented in pictorial or graphic images communicate this information and convert the information into visual representations.
6. **Technological Literacy:** Having the ability to use digital technology to improve learning, productivity and performance.

CONCLUSION

In this growing age of technology, a number of new technological devices and tools have been designed and their benefits are easily apparent to all irrespective irrespective of geological isolation, and the demographic, social, and economic diversities... This paper attempts to discuss the importance, usage and benefits of ICT in the developing countries as the developed countries have already adopted

and embraced ICT in the various facets. The paper also reflects on the emerging tools and concepts that came about with the proliferation of ICT and then discusses the trending impact of ICT in the education sector.

The paper identifies many positive impacts of ICT in the field of education and how it has assisted and improved the facilitation and delivery of content in HEI. Together with this, ICT has brought changes in the pedagogical practices as new learning environments such as cohort-based, blended and online learning were created. As such, the role of the facilitators changed due to the new pedagogical strategies and learning became more enquiry based.

Since, the paper reflects on so many benefits of ICT, we also realised that in order to reap the full potential and benefits of ICT in the developing countries, the individuals need to attain proper skills so that they can actively participate in using the new technologies that evolve with time. This can be achieved through digital literacy- one of the major concepts discussed in this paper. As the individual's skills are developed, the individuals will encompass a greater knowledge on using these technologies and hence contribute to national building and achievement of the SDG goals as shown in Figure 1. The aforementioned theory gave arise to the four gear model for this paper which shows that digital literacy plays a pivotal role to drive the use of ICTs to attain sustainable development goals.

This study has finally redefined digital literacy and the six components of digital literacy that we have adopted from Covello (2010). The paper recommends that the components of digital literacy that has been identified and redefined in this paper can be used to develop a digital literacy scale to measure the digital competencies of individuals. This is needed so that individual competencies can be known and proper interventions can be developed to improve the digital literacy of individuals.

REFERENCES

Ademola, A., & Kaka, E. (2011). Information and Communication Technology (ICT) and Banking Industry. *Proceedings of the 1st International Technology, Education and Environment Conference*.

AdvanceH. E. (2018). *Student 2.0*. Retrieved from https://www.heacademy.ac.uk: https://www.heacademy.ac.uk/knowledge-hub/student-20

Aghaei, S., Nematbakhsh, M., & Farsani, H. (2012). Evolution of the world wide web: From Web 1.0 to Web 4.0. *International Journal of Web & Semantic Technology*, 1-10.

Aithal, P. (2016). A Comparison of Ideal Banking Model with Mobile Banking System. *International Journal of Current Research and Modern Education*, 206-224.

Alam, M. (2016). Use of ICT in Higher Education. *International Journal of Indian Psychology*, 163–171.

Aleke, B., Ojiako, U., & Wainwright, D. (2011). ICT adoption in developing countries: Perspectives from small-scale agribusinesses. *Journal of Enterprise Information Management*, *24*(1), 68–84. doi:10.1108/17410391111097438

Altbach, P., Reisberg, L., & Rumbley, L. (2009). Trends in Global Higher Education:Tracking an Academic Revolution. *UNESCO 2009 World Conference on Higher Education.*

Amiri, S., & Woodside, J. (2017). Emerging markets: The impact of ICT on the economy and society. *DIGITAL POLICY. Regulation & Governance*, *19*(5), 383–396. doi:10.1108/DPRG-04-2017-0013

Amrute, S. (2019). Of Techno-Ethics and Techno-Affects. *Sage Journals*, 56-73.

Anderson, P. (2007). *What is Web 2.0? Ideas, technologies and implications for education.* Retrieved from www.ictliteracy.info: http://www.ictliteracy.info/rf.pdf/Web2.0_research.pdf

Andersson, A., & Hatakka, M. (2013). What are we doing? Theories used in ICT4D research. In *12th International Conference on social implications of computers in developing countries* (pp. 228-300). Mona-University of the West Indies.

Andreopoulou, Z. (2012). Green Informatics: ICT for Green and Sustainability. *Agrárinformatika Folyóirat*, 1–8.

Arshavskiy, M. (2017). eLearning Evolution - The 3 Biggest *Years and How to Adapt to Them for Success*. Retrieved from https://www.shiftelearning.com: https://www.shiftelearning.com/elearning-evolution-the-biggest-changes

Arvanitis, S., & Loukis, E. (2016). Investigating the effects of ICT on innovation and performance of European hospitals: An exploratory study. *The European Journal of Health Economics*, *17*(4), 403–418. doi:10.1007/s10198-015-0686-9 PMID:25822165

Arvantis, S., & Loukis, E. (2016). Investigating the effects of ICT on innovation and performance of European hospitals: an exploratory study. *The European Journal of Health Economis*, 403-418.

Asian Development Bank. (2003). *Information and Communication Technology for Development in the Pacific*.

Asian Development Bank. (2019). *ADB Expands Financial, Technical, Staff Support to the Pacific*. Retrieved from https://reliefweb.int: https://reliefweb.int/report/world/adb-expands-financial-technical-staff-support-pacific

Atikson, S. (2017, October 12). *ICT as driver for achieving the Sustainable Development Goals*. Retrieved from https://www.ca.com: https://www.ca.com/en/blog-highlight/ict-as-driver-for-achieving-the-sustainable-development-goals.html

Balanskat, A., Blamire, R., & Kefala, S. (2006). *The ICT Impact Report- A review of studies of ICT impact on schools in Europe.* European Communities. Retrieved from http://unpan1.un.org: http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan037334.pdf

Bangladesh Development Research Center- BDRC. (2015). *Impact of ICT on Health Services in Bangladesh.* Retrieved from http://www.bangladeshstudies.org: http://www.bangladeshstudies.org/files/WPS_no26.pdf

BelshawD. (2012). http://neverendingthesis.com/doug-belshaw-edd-thesis-final.pdf

Bhatt, M. (2015). Learning by ICT in Association to their Learning Styles: An Attitudinal Study of High School Students. *International Education Conference on Learning Technologies in Education*, 343-353.

Bhattacharjee, B., & Deb, K. (2016). Role of ICT in 21st Century's Teacher Education. *International Journal of Education and Information Studies*, 1-6.

Borena, B., & Negash, S. (2016). IT Infrastructure Role in the Success of a Banking System: The Case of Limited Broadband Access. *Information Technology for Development*, *22*(2), 265–278. doi:10.1080/0268110 2.2014.979392

Bredo, E. (1994). Reconstructing educational psychology: Situated cognition and Deweyian pragmatism. *Educational Psychologist- Taylor and Fransis Online*, 22-35.

Buckingham, D. (2007). Digital Media Literacies: Rethinking Media Education in the Age of the Internet. *SAGE Journals*, 43-55.

Budhedeo, S. (2016). Issues And Challenges in Bringing ICT Enabled Education To Rural India. *International Journal of Scientific Research and Education*, 4759-4766.

Bull, R. (2015). ICT as an enabler for sustainable development: Reflections on opportunities and barriers. *Journal of Information Communication and Ethics in Society*, 19-23.

Cassidy, M., & Knowton, J. (1983). Visual litercay: A Failed metaphor? *Educational Communication and Technology*, 67–90.

Chyau, C., & Raymond, J. (2005). *What works: First mile solutions' daknet takes.* USAid.

Cisotto, G., & Pupolin, S. (2018). Evolution of ICT for the improvement of quality of life. *IEEE Aerospace and Electronic Systems Magazine*, *33*(5-6), 5–6. doi:10.1109/MAES.2018.170114

Cisotto, G., & Pupolin, S. (2018). Evolution of ICT for the improvement of quality of life. *IEEE Aerospace and Electric Systems Magazine*, 5-6.

Considine, M. (1986). Visual Litercay and Children's Book: An Integrated Approach. *School Library Journal*, 38–42.

Cook, J., & Smith, M. (2004). Beyond formal learning: Informal community eLearning. *Computers & Education*, *43*(1-2), 35–47. doi:10.1016/j.compedu.2003.12.003

Coutinho, P. (2007). Cooperative Learning in Higher Education using weblogs: a study with undergraduate students of Education in Portugal. In *World Multi- Conference on Systemics, Cybernetic and Informatics*, (pp. 60-64). Academic Press.

Covello, S. (2010). *A Review of Digital Literacy Assessment Instruments.* Academic Press.

CTA. (2019). *Blockchain for agriculture: making it happen*. Retrieved from https://www.cta.int/: https://www.cta.int/en-GB/search?location=2205218

Cullen, R. (2017). The Use of ICT in the Health Sector in Pacific Island Countries. In R. Cullen & G. Hassall (Eds.), Achieving Sustainable E-Government in Pacific Island States. Public Administration and Information Technology (pp. 305-335). Springer Cham. doi:10.1007/978-3-319-50972-3_11

Cullen, R., & Hasall, G. (2016). *e-Government in the Pacific Island states: ICT policy and implementation in small island developing states.* Wellington: Springer. Retrieved from pippr.victoria.ac.nz

Cunningham, M. (2019). *Economic Inequality: Differences in Developed and Developing Nations*. Retrieved from https://study.com/academy/lesson/economic-inequality-differences-in-developed-and-developing-nations.html

Delponte, L., Grigolini, M., Moroni, A., & Vignetti, S. (2015). *ICT in the developing world.* Academic Press.

Digital Education Advisory Group. (2012). *Beyond the Classroom:A New Digital Education for Young Australians in the 21st Century.* Academic Press.

Din, I., Xue, M., Ali, M., Shari, T., & Ilyas, A. (2017). Role of information & communication technology (ICT) and e-governance in health sector of Pakistan: A case study of Peshawar. *Cogent Social Sciences*, 1–18.

Dios, I., Igartua, J., & Gonzalez, A. (2016). Development and Validation of a Digital Literacy Scale for Teenagers. *4th International Conference in Technological Ecosystems for Enhancing Multiculturality TEEM'16*, 1-8.

Dipartimento di Ingegneria Gestionale. (2018). *Managing ict for business, industry, government and society*. Retrieved from http://www.dig.polimi.it/index.php?id=524

Duță, N., & Rivera, O. (2015). Between theory and practice: the importance of ICT in Higher Education as a tool for collaborative learning. *Elsevier- Procedia - Social and Behavioral Sciences*, 1466 – 1473.

Elías, P., Tomasegovic, T., & Mrvac, N. (2010). E-Learning and Evaluation in Modern Educational System. *Proceedings of INTED2010 Conference*, 1-6.

Englund, C., Olofsson, A., & Price, L. (2016). Teaching with technology in higher education:understanding conceptual change and development in practice. *Higher Education Research & Development*, 73–87.

Eyman, D. (2007). *Digital Literacies, Digital Discourse and Communities of Practice: Litercay Practices in Virtual Enviornments*. Retrieved from www.researchgate.net: https://www.researchgate.net/profile/Douglas_Eyman/publication/237436831_Digital_Literacies_Digital_Discourses_and_Communities_of_Practice_Literacy_Practices_in_Virtual_Environments/links/00b49526fe4fbefe07000000/Digital-Literacies-Digital-Discourses-and-

Farahat, T., Hegazy, N., & Mowafy, M. (2018). Information and communication technologies in primary healthcare facilities in Egypt. *Primary Health Care Research and Development*, *19*(01), 88–95. doi:10.1017/S1463423617000470 PMID:28786373

Farhadi, M., Ismail, R., & Fooladi, M. (2012, November 12). *Information and Communication Technology Use and Economic Growth*. Retrieved September 08, 2018, from Plos.org: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0048903

Fu, J. (2013). ICT in Education: A Critical Literature Review and Its Implications. *International Journal of Education and Development Using Information and Communication Technology*, 112–125.

Galusha, J. (1998). Barrieers to Leanring in Distance Eductaion. *ERIC*, 1-23.

Gatautis, R., Medziausiene, A., Tarute, A., & Vaiciukynaite, E. (2015). Towards ICT Impact Framework: Private and Public Sectors Perspective. *Journal of Economics, Business and Management*, 465-469.

Gerstein, J. (2014). *Moving from Education 1.0 Through Education 2.0 Towards Education 3.0*. Retrieved from https://scholarworks.boisestate.edu: https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1104&context=edtech_facpubs

Ghosh, V., & Chandrasekhar, C. (2002, July). *The potential and the constraints in low income countries*. Retrieved from https://www.medicusmundi.ch/: https://www.medicusmundi.ch/de/bulletin/mms-bulletin/informations-und-kommunikationstechnologien/ict-and-health-development-potential-and-constraints/the-potential-and-the-constraints-in-low-income-countries

Glister, P. (1997). *Digital Literacy*. academia.edu.

Gonel, F., & Akinci, A. (2018). How does ICT-use improve the environment? The case of Turkey. World Journal of Science. *Technology and Sustainable Development*, 2-12.

Greenit. (2019). *The green IT- All about the green-IT*. Retrieved from green it consulting: http://www.greenit-monaco.com/en/the-green-it.html

Growth Engineering. (2018). *Why Traditional ELearning Does Not Work*. Retrieved from https://www.growthengineering.co.uk/traditional-elearning-doesnt-work/

Gu, L., Xiaodong, J., Din, D., & Lindberg, J. (2012). Case Studies on the Use of Technology in TPD (Teacher Professional Development). *US-China Education Review*, 278-290.

Gupta, R., & Prakash, A. (2018). *ICT Enabled Agricultural Transformation: Some Notes for Fiji*. Retrieved from researchgate.net: https://www.researchgate.net/publication/322789646_ICT_Enabled_Agricultural_Transformation_Some_Notes_for_Fiji

Gurak, J. (2001). *CyberLiteracy: Navigating the Internet with Awareness*. Yale University Press.

Haluza, D., & Jungwirth, D. (2018). ICT and the future of healthcare: Aspects of pervasive health monitoring. *Informatics for Health and Care - Taylor & Francis Online*, 1-11.

Hameed, T. (2006). *ICT as an enabler of Socio-Economic Development.* Retrieved from www.itu.int: https://www.itu.int/osg/spu/digitalbridges/materials/hameed-paper.pdf

Heeks, R. (2008). ICT4D2.0: The next phase of Applying ICT for International Development. *IEEE Digital Explore- Computer*, 26-33.

Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of 'useful' digital technology in university teaching and learnin. *Studies in Higher Education*, 1567-1579.

Higon, D., Gholami, R., & Shirazi, F. (2017). ICT and environmental sustainability: A global perspective. *Teelmatics and Informatics*, 85-95.

Hinostroza, J. (2017). New Challenges for ICT in Education Policies in Developing Countries: The Need to Account for the Widespread Use of ICT for Teaching and Learning Outside the School. In Educational Communications and Technology: Issues and Innovations (pp. 99-119). SpringerLink.

Hossain, J. (2011). Role of ICTs in the Health Sector in Developing Countries: A Critical Review of Literature. *Journal of Health Informatics in Developing Countries*, 197–208.

Ilomaki, L. (2008). *The effects of ICT on school: teacher's and student's perspective.* Retrieved from https://pdfs.semanticscholar.org/09a6/2d0c51d773656626d90122a5601e5003050b.pdf

ITU. (2016, July 15). *ICTs as a catalyst for sustainable development*. Retrieved from https://sustainabledevelopment.un.org: https://sustainabledevelopment.un.org/index.php?page=view&type=20000&nr=579&menu=2993

Juma, K., Raihan, M., & Clement, C. (2016). Role of ICT in Higher Educational Administration in Uganda. *World Journal of Educational Research*, 1-10.

Kakroo, U. (2007, January). *ICT empowering citizens of Malaysia: Development with Destiny.* Retrieved from http://unpan1.un.org: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan026242.pdf

Kanvaria, V., & Bisht, S. (2016). Intergrating ICT in Education For Sustainable Development: A Facilitators Comprehension. *International Journal of Education & Applied Sciences Research*, 51-58.

Kasemsap, K. (2018). Cloud Computing, Green Computing, and Green ICT. IGI Global.

Kastis, N., & Carneiro, R. (2009, February 12). *Digital Literacy- The Evolution of the 21st Century Literacies*. Retrieved April 8, 2018, from https://www.openeducationeuropa.eu: https://www.openeducationeuropa.eu/en/paper/digital-literacy-%E2%80%93-evolution-21st-century-literacies

Kaur, H. (2016). Role of ICT in Teacher Education. *International Journal of Education and Information Studies*, 18-21.

Kayana, M., Haq, P., & Humayun, H. (2011). Analyzing barriers in e-Government implementation in Pakistan. *International Journal for Infonomics*, 495-500.

Keegan, D. (2013). *The Foundations of Distance Education*. Routledge. doi:10.4324/9781315004822

Kimbrell, J. (2013). *The Impacts of Web 2.0, Web 3.0, and Web 4.0 Technologies Used in Distance Education.* Retrieved from https://thescholarship.ecu.edu/: https://thescholarship.ecu.edu/bitstream/handle/10342/1821/Kimbrell_ecu_0600M_10890.pdf?sequence=1

King, A. (1993). From Sage on the stage to guide on the side. *J Stor*, 30-35.

Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? A critical literature review. *Learning, Media and Technology in Higher Education*, 6-36.

Klimova, B., & Poulová, P. (2016). Mobile Learning in Higher Education. *Advanced Science Letters*, *22*(5), 1111–1114. doi:10.1166/asl.2016.6673

Krull, G., & Duart, J. (2017). *International Review of Research in Open and Distributed Learning*. Retrieved from http://www.irrodl.org: http://www.irrodl.org/index.php/irrodl/article/view/2893/4449

Kumar, B., & Mohite, P. (2017). Usability of mobile learning applications: a systematic. *Journal of Computers and Education*, 1-17.

Kundishora, S. (2016). *The Role of Information and Communication Technology ICT) in Enhancing Local Economic Development and Poverty Reduction.* Retrieved from https://siteresources.worldbank.org: https://siteresources.worldbank.org/CMUDLP/Resources/Role_ICT_paper.pdf

Kurtz, G., & Peled, Y. (2016). Digital Learning Literacies – A Validation Study. *Issues in Informing Science and Information Technology*, 145-158.

Kwon, J., & Ahn, S. (2017). The Study of Needing Ethical Education on Digital Litercay. *Journal of Engineering and Applied Sciences (Asian Research Publishing Network)*, 5695–5698.

Lankshear, C., & Knobel, M. (2008). *Digital Literacies—Concepts*. Policies and Practices.

Lee, James, Hendler, Ora, & Lassila. (2001). The Semantic Web. *The Scientific American Journal*, 1-10.

Lee, S. (2018). *Connecting the disconnected: How technology can accelerate human progress.* Retrieved from Chicago Policy Review (Online): https://search.proquest.com/docview/1993438649?accountid=134156

Li, M., Chen, H., & Liu, K. (2017). A Study of the Effects of Digital Learning on Learning Motivation and Learning Outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, 3554–3564.

Lopez, I. (2009). *Measuring_digital_development_for_policy-making_mo.pdf.* Retrieved from researchgate.net: https://www.researchgate.net/profile/Ismael_Pena-Lopez/publication/43669362_Measuring_digital_development_for_policy-making_models_stages_characteristics_and_causes/links/09e4150bddc513daa1000000.pdf

Luka, M., & Frank, I. (2012). The Impacts of ICTs on Banks A Case study of the Nigerian Banking Industry. *International Journal of Advanced Computer Science and Applications,* 145-149. Retrieved from http://unpan1.un.org: http://unpan1.un.org/intradoc/groups/public/documents/aapam/unpan026533.pdf

Luppicini, R. (2017). *Technoethics and Digital Democracy for Future Citizens*. IGI Global. doi:10.4018/978-1-5225-2463-2.ch001

Majumdar, S. (2006). *Emerging Trends in ICT for Education & Training*. Academic Press.

March, H. (2018). The Smart City and other ICT-led techno-imaginaries: Any room for dialogue with Degrowth? *Journal of Cleaner Production - ScienceDirect*, 1694-1703.

Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and Tools for Digital Literacy Development. *Innovation in Teaching and Learning in Information and Computer Sciences*, 249-267.

Marutha, N., & Ngoepe, M. (2017). The role of medical records in the provision of public healthcare services in the Limpopo province of South Africa. *South African Journal of Information Management*, *19*(1), 1–8. doi:10.4102/sajim.v19i1.873

Matheswell, L. (2008, March 8). *Medical Centre Gets Boost*. Suva.

McLeod, S. (2017). *Behaviorist Approach*. Retrieved from simplypsychology.org: https://www.simplypsychology.org/behaviorism.html

McNamara, K. (2007). *Improving Health, Connecting People:The Role of ICTs in the Health Sector of Developing Countries.* Retrieved from http://unpan1.un.org/: http://unpan1.un.org/intradoc/groups/public/documents/un-dpadm/unpan036467.pdf

Mechlova, E., & Malčík, M. (2012). ICT in changes of learning theories. *10th IEEE International Conference on Emerging eLearning Technologies and Applications, Proceedings*, 253-262.

Microsoft. (2004, December). *ICTs As Enablers of Development:A Microsoft White Paper.* Retrieved from www.itu.int/: https://www.itu.int/net/wsis/stocktaking/docs/activities/1109618441/ICTwhite%20paper.doc

Ministry of ICT & National Guidance. (2018). *eGovernment*. Retrieved from http://www.ict.go.ug: https://www.ict.go.ug/initiative/egovernment

Mioduser, D. N. (2003). Analysis Schema for study of Domains and levels of Pedagogical Inovaions in schools using ICT. *Education and Information Technologies*, *8*(1), 23–36. doi:10.1023/A:1023922207476

Mishra, A., & Tiwary, M. (2011). *Successful ICT Innovations from Emerging Economies*. ITU.

Mukaida, L. (1996). *Telemedicine and telehealth in the pacific island region: A survey of applications, experiments, and issues*. Academic Press.

Mukherjee, S. (2011). Application of ICT in rural development:opportunities and challenges. *Global Media Journal*, 1–8.

Nand, R., & Sharma, B. (2019). Meta-heuristic approaches to tackle Skill Based Group allocation of Students in Project Based Learning Courses. *IEEE Congress on Evolutionary Computation (CEC)*, 1782-1789. doi:10.1109/CEC.2019.8789987

Nashipudi, M. (2012). Web 2.0 and Folksonomy. *International Journal of Digital Library Services*, 29-35. Retrieved from http://www.ijodls.in: http://www.ijodls.in/uploads/3/6/0/3/3603729/3_mohmedhanif__29-35_.pdf

Ngwenyama, O., Baidoo, F., Bollou, F., & Morawczynski, O. (2006). Is there a relationship between ICT, health, education and development? An empirical analysis of five west african countries from 1997-2003. *The Electronic Journal on Information Systems in Developing Countries*, 1-11.

Niebel, T. (2018). ICT and economic growth – Comparing developing, emerging and developed countries. Elsevier.

Nova, S. (2011). *Web 3.0: The Third Generation Web is Coming*. Retrieved from https://lifeboat.com/ex/web.3.0: https://lifeboat.com/ex/web.3.0

OECD. (2004). Retrieved from oecd.org: http://www.oecd.org/cfe/smes/31919255.pdf

Oliver, R. (2002, January). *The role of ICT in higher education for the 21st century: ICT as a change agent for education.* Retrieved from ResearchGate: https://www.researchgate.net/publication/228920282_The_role_of_ICT_in_higher_education_for_the_21st_century_ICT_as_a_change_agent_for_education

Oyedemi, O. (2015). ICT and Effective School Management:Administrators' Perspective. *Proceedings of the World Congress on Engineering*, 1-4.

Panir, J. (2011). Role of ICTs in the Health Sector in Developing Countries: A Critical Review of Literature. *Journal of Health Informatics in Developing Countries*, 197–208.

Pattichis, C. K., Voskarides, S., Pattichis, M., Istepanian, R., & Schizas, C. (2002). Wireless telemedicine systems: an overview. *IEEE Xplore - Digital Library*, 143-153.

Paul, M., & Das, A. (2017). Provisioning of Healthcare Service in Cloud. *Information and Communication Technology*, 259-268.

Perdana, R., Jumadi, J., & Rosana, D. (2016). Measuring Digital Literacy Skill: Development, Reliability, and Validity of Open-ended Test. *International Journal of Educational Research Review*, 1-13.

Perron, B., Taylor, H., Glass, J., & Leys, J. (2010). *Information and Communication Technologies in Social Work.* Retrieved from https://deepblue.lib.umich.edu/bitstream/handle/2027.42/78034/46.pdf

Pojani, D., & Stead, D. (2015). Sustainable Urban Transport in the Developing World: Beyond Megacities. *Sustainbility*, 7784-7805.

Ponelis, S., & Holmner, M. (2015). ICT in Africa: Building a Better Life for All. *Information Technology for Development*, *21*(2), 163–177. doi:10.1080/02681102.2015.1010307

PRIF. (2015). *Economic and Social Impact of ICT in the Pacific*. PRIF.

PWC. (2018). *The 2018 digital university- Staying relevant in the digital age*. Retrieved from https://www.pwc.co.uk/assets/pdf/the-2018-digital-university-staying-relevant-in-the-digital-age.pdf

Qaisar, N., & Khan, H. (2010). E-Government challenges in public sector: A case study of Pakistan. *International Journal of Computer Science Issues*, 310–317.

Rajiv, & Lal, M. (2011). Web 3.0 in Education & Research. *BIJIT - BVICAM's International Journal of Information Technology*, 335-340.

Raturi, S. (2018). Understanding learners preferences for learning environments in higher education. *The Online Journal of Distance Education and e-Learning*, 84-100.

Ravindra, S., Chandra, R., & Virallikattur, D. (2015). A Study of the Management of Electronic Medical Records in Fijian Hospitals. Academic Press.

Reddy, E., Reddy, P., Sharma, B., Reddy, K., & Khan, M. (2016). Student Readiness and Perception to the Use of Smart Phones for Higher Education in the Pacific. *2016 3rd Asia-Pacific World Congress on Computer Science and Engineering*, 258-264.

Reddy, E., Sharma, B., Reddy, P., & Dakuidreketi, M. (2017). Mobile Learning Readiness and ICT Competency: A Case Study of Senior Secondary School Students in the Pacific Islands. *Asia-Pacific World Congress on Computer Science and Engineering,* 137-143.

Reddy, P., Sharma, B., & Chandra, S. (2020). Student readiness and perception of tablet leaning in HE in the Pacific: A cased study of Fiji and Tuvalu. *Journal of Cases on Information Technology*, 52–69. doi:10.4018/JCIT.2020040104

Reddy, P., Sharma, B., & Hussein, S. (2017). Tablet learning and its perceived usage at a higher education institute in Fiji. *Fijian Studies: A Journal of Contemporary Fiji*, 131-142.

Rehman, M., Esichaikul, V., & Kamal, M. (2012). Factors influencing e-government adoption in Pakistan. *emraldinsight- Transforming Government: People, Process And Policy*, 258-282.

Reyna, J. (2012). From flash to HTML5: The eLearning evolution. *Training & Development*, 28–29.

Rosenblit, S. (2011). *Digital Technologies in Higher Education: Sweeping Expectations and Actual Effects*. Nova Science Publishers, Inc.

Ruxwana, N., Herselman, M., & Conradie, P. (2010). ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa. *Health Information Management*, *39*(1), 17–29. doi:10.1177/183335831003900104 PMID:20335646

SalmonS. (2016). *Education 1.0 to 3.0*. Retrieved from https://www.gillysalmon.com: https://www.gillysalmon.com/uploads/5/0/1/3/50133443/education_1-0_to_3-_0.pdf

Sapkota, N., Paudel, N., Subedi, D., Bhattaraid, R., & Shrestha, R. (2018). Role of Information Communication Technology (ICT) in Nepalese Banking Industry. *American Scientific Research Journal for Engineering, Technology and Services*, 75-88.

Sarkar, S. (2012). The Role of Information and Communication Technology (ICT) in Higher Education for the 21st Century. *The Science Probe*, 30-41.

Scher, R. (1984). The Computer Backlash. *Journal of Electronic Learning*, 23-27.

Segura, L., & Pena, J. (2017). The Digital Revolution in Developing Countries: Brief Analysis of the Dominican Republic. Advanced Sciences and Technologies for Security Applications.

Shakeb, E. (2011). Open and Distance Education under the Umbrella of Information and Communication Technology (ICT). *International Journal of Clothing Science and Technology*, 1–4.

Sharma, B., Jokhan, A., Kumar, R., Finiasi, R., Chand, S., & Rao, V. (2015). Use of Short Message Service for Learning and Student Support in the Pacific Region. In Y. Zang (Ed.), Handbook of Mobile Teaching and Learning (pp. 199-220). Academic Press.

Sharma, B., Lauano, F., Narayan, S., Anzeg, A., Kumar, B., & Raj, J. (2018). Science teachers accelerated programme model: A joint partnership in the Pacific region. *Asia-Pacific Journal of Teacher Education*, *46*(1), 38–60. doi:10.1080/1359866X.2017.1359820

Sharma, B., Nand, R., Mohammed, N., Reddy, E., Narayan, S., & Reddy, K. (2019). Smart Learning in the Pacific: Design of New Pedagogical Tools. In *IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, (pp. 573-580). New South Wales, Australia: IEEE.

Sharma, B., & Reddy, P. (2015). Effectiveness of tablet learning in online courses at the University of the South Pacific. In *2nd Asia-Pacific World Congress on Computer Science and Engineering* (pp. 1-9). Suva, Fiji: IEEE. doi:10.1109/APWCCSE.2015.7476229

Sharma, B., Reddy, P., Reddy, E., Narayan, S., Singh, V., Kumar, R., & Prasad, R. (2019). Use of mobile devices for learning and student support in the Pacific region. In Y. Zhang & D. Cristol (Eds.), *Handbook of Mobile Teaching and Learning.* Springer.

Sharma, G., Bao, X., & Peng, L. (2014). Public Participation and Ethical Issues on E-governance: A Study Perspective in Nepal. *Electronic Journal of E-Government*, 82–96.

Shopova, T. (2012). E-Learning in Higher Educational Environment. *International Conference The Future of Education*, 1-5.

Singh, K., Binti, N., & Jalil, A. (2019). Relationship of digital literacy and teacher's perception of 21st century learning: A study of SMK Bako Kuching, Sarawak. *International Conference on Education in the Digital Ecosystem*, 367-387.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. doi:10.1016/j.jbusres.2019.07.039

Solanki, M., & Dongaonkar, A. (2016). A Journey of Human Comfort: Web 1.0 to Web 4.0. *International Journal of Research and Scientific Innovation*, 75-78.

Stommel, J. (2016). *The Student 2.0.* Retrieved from http://hybridpedagogy.org: https://hybridpedagogy.org/the-student-2-0/

Suhor, C., & Little, D. (1988). Visual Litercay and Print Litercay- Theoretical Considerations and Points of Contact. *Eric-Reading Psychology*, 69-81.

Surbhi, S. (2019). *Difference Between Developed Countries and Developing Countries.* Retrieved from https://keydifferences.com/difference-between-developed-countries-and-developing-countries.html

Tabusum, S., Saleem, A., & Sadik, M. (2014). *Digital Literacy Awareness among Arts and Science College Students in Tiruvallur District.* Retrieved from https://www.researchgate.net/publication/324829364_Digital_Literacy_Awareness_among_Arts_and_Science_College_Students_in_Tiruvallur_District_A_Study

techterms. (2018). *ICT definition*. Retrieved September 02, 2018, from /techterms.com: https://techterms.com/definition/ict

techthought. (2018). *The Difference Between Education 1.0 & 3.0*. Retrieved from https://www.teachthought.com/the-future-of-learning/past-time-education-3-0/

Thakral, P. (2015, April). *Role of ICT in Professional Development of Teachers.* Retrieved from http://ndpublisher.in/admin/issues/LCV6N1m.pdf

The Fijian Government. (2019). *Digital Government Transformation*. Retrieved from digitalFiji: https://www.fiji.gov.fj/digitalFIJI

Tondeur, J., Aesaert, K., Pynoo, B., Braak, J., Fraeyman, N., & Erstad, O. (2017). Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century. *British Journal of Educational Technology*, *48*(2), 462–472. doi:10.1111/bjet.12380

Town, S. (2003). Information Literacy:definition, measurement, impact. In Information and IT literacy:enabling learning in the 21st Century (pp. 53-65). Academic Press.

UNCTAD. (2008). *Measuring the impact of ICT use in business: the case of manufacturing in Thailand.* UNCTAD.

UNDP. (2008). *Mozambique report*. Retrieved from http://hdr.undp.org/sites/default/files/mozambique_nhdr_2008_ict.pdf

UNESCO. (2011). *ICT for Higher Education - Case Studies from Asia and the Pacific.* Retrieved from https://unesdoc.unesco.org/images/0021/002141/214143e.pdf

UNESCO. (2011). *Classroom revolution through SMART education in the Republic of Korea:case study by the UNESCO-Fazheng project on best practices in mobile learning.* Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000366729

United Nations. (2018). *Sustainable Development Goals*. Retrieved from https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Veletsianos, G. (2010). *A Definition of Emerging Technologies for Education*. Athabasca University Press.

Vis, C., Mol, N., Kleiboer, A., Buhemann, L., Finch, T., Smith, J., & Riper, H. (2018). Improving Implementation of eMental Health for Mood Disorders in Routine Practice: Systematic Review of Barriers and Facilitating Factors. *JMIR Publications: Advancing Digtial Health Reseach*, 1-5.

Vugec, D., Spremić, M., & Bach, M. (2017). IT Governance adoption in banking and insurance sector: Longitudinal case study of cobit use. *International Journal of Qualitative Research*, 691–716.

Wade, W., Hodgkinson, K., Smith, A., & Arfield, J. (2013). *Flexible Learning in Higher Education*. Routledge.

Walsham, G. (2017). ICT4D research: Reflections on history and future agenda. *Information Technology for Development*, *23*(1), 18–41. doi:10.1080/02681102.2016.1246406

Walton, G. (2016). Digital Literacy: Establishing the Boundaries and Identifying the Partners. *New Review of Academic Librarianship*, *22*(1), 1–4. doi:10.1080/13614533.2015.1137466

Watson, A., Sabumei, G., Mola, G., & Ledema, R. (2015). Maternal Health Phone Line: Saving Women in Papua New Guinea. *Journal of Personalized Medicine*, *5*(2), 120–139. doi:10.3390/jpm5020120 PMID:25923199

Wescott, C. (2015). *E-Government and the Applcations of Technology to Governement Services*. Academic Press.

Wiley, T. (1996). Literacy and Language Diversity in the United States. Center for Applied Linguistics.

Witt, C., & Gloerfeld, C. (2017). Mobile Learning and Higher Education. *The Digital Turn in Higher Education*, 61-79.

Wong, M., Yee, M., & Nohr, C. (2018). Socio-technical consideration for blockchain technology in healthcare. *Studies in Health Technology and Informatics*, 636–640. https://eprints.utas.edu.au/27633/ PMID:29678038

World Health Organisation-WHO. (2004). Retrieved from https://www.who.int/eht/en/EHT_strategy_2004-2007.pdf

Zekmer, J., Ronchi, E., & Hypponen, H., Villanueva, C., Nohr, C., . . . Milstein, J. (2017). International health IT benchmarking: Learning from cross-country comparisons. *Journal of the American Medical Informatics Association*, 371–379. PMID:27554825

Pritika Reddy is an Assistant Lecturer in the department of Computing Science and Information Systems at Fiji National University (FNU) in the Fiji Islands. She holds a Master's Degree in Information Systems from USP and has also published her research work. Pritika is very passionate about her research in distance education and flexible learning and her research revolves mainly on how new digital tools and technology can be used to enhance higher education particularly in the Pacific Islands.

Bibhya Sharma is an Associate Professor in Mathematics at School of Computing, Information and Mathematical Sciences at the University of the South Pacific. His Research Interests are in ; Stability of Nonlinear Systems, Robotics and Artificial Neural Networks.

Kaylash Chaudhary is a Lecturer in School of Computing, Information and Mathematical Sciences at the University of the South Pacific. His research interest revolves around artificial intelligence and block chain technology.