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# Research Papers on knowledge, Innovation and Enterprise

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**Research Papers on  
Knowledge, Innovation  
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# Research Papers on knowledge, Innovation and Enterprise

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## Editorial

Traditionally, the *Research Papers on Knowledge, Innovation and Enterprise (KIE Conference Proceedings)* is dedicated to papers submitted to the *International Conference on Knowledge, Innovation and Enterprise* which was held on 27-29 July 2021. This ninth volume of the journal continues the tradition.

Like the 2020 edition of the annual conference, this year's conference was virtual due to the impact of the coronavirus pandemic.

There are three papers in this volume. The first paper by Mzuyanda Percival Mavuso, Emmanuel Olawale & Nkosinathi Mkosi examines a South African school curriculum policy that proposes the integration of indigenous knowledge into the mainstream curriculum and the role of teachers, subject expert-advisors and head of departments in the integration process. The paper finds that although 'stakeholders understand their role and try every possible best towards the successful integration of indigenous knowledge, lack of training, western models and theories that are uncritically adopted,' as well as the absence of policy direction have so far made such integration inefficient.

The second paper – 'The Rise and Fall of English as a Medium of Instruction Globally in Higher Education' – by Gillian Hilton discusses the use of English as a medium of instruction (EMI) in universities across the world. Hilton uses her professional experience as a reviewer and evaluator for schools outside the UK, and presents both positive and negative results arising from the use of EMI.

The third paper by Deryn Graham speaks to the innovation theme of the conference particularly the in-filled 9<sup>th</sup> *Big Data Analytics & E-Business Symposium* – 'The Application of Data Analytics and Artificial Intelligence for Post-Covid Recovery and a Big Data Smart Future'. The paper assesses the impacts of the pandemic 'through the lens of the Digital Society, which encompasses the domains of health, education, work and the home.' The paper raises the question as to whether data analytics and artificial intelligence can be leveraged for post-Covid recovery to provide 'Big Data Smart Future'.

As the pandemic shows some signs of receding, it is pleasing to serve you with yet another varied interesting papers to enjoy.

James Ogunleye, PhD, FRSA  
Chairman, 2021 KIE Conference



# Integration of Indigenous Knowledge in the Intermediate Phase Curriculum: a case of South African Schools

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## Abstract

There have been various concerns that the integration of indigenous knowledge systems in the curriculum generally and in the teaching of respective subjects, in particular does not necessarily happen as it should be. Thus, given that the South African school curriculum policy proposes that the curriculum should be flexible in valuing IK through its integration into the mainstream curriculum, the study sought to examine the role of teachers, Subject Advisors and HoDs in such integration at the Intermediate Phase. Underpinned by an interpretivist paradigm, the study employs a qualitative research approach and a case study design in order to investigate how Indigenous knowledge is integrated into the intermediate phase curriculum in selected Education District in the Eastern Cape Province, South Africa. As such, 38 intermediate phase teachers, 10 subject HoDs, and, 5 subject advisors were purposively selected for data collection. Research findings revealed that while relevant stakeholders understand their role and try every possible best towards the successful integration of indigenous knowledge, lack of training, western models and theories that are uncritically adopted, as well as the lack of clear policies render its integration futile. The paper concludes that the successful incorporation of indigenous knowledge is capable of transforming the global educational system by giving education a new face, as such, relevant stakeholders saddled with the responsibility of implementing IK should understand that education systems are not value neutral. It was therefore recommended that Indigenous Knowledge should not be integrated in isolation but rather used as prior knowledge in line with the philosophical teaching principle of starting from the known and moving to the unknown.

*Keywords:* Education, Integration, curriculum, Implementation, Indigenous knowledge, Intermediate Phase

## Introduction

Research on Indigenous Knowledge (IK) and its benefits and prospects for the curriculum have become more pronounced and have been undertaken globally, in Africa, and in South Africa since the United Nations Educational, Scientific and Cultural Organization (UNESCO) and World Intellectual Property Organization pioneered the role of Indigenous Knowledge Systems in 1978 (Zazu, 2008; Sebola,

2015). The recognition of IKS led to countries such as the post-apartheid South Africa developing their own national IKS policy, which in turn led to various government departments developing their own IKS sensitive and accommodative policies (Mkhwanazi, 2014). The South African IKS policy that was adopted in November 2004 as result of an inter-departmental effort aimed at creating a framework for the recognition, understanding, integration and promotion of South Africa's (SA) abundant IK resources. The policy incorporated a wide scope of recommendations concerning IKS, *inter alia*, integration of IK into the national education and research systems (South Africa Department of Trade and Industry [DTI], 2008). As such, the post-apartheid South Africa's new curriculum policy statement's aims, and principles strive to realign themselves with those contained in the Constitution of South Africa, that, *inter alia*, puts emphasis on inclusivity, valuing IK, and social justice for all (Mkhwanazi, 2014).

According to Mapara (2017), Indigenous knowledge (IK) is a term that is used to refer to the intellectual activities of indigenous societies scattered throughout the world and have almost all been colonialism and intentional extermination. It is also known as indigenous technical science which is passed down from generation to generation and is not static and fossilised in people's minds, as some would like to think. Similarly, Indigenous Knowledge Systems (IKS) is a designation that is used to refer to the modus operandi and processes that the indigenous peoples use to harness the indigenous knowledge (Mapara, 2017). This knowledge is not external but is generated after being informed by the local environment. It can therefore be referred to as the knowledge that has its roots in the local biophysical and social environment (Mapara, 2017).

In the African context, including South Africa, a curriculum involving IK focuses on cultural survival, environmental responsibility, and sustainable development (Dziva, Mpofu & Kusure 2010). Despite being contrasted in some way to the Western, hegemonic views of science – IK facilitate the study of these science. This is because of the IK promotion of “science for all” and “education for all” (Dziva et al., 2010, p 2). However, there is no formal system in place for the implementation of IK because it does not happen in a systemic, regular, or predictable fashion. As such, Dziva et al. (2010) argues that the challenges to implementation of IE include but not limited to the balance between superstitions and natural knowledge, communicating the new curriculum to parents, and making the lessons relatable and applicable to students' everyday lives. Based on the above contention, this study seeks to examine the role of stakeholders (Intermediate phase teachers, subject advisors, as well as head of department) in integrating IE into the intermediate phase curriculum in selected schools in the Eastern Cape Province, South Africa.

## **Literature Review**

### ***Current Debates on Indigenous Knowledge***

There are several debates in the IKS realm. One of the most topical is the commodification of knowledge by means of intellectual property rights, which raises serious ethical issues. This is particularly so in terms of the use of knowledge that is freely given in one culture but then is commodified for private profit in another (Brush, 2013). This is all compounded by the fact that there is increased pressure for all nation states to implement intellectual property protection and to conform to

a common international standard. These trends raise questions about the legal status of indigenous groups and their control over culturally specific but widely useful information and point to the need to conserve biological resources and indigenous knowledge (Stabinsky & Brush, 2007). Mothwa (2011) also argues that majority of the school textbooks have little or no proper information about IK, this is because it is given as examples, and there are hardly any teaching strategies suggested, neither is there practical work that can be done (Mothwa, 2011; Matike, 2012).

In line with the above contention, Diwu and Ogunniyi (2011) assert that IK is not documented and is not readily available to teachers. Moreover, many teachers believe that available textbooks are not helpful to learners because they contain only a few cultural activities that are mainly case studies (Lubben, 2011); the textbooks thus have very little material to support the teachers (Diwu & Ogunniyi, 2011). Another major debate around IK has been the role played by universities in the IKS agenda (Balcomb, 2001). There are doubts whether enough is done by universities in South Africa to push the IKS agenda. Despite the demise of colonialism, apartheid and many efforts taken by the government to position IK on the plans of universities (knowledge-producing sector), the situation seems to be similar across borders (Mapara, 2017). Thus, Ngulube, Dube and Mhlongo (2015) posited that the pedagogic practices emanating from the colonial era, and which undervalue IK, continue to dominate the higher education landscape and exclude IK in the process.

Although, the apartheid baggage from the segregatory policies of South Africa has an adverse impact on IKS in the school curriculum (Khupe, 2014), however, it is not apartheid alone that marginalised IKS in education; colonialism, in general, resulted in the colonial subjugation of IKS in Africa in all aspects of life of the indigenous people, including education (Higgs & van Wyk, 2007). In a similar vein, Ngara (2017) asserted that the Western knowledge paradigm rendered many indigenous knowledge systems invalid, illegitimate and irrelevant, and IKS generally and particularly indigenous medical knowledge systems, struggled to articulate their voices from the marginalisation imposed by colonialism, globalisation and modernity. In agreement, Oroma and Ali (2018, p. 36), averred that “traditional wisdom”/IK has been ignored by the Western former colonialist. According to Msila (2016), the time is long overdue for African traditional knowledge or IK to be recognised in schools.

### ***Views of Teachers on Issues of Integration of IK in the School Curriculum***

Afonso-Nhalevilo (2013) argued that while there have been some efforts and semblance of success in incorporating IK into the school curriculum; this has not achieved the intended objectives. Although many strategies in the so-called culturally inclusive science curricula tend to take students along the pathway of cultural assimilation by integrating IKS into modern science topics, however, IKS by virtue of being subservient to the mainstream Eurocentric curriculum ends up serving the goals of the Western-inspired education system (Afonso-Nhalevilo, 2013).

Thus, Naidoo and Vithal (2014) investigated the approaches that could be used in the integration of IK, their study revealed that teachers, given the opportunity to integrate, would engage IKS using three approaches which are: an incorporationist approach that brings selected indigenous knowledge into science by seeking how ‘best IKS fits into science’; a separatist approach that holds IKS ‘side-

by-side' with scientific knowledge; and an integrationist approach that makes 'connections' between IKS and science (Naidoo & Vithal, 2014). According to Keane (2015), most science teachers exhibit reservations concerning incorporating IK into classroom practices because they view science as a more powerful system of knowledge than IK. Hence, they seem to be reluctant to include IKS into their lessons, because of the culturally diverse composition of their classes (Keane, 2015).

Thus, Hewson et al. (2009) recommended collaboration between science teachers, traditional health practitioners, and cultural elders – suggesting that the three could co-teach at all science levels. Together, these teachers could provide practical experiences such as preparing traditional medicine or demonstrating the use of various plants. Similarly, Dziva et al. (2010) suggested strategies which includes: (a) asking what students know already and building upon that knowledge; (b) clarifying concepts in the native language, as opposed to sticking to English; and (c) using familiar materials, such as pots and pans, to illustrate scientific concepts. However, these methods have not been standardised to and for all curricula.

### ***State of Support for Integration of IK into the South African School Curriculum***

While there is considerable debate in the literature on the integration of IKS into the South African school curriculum, it is important to point out that the policy framework is in place. According to Onwu and Mosimege (2004), what needs to be interrogated and investigated are the modalities and not the merits of integration. This is because the Curriculum 2005 Natural Science Policy Document clearly spells out that IKS needs to be included in the school curriculum. It should be noted though, that it is not only the natural sciences that are required to integrate IKS. The principle of valuing and inclusion underpins all Curriculum Assessment Policy statement (CAPS) throughout the grades, and for all subjects or learning areas (Onwu & Mosimege, 2004; Khupe, 2014). van Wyk (2002) argued that although IKS are facing an onslaught in the face of globalization where the production and value of Eurocentric knowledge and education is being standardized. However, there is a need for a concerted integration effort so that learners do not become alienated from the IK around them (van Wyk, 2002).

Hewson et al. (2009) argue that while the revised National Curriculum Statement implicitly supports IKS integration, one of the obstacles has been that teachers do not necessarily know about the various IKS in South Africa. At most, they can only teach what they know, and without a standardized IKS curriculum there is a danger of the education system being fractured. Thus, Barnhardt (2010) suggested that the strategies utilized in other countries (such as Alaska) to support integration of IK could be adapted to fit the South African education arrangement. As such, guidelines and models for assisting teachers and districts with IKS integration could be developed; orientation integration programmes could be developed for teachers; and an online database of teaching curricular materials could be developed for easy access (Barnhardt, 2010).

### **Theoretical framework**

This study is underpinned by the theory of collateral learning (Jegade & Aikenhead, 1999). Collateral learning is the process through which a student in a non

-Western classroom builds Western and traditional interpretations of a basic idea side by side and with minimum intervention and interaction. Collateral knowledge is therefore the declarative knowledge of a notion that a student retains in long term memory with the capacity of strategic application in either the Western or traditional environment (Jegede, 1997). This theory provides an explanation as to what happens in the mind of the learners when they are at the borders of their community culture and science culture (Jegede & Aikenhead, 1997; 1999). According to Nnadozie (2009), learners can hold ideas of their community culture and the contrasting ideas of the science culture in their memory simultaneously for a long time. These conflicting ideas can either interact or not interact. In the case where the conflicting ideas interact, the learners develop good grounds for holding on to the conflicting ideas and will have identified similarities in the ideas which will lead to the learners developing new ideas in the long-term memory. Hence, the conflict of ideas is resolved (Jegede & Aikenhead, 1999). In a situation where the conflicting ideas do not interact, the learners access the ideas separately depending on whether they are where the community cultural ideas are used or where the science cultural ideas are used (Jegede & Aikenhead, 1999).

Translated into classroom situation, it is not difficult to understand how indigenous students learn collaterally as well as their acceptance of this situation as an everyday occurrence. Thus, when the cognitive processes that occur in a learner's schema are combined with the way most school books and teachers portray the Western worldview as the only legitimate way of understanding nature, the cognitive processes that occur in a learner's schema become a complex array of dilemmas, conflicts, and ongoing attempts to grapple with a situation central to how concepts are learned (Jegede, 1997). The Collateral learning theory thus become suitable for this study because it provides an explanation of what learners' experience when they bring their indigenous knowledge to the class and engage in learning. As the learners' border cross, collateral learning helps the educators to understand how the learners experience the science knowledge in addition to the learners' indigenous knowledge (Nnadozie, 2009). This helps the educators in devising better strategies to function as cultural brokers.

### **Statement of the problem**

There is concern that the main implementers of the school curriculum, and school-teachers, do not integrate IKS into their practice (Dziva et al., 2010); and among those that do integrate IK, there are no standardized methods or best practices for such instruction. Further concerns are that teachers appear not to integrate IKS – owing to the curriculum statements not being explicit on how integration should occur, and so leading to many different interpretations and implementation methods (Jacobs, 2015). Thus, given that the South African school curriculum policy proposes that school curriculum should be flexible in valuing IK through integrating IK in the mainstream curriculum, non-integration is contrary to the policy statement. Moreover, another major concern is that teachers' conceptualization of IK appears to be limited and narrow (Abah et al., 2015; Jacobs, 2015). Hence, the need to investigate the role of stakeholders in integrating Indigenous Knowledge (IK) in school curriculum in the Eastern Cape Province, South Africa.

## Research question

What role do teachers, Subject Advisors and HoDs play in integrating IKS into the Intermediate Phase school curriculum?

## Methodology

Underpinned by an interpretivist paradigm, this study employs a qualitative research approach and a case study research design. According to Creswell and Creswell (2018), qualitative research approach relies on studying people, events, and programs in their natural setting. Thus, to examine the role of stakeholders in integrating Indigenous Knowledge (IK) in school curriculum in the Eastern Cape Province, South Africa, the use of semi-structured interviews, was used for data collection. The samples for this study were drawn from a population consisting of Intermediate Phase teachers, subject HoDs and Subject Advisors from 20 schools in the selected Education District. 38 Intermediate Phase teachers, 10 subject HoDs, and 5 Subject Advisors were purposively selected, making a total sample of 53. The decision on one Education District and the number of the sample was informed by logistical considerations such as expenses, time and accessibility (Cohen, et al., 2011) – considering that the selected Education District, particularly, and the Eastern Cape Province, generally, are vast and mainly rural. As such, data collected from participants was gathered and analysed thematically. Thirty-eight intermediate phase teachers, ten HODs and five Subject Advisors from the selected education district were coded as IP-T1-38, HOD1-10, and SA1-5 respectively.

## Results and Discussion

The study sought to investigate the role of stakeholders (IP teachers, HoDs and Subject Advisors) in integrating IKS into the Intermediate Phase school curriculum. As such, result and discussion was presented under the following themes:

- Role of IP teachers, Subject Advisors and HoDs in Supporting and Monitoring the Integration of IKS
- Challenges of implementing IKS into the Intermediate Phase school curriculum

### ***Role of IP teachers, Subject Advisors and HoDs in Supporting and Monitoring the Integration of Indigenous knowledge***

Participants were asked “what are the role of IP teachers, subject advisors and HoDs in integrating IK in the curriculum?”. Findings revealed that IP teachers, Subject Advisors and HoDs admit that they have a significant role to play through community engagement, organising advocacy programmes, as well as involving other stakeholders to have input in the integration of IE in schools. For instance, a participant stated that

*..... I make sure I involve all stakeholders to have input on the integration of indigenous knowledge. I encourage them to provide resources. Employ more human resources. I also try to conduct an advocacy campaigns and train stakeholders (including teachers) in workshops and the theory of integration ... (HOD3).*

Similarly, a Subject Adviser stated that;

*we formally approach the community to come to the school and talk to teachers and learners on issues relating to indigenous knowledge, and as such, we use this information while teaching students through storytelling, discussion, questioning and answer methods (SA3)*

Furthermore, an intermediate phase teacher adds that:

*We involve the community by requesting them to donate examples of indigenous objects and invite elders to talk about indigenous knowledge and other indigenous materials that can be display in the classroom for teaching and learning purposes. Also, as teachers, we normally approach our subjects as a team which allows us to share ideas and experiences on how to integrate IK into our subject for the benefit of our learners (IP-T14)*

Research findings revealed that the role of teachers, subject advisors and head of schools in integration of indigenous knowledge into the intermediate phase curriculum include ensuring that meaningful inclusion of IK content into the curriculum, checking with local communities to decide upon content to be incorporated, as well as ensuring that all learners benefits from teaching and understand cultural practices. Similarly, the HOD also added that:

*We try to organise an advocacy campaigns that highlight the importance and benefits of indigenous knowledge in the curriculum. All those benefits like the principle of moving from known to unknown, the indigenous language's importance and the preservation and promotion of the traditional knowledge, and how it should be spread among people in the education field (HOD1).*

Thus, it is quite evident that the integration of IK requires effective knowledge management, as well as effective communications strategies relevant to indigenous communities which are essential to improve the lives of both the students and the communities at large. This finding corroborates that of Hewson et al. (2009) who posit that school managers, traditional health practitioners, as well as cultural leaders through effective communication should work together to create a practical experience for students. Sebola (2015) also adds that communication plays an important role in integrating indigenous knowledge because everything needs to be communicated to students so that activities can be properly carried out. It is therefore important to consider the type of communication that is relevant and understood by students and the indigenous communities. Thus, Osho (2011) highlight the uniqueness of African ways of communication simply because of its originality and the use of oral media. This implies that teachers should be familiar with the indigenous ways of communicating and use this way of communication to encourage active participation of indigenous people while teaching in schools.

### **Challenges of implementing IK into the Intermediate Phase school curriculum**

Similarly, participants were asked about the challenges they faced in implementing indigenous knowledge into the intermediate phase school curriculum. Research findings revealed that while teachers, Subject Advisors and HoDs seeks to play a significant role in the integration of IK, they all agree on the limited capacity, inadequate or no training, work overload and no clear policy on the integration of IK. For instance, a participant stated that:

..... *There is no clear policy that guides us on how indigenous knowledge should be integrated, and how stakeholders should contribute to its integration and as a reason we tend to ignore or reject the integration of IK (Subject Advisor 2)*

Similarly, another participant added that;

..... *We don't have what I think is a tool to monitor or integrate indigenous knowledge really. So, our integration and monitoring are just general monitoring of syllabus coverage and monitoring during moderation ... (HOD1).*

In addition, a teacher stated that:

..... *the problem with IK is that there is no training on integration of indigenous knowledge in the curriculum. Myself too, as a teacher, I don't have formal training, but I do integrate the knowledge of learners from their communities with what is being taught ... (IP-T81).*

Research findings revealed that stakeholders (teachers, HODs and Subject Advisors) faces various challenges which include appropriate monitoring tools, lack of clear policies, selection of appropriate materials to be included in the curriculum as well as lack of professional development amongst many others. In line with the above is Kaya and Seleti (2013) who posit that one of the major problems in the integration of indigenous knowledge is that educational structures inherited from colonialism are based on cultural values different from those existing in most of the African indigenous societies. A similar sentiment was echoes by one of the participants who stated that:

.... *the main problem with the integration of indigenous knowledge is in its practical application as they have no theory that explains them. Also, in our schools, we focus more on cultural values that are very different from that of the African indigenous communities which often creates a very big challenge in IK implementation (IP-T23).*

From the above response, it is evident that participants do not see the link between indigenous knowledge in the immediate community and the school curricula. This is line with Nkondo (2012) who stated that the western perception of African indigenous knowledge as mere reception of practices without any theory to explain them is a depiction of western cultural and intellectual arrogance. Thus Kaya and Seleti (2013) posit that African intellectuals should endeavour to assist Africans in closing the gaps created by several years of domination and marginalisation of African people's knowledge system, by rejecting the use of dominant western world views of knowing and knowledge production as the major and only way of knowing.

## **Conclusion**

In examining the role and challenges of teachers, subject advisors and head of departments in implementing indigenous knowledge in the intermediate phase curricula in South African schools, the paper concludes that while IK is capable of providing students with the opportunity to learn relevant and appropriate community values for sustainable livelihood, lack of training, western models and theories that are uncritically adopted, as well as the lack of clear policies render its integration futile. Thus, given that the successful incorporation of indigenous knowledge

is capable of transforming the global educational system by giving education a new face, relevant stake holders (teachers, subject advisors and head of departments) saddled with the responsibility of implementing IK should understand that education systems are not value neutral. As such, what is taught, and how it is taught should reflect cultural beliefs that is capable of assisting students in navigating through different cultural ideas.

### **Recommendations**

Based on the findings of the study, it was recommended that IK should not be integrated in isolation but rather used as prior knowledge in line with the philosophical teaching principle of starting from the known and moving to the unknown. Similarly, the study recommends that community-based approach should be considered in assisting teachers, subject advisors, as well as head of schools in mitigating the contradictions that exists between theory and practice in indigenous knowledge integration. As such, relevant stakeholders (teachers, subject advisors and head of departments) entrusted with the implementation of IK must make sure that indigenous knowledge is not trivialized in schools and in the classroom by converting very significant traditional activities into “arts and crafts”. Instead, should be used to assist learners in understanding cultural traditions and learning about them in an authentic setting.

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# The Rise and Fall of English as a Medium of Instruction Globally in Higher Education

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## Abstract

This paper addresses the use of English as a medium of instruction (EMI) in universities globally. This phenomenon has risen rapidly over the last decades, to the extent now that some universities use the English language for teaching rather than the indigenous language of the country. This has occurred for a variety of reasons, including; financial benefits and prestige for the institution. The language used for many of the subjects students now wish to follow, particularly technology, business and finance, are embedded in English for terminology and operational instructions. Students also see that studying in English gives them more opportunity to acquire good jobs and move to other countries for employment. However, all is not well with this innovation, as staff are being forced to use English in which they may not be fluent and students may find that they are learning less, as they struggle to understand the language used. Much research too is carried out in places where using English to communicate is essential. The paper presents the positive and negative results of using EMI. In addition, it uses the experience of the author, who has worked in English with international teams of reviewers in countries when only one of the team could speak the local language and personally teaching in English to students in a country, where many are not fluent in that language. Nor is the use of interactive, collegiate methods of teaching and learning common practice, which presented students with a double challenge. The paper concludes that much more research needs to be undertaken to examine the effect of this use of EMI in order to prevent the loss of native languages and cultures.

*Keywords:* Globalisation, Higher Education, English as a Medium of Instruction (EMI), English as Lingua Franca

## Introduction

Over the last decades globally, Higher Education has seen a seismic shift to English as a Medium of Instruction (EMI). National and local languages are being set aside, as more and more institutions have begun to offer programmes of study with English as the language of teaching, learning and assessment. This has and will have, enormous effects on culture, economic and social activities across the world, whether the form of language used is traditional English or USA English. As a result, most conferences and a great deal of research is taking place, either using English as the method of delivery in presentations and papers, or a dual approach using both the native language and English. To some extent, there has eventually

been a backlash against this process and now some nations, cultures and institutions, are making strong efforts to support the primacy of their native language in higher education activities and processes. They are of course fighting against a global trend, where films and television programmes using English are viewed everywhere. Many original non-English speakers confess to their medium of Instruction in English being, in the main, the entertainment industry.

However, the use of EMI in universities may well badly affect students and also staff, whose English language skills may leave something to be desired, resulting in poor communication, lack of understanding and added difficulties for all those involved. There are however of course, advantages of learning and using a globally understood language, as it can often lead to a choice of workplace and advancement of one's career. Certainly, it has increased the workload of journal or conference paper reviewers, as there has been an exponential rise in papers written and delivered in hard to understand English. Their quality of the material may well have been high, but not experienced by the readers or listeners, as meanings are often unclear. Certainly, a common language when working across national boundaries is very important and at the present time that language is English. Additionally, claims have been made that EMI increases the language skills of students, thereby increasing their employability and career prospects. However, this has been questioned by many, Macaro, et al. (2018) raise serious questions about this assumption, as a result of the examination and review of 813 studies demonstrating the growth of EMI globally

This paper therefore sets out the case for and against EMI in universities, using a wide literature search. In addition, it records the experiences of the author in teaching in an EMI situation in the Baltic States and also working there, reviewing education programmes in universities and colleges, using English as the common language. This involved communicating with a multinational inspection team and university tutors with varying English language skills.

## **The Global Picture of Higher Education**

The rise of the demand for higher education has increased massively over the last few decades and is expected to continue. Masien (2012) reported that student numbers globally were predicted to double by 2025. Accompanying this is the rise in travel and cross globe experiences in working, living and leisure activities. Long gone are the days when higher education was the prerogative of the rich and to some extent viewed as a 'finishing school'. There has been an explosion globally in the demand for higher learning, encouraged by better economic global conditions, despite some challenges which caused slight backtracking in the growth of wealth. Now, more people see higher education as a necessity, in order to gain a higher salary, or enjoy better social status and lifestyle. Added to the growth of higher education being perceived in many developed nations as the norm, there has been a massive increase in young people in developing nations demanding higher learning and enjoying study abroad. Sometimes they are supported by grants from home governments, or from richer nations and higher education institutions or charities. All this change has been enlivened by the phenomenon of globalisation, which has encouraged the acquisition of knowledge and understanding, on which modern economies are based. The global improvement in many economies, the rising numbers of young people, improvements in technology and more countries enjoying democratic government, helped build pressure on the provision of univer-

sity places and the need to raise the standards of education in order to continue the forward movement. Added to this is the rise of the internet, bringing down barriers to learning and knowledge sharing across the world. This has opened up learning to many, who though living in remote areas and lacking the finance to attend a prestigious institution, have been able to access programmes of learning from all across the world. Certainly, there are still many areas where such accessibility to learning does not exist, but there has, in the last few decades been an enormous rise in the numbers of people able to access higher learning in one form or another, who previously could not have even dreamed of that opportunity. All these changes have brought pressure on universities to change. This has resulted in an exponential rise in the numbers of universities available for students to choose, updating of curricular and programmes offered, increasing pressures on academic staff to modernise teaching methods and far closer links between education and business and industry. Life in universities has changed with a more business-like approach being favoured, as state finance decreases and individual student or industry contributions to education have risen dramatically. As a result of this, more emphasis has had to be made to ensure that learners receive value for the fees they pay and good support within the institution. In addition, the ranking of universities as far as status, research output and student satisfaction, has resulted in the learner becoming more powerful, as there is more choice, so the satisfaction of the student as consumer, is essential for universities to succeed.

In comparing education systems, it is important to consider other influences on those systems namely, the context in which they exist and how those systems relate to the global influences on different countries and the state of development of those systems in comparison to others (Wolhuter et al. 2018).

### **Using EMI in Higher Education**

Over recent years there has been a marked increase in universities, in non-native English-speaking countries, providing programmes in the English language; that is, using EMI for their own students and for foreign nationals. Jenkins (2018) describes the use of English as the ‘lingua franca’ in Higher Education around the world and its rapid rise in the last twenty years in both teaching and research. This author also points out that in many cases, the English used across the globe is not the English that is used by native speakers, as national and cultural differences hold sway. Wiseman and Odell (2014) from the British Council examined this rise in the use of EMI by universities and reported that in 2002 there were 560 Masters programmes delivered in English in 19 EU countries (excluding UK and Ireland). By 2012 this had risen to 6,800 in 11 European Union (EU) countries and the EU is not alone in offering EMI, for learning and teaching in Higher Education Institutions (HEIs). Galloway et al. (2020) describe the initial growth as happening in Europe, but then spreading across the globe, so that now international rankings are influenced by the proportion of programmes and research using/occurring in EMI, as is government funding. In addition to this, the search for staff who can deliver courses in the English language is affecting recruitment. The reasons for this growth are obvious, in that English provides a medium that people from a variety of nations can understand to a certain degree and it can be seen to be an ‘advantage’ to learn in an internationally dominant language. One reason for the increase can be understood by examining the policies of the EU and the Council of Europe, which promote the diversity of language understanding across the conti-

ment; though this to some extent has been overtaken by the inexorable rise in the use of English as a ‘lingua franca’. Coleman (2006) put forward the idea that English was rapidly becoming the language of Higher Education across the continent and this is well before the explosion of EMI occurred. A Webinar, carried out in 2014 by the OECD (Madhavan and McDonald, 2014), found that participants agreed that EMI was an important trend and was on the rise for a variety of reasons, though there were concerns as to whether it was of advantage or not to staff and students. Wiseman and Odell (2014) also discuss the EU’s attempts to encourage mobility between its constituent nations and the need for HEIs to use an international language such of English, for at least some of their teaching. Programmes at Master’s and Bachelor’s levels, (other than in the UK) are most common in The Netherlands (de Witt, 2017). However, this practice has spread further than Europe, with countries such as South Korea and China following the movement, whilst Australian universities are major players in this field, attracting many Asian students.

Hultgren et al. (2015) suggest that the internationalization agenda has been directed from government level, rather than by institutions themselves, but those bodies have rapidly realised that to succeed and receive acknowledgement of their open outlook, they need to work in an international language to demonstrate their modern identity and international agenda. The Bologna Agreement (1999), which opened up staff and student exchange and travel across the EU, has had a marked effect on the internationalization process and hence the increase in the offering of programmes using EMI. This move was underpinned by the introduction of the European Higher Education Area in 2005, with the three cycles of study, undergraduate, Masters and Doctorates and the common European Credit Transfer System (ECTS) This, bringing an understanding of credit parity across programmes, which allowed students to move across the EU, collecting programme credits which would be recognized in their own countries HEIs. (Aittola, 2009). The result of this was an ever-growing number of programmes using EMI and a move to improve staff and student language understanding. However, this did not translate into an improvement in the study of European or other languages in the UK, but a distinct fall in student numbers and subsequently foreign language course closures in British universities. Furthermore, for UK universities there were many requests to study from students from mainland Europe, but fewer of their own students wanted to go abroad to study, despite urgent and repeated sessions on the value of studying in another country, held on Erasmus awareness days etc. This and had of course financial complications for British universities, as their programme numbers and costs increased.

### **The reasons for the global increase of the use of EMI**

An exploration of the literature Odell and Wiseman (2014) suggest the reasons for universities choosing EMI are that HEIs see it as a way of recruiting fee paying students from other countries, who could not study in any programme produced in a specific country’s language. Now, many countries have introduced the learning of English into school curricular, so many potential students have some English understanding and can therefore be attracted by a programme taught in that language. This has been particularly prevalent in the ex-Soviet States, where Russian was compulsory and when independence was gained, learners in those nations changed to their own language as a learning instrument first, with English becom-

ing the desired second. Hilton (2019) noted this change in the Baltic States, whilst advising governments there on how to improve and Westernise teacher education programmes. Initially most staff spoke their native language and Russian, whilst the students were eager to learn English and on repeated visits, the improvement in English use and comprehension, was obvious to the international reviewer teams which she led.

Bogachenko (2016) suggests that English is the dominant language in many modern subject areas, including the media, business, technology, advertising and marketing and in addition many people around the world watch English language films and television. Students appear to believe that studying in English will provide better opportunities for employment, internationally or in their own countries (Bozdođan & Karlýdag, 2013; Chapple 2015). The view that EMI programmes will lead to improved employment opportunities at home is echoed by Mankowska (2018) who suggests that in addition to opening up job opportunities in other countries for students, EMI programmes are popular with Chinese students, as having a high level of English competence as opposed to only subject proficiency, improves their job opportunities in their own country. Certainly, within the EU this has been clearly noted, particularly as students' and staff travel between countries to study or teach has been financially supported. However, as one quarter of the world speaks some form of English it, is obvious that using EMI in programmes will attract foreign nationals who often pay high fees for the privilege of studying abroad.

Madhavan and McDonald's (2014) Webinar discussed the internationalisation of Higher Education and as a result, the growth in the publication of materials to aid EMI, which is profitable for publishing companies who are creating training materials for staff using EMI. Webinar participants reported the benefits of using EMI improved the competitiveness of universities and also developed the staff involved in using EMI. This changes professional cultures and thus provides the possibility for staff to work in a variety of countries. It also allows universities to be more financially competitive, in an ever more challenging market in Higher Education. EMI allowed the teaching of students from a great variety of countries to be carried out in nationally mixed groups, thereby reducing costs.

Most researchers agree that the key reason why universities are eager to introduce more EMI programmes, is that they perceive English to be an international language and use it as a way of demonstrating that they have a global/international outlook and are at the forefront of development. Jensen & Thogersen (2011) state that when questioning Danish lecturers they found that respondents were keen to increase the number of EMI programmes, so that non-Danish students would be attracted to come to Denmark to study, thereby improving the internationalisation of the universities and increasing funds. Furthermore, Earls (2016) claims that German students see that it is more progressive and sensible to teach programmes with subject matter that is common world-wide, in English. However, this is not merely an EU phenomenon, as Khan (2013) claims that Pakistani students believed that EMI use would help to modernise an outdated education system and bring about much needed change within the country. There seems to be a belief held globally, that moving to English will bring an increase in prosperity and affect more than just the students who are using EMI. Universities it appears, have been quick to respond to this demand hence an advertisement in *Times Higher Education* (19.07.2019 p51) for the University of Macau China, listing as one of its

important attractions that 'English is the main medium of instruction' and that the University is outstanding 'with a high degree of internationalisation'.

The internationalisation of education across the globe has led to some countries positively encouraging the use of English in all education systems. For example, in Turkey many universities have introduced a preparatory year for students before they commence learning their chosen subject. During that year students are obligated to undertake an English language programme that is intended to bring them up to a level, at which they can cope with programmes delivered using EMI (Dearden, 2014). This appears to be a positive move, but the author claims had not been particularly welcomed by many students and staff.

EMI also it appears affects staff, in that the university involved is considered more international, open-minded and forward thinking if programmes are offered in English. This, therefore changes the type of academics who apply for positions in the university. Reporting on the views of a member of university staff, a Professor of Management, Valcke et al (2017:256) put forward the view that 'English Taught Programmes (ETPs) attract a younger and more international staff, who adopt a more inter-active teaching methodology'.

### **Concerns over the negative effects/challenges of EMI use**

The contrary argument to EMI usage is gathering interest and numerous research projects have been started. Many researchers point to the effects on national culture that is the beliefs, social norms, and traits of specific groups. These shared affiliations are of great importance to people and to institutions. Where a shared set of attitudes, practices, goals and values brings strength and characterises an institution or organisation. The change in culture caused by use of EMI therefore has to be considered carefully, before assuming that students from a variety of countries will be able to cope with the difference and adjust to new behaviours and attitudes. There are some examples of students suffering racist remarks or physical attacks (Brown and Jones, 2013) but these it appears, are not general. More likely are concerns from foreign students about local social behaviour, such as hugging and touching and student protests, not common in Asian countries (Wang and Shan, 2006). Students leaving home for a foreign country, or those being taught by native English speakers often have the double difficulties of adjusting to a new culture and also the problems of understanding the language used by native teachers. They may have an accent not experienced by students in their own countries. Hilton (2018) teaching in Lithuania in English to a group of students with limited experience of the language, found that the students had experienced heavily accented English from their local tutors and were unused to the 'pure' English used by the visitor who was a native speaker. Staff thought it was 'wonderful' to have the chance to listen to English spoken by a native, but it made the teaching and learning environment, for both tutor and students alike difficult.

Coleman (2006) points out that some believe that this EMI phenomenon is imperialist and capitalist in origin, despite the multitude of other reasons why EMI has become so popular. In addition, this author also raises the problem of the possibility of many world languages becoming extinct by the end of this century due to the rise in the use of English as an international language. This concern is echoed by Labia (2011; 2014) who asserts that cultural differences must be taken into account when using EMI, as student behaviours across the world are different and this affects how they respond to teaching practices. Some students are unused to

interactive techniques and are not expected by tutors to question or critique ideas learned from reading, their tutors' lectures, or the teaching processes of their tutors. Expecting critical analysis in some parts of the world, where merely absorbing, remembering and regurgitating material is the norm, can cause distress and confusion to students. In addition, expecting students from certain cultures to admit publicly to not understanding, is asking them to feel shamed and belittled.

Wiseman and Odell (2014) deliberate on student priorities, that is if students studying in English concentrate more on the subject matter of the lecture or discussion, or whether they are more intent on improving their English skills and raising their communication abilities in both spoken and written forms of the language. To do both is extremely difficult. This question appears to cause problems for researchers and as yet there seems to be no overall agreement, as research has produced a diversity of responses.

One of the main concerns over the increasing use of EMI, is the lack of proficiency in the English language; an essential skill required to enable students to fully appreciate what they are being taught. Cho (2012) records that some Korean students admitted they only understood about sixty percent of lectures delivered in English and that they had limited listening skills. This was also noted in Qatar, where students considered learning in Arabic, even in international subjects such as business would have been preferable for grasping the meaning of the material offered (Ellili-Cherif & Alkhateeb 2015). Belhiah and Elhami (2014) in their research in the Gulf, also stress that students fail to learn content when taught in a foreign language, as they struggle with understanding. Also, the ability of tutors to express themselves in good quality English has been called into question.

Dearden and Macaro (2016) question why institutions across the world have not consulted the people who will be at the front of this language change that is, the staff, who are teaching and the students who are learning. They consider why Faculty across the world are not involved in deciding which subjects/programmes to use for the move into EMI delivery. These authors quote Cho (2012) who, discusses a Korean study which claimed that EMI was imposed on 52.9% of the people who took part in the study, with no consultation whatsoever. Students studying in English were in many cases, not offered that programme in their native language, so were forced to choose EMI delivered programmes. This it appears, has also to do with the understanding that most of the resources for teaching the areas chosen are written in English, particularly in science and technology. A study in Saudi Arabia by Al-Masheikhi et al (2014) found forty five percent of respondents saw an undisputable link between English language and the language of science and technology, so considered that learning in English is essential. However, thirty percent of respondents did not agree that this was necessary. It appears that the reason for choosing to study in EMI has been shown to be closely linked to the subject expertise, not the language expertise of the lecturer (Kang and Park 2005; Yeh, 2014).

Matthews (2018;26) also raises the question as to whether this dominance of the English language across the globe is affecting research, particularly in areas such as science and technology. He quotes Michael Gordin, a science historian who claims that 'ninety nine per cent of publications, conferences on scientific topics and even Skype conversations and emails are conducted in English'. Matthews as a result, points to problems in Germany where he is based, as there has been considerable resistance to the domination of English and most classes are still taught in German. However, scientific research is based in English and Matthews

claims that as a result, German universities will have to call on other organisations to conduct their research for them, using English. This he believes, excludes German academic staff from being involved in research projects and therefore will result in them being unable to integrate the latest ongoing research findings into their teaching. Matthews examines what he calls the 'irony' of this situation as the idea that research should inform teaching was originally a German concept which spread across the world.

In some countries for example, Italy and Denmark the numbers of foreign students arriving to study and the offering of so many programmes in English has proved to be problematic. Gazzola (2017), describes the rising protests across Italy over the use of EMI. This author claims the rise in EMI use is brought about by the phenomenon of league tables, ranking universities across the world, where the numbers of non-national students enrolled increases scores. The move towards using EMI in many more universities and subject areas in Italy he claims, has resulted in so many protests that the Italian Constitutional Court had decreed that exclusive teaching in English violated the Italian Constitution. Morgan (2019) discusses the difficulties in the Netherlands, where there has been a rise in the numbers of people who object to the use of English not Dutch, in universities such as in the Erasmus University in Rotterdam. Morgan (2019:38) notes that there all the signage is in English, not the native language. He describes the language debate as 'deeply political', with opponents to the use of English accusing universities of undermining 'Dutch civilisation'. Some believe that the lack of use of Dutch in education is of real concern, in that it intensifies the perceived threats of internationalisation and globalisation and that by losing their language because of the introduction of English, some Dutch people feel they are losing their identity. However, Morgan (2019) states that Dutch students do want to learn in English, as they believe it will further their careers and now seventy-one per cent of Master's Degree students in Denmark, native and foreign alike, are taught wholly in English.

The learning experiences of foreign students can also cause problems for both learners and tutors alike. Hilton (2018) describes the difficulties experienced using active learning and teaching methods such as group work and group presentations, involving students re-planning their own learning programmes, whereas local teachers used much more formal methods of instruction, 'chalk and talk'. Students were unused to expressing their opinions and critically analysing material presented to them; they found this a difficult challenge, particularly in a foreign language. Therefore, they were presented with the dual difficulty of learning in a foreign language, whilst adjusting to completely new methods in the way material was taught. With perseverance and encouragement however, they achieved the learning outcomes intended and were extremely proud of their efforts. However, Kang and Park (2005) and Yeh (2014) point out that students choose EMI programmes not because of the English language experience, but because they have no other possibility of being taught by a lecturer who is a subject expert.

Hilton (2013) noted the language difficulties for staff and students, when they had to receive reports in English, after reviews of Education Programmes in Lithuania and Latvia; they found understanding feedback difficult. Languages do not always translate accurately, especially if a word used in one language has no exact equivalent in the other, which can cause total confusion. One instance in working in the Baltic was that the word rigour, used to describe increasing difficulty and depth in education discussion and thinking, is not found in Baltic languages, only rigour related to death. Explaining this phenomenon was not easy, after the

use of the word had caused confusion for the interpreter and audience alike. This problem is noted also by Helm and Dalziel (2017) who note the use of words such as ‘Wi-Fi’ and ‘hot spot’ on Italian campuses as they have become more used than the Italian equivalent and this again raises questions about the destruction of native languages as English takes over. This can be linked closely to the decline in the use of Welsh in the UK, resulting in there being no Welsh words for much of the modern technology used in learning.

### **Challenges for subject areas in the use of EMI**

Undoubtedly challenges need to be faced in Higher Education in the use of EMI. As mentioned above those might involve accents, the command of English of staff and students, the drive to enforce EMI as a way of appealing to a wider range of students and to increase university standing and incomes. However, the challenges across subjects are not necessarily similar. In some areas as described, the material provided for study is often in English. This affects sciences and the so termed ‘modern’ subjects of business, media, advertising and technology in particular. Students in different countries have differing levels of English understanding and in some cases are made to apply for programmes where the most highly rated tutors in subject understanding and experience, only offer EMI courses. The problems of internalising content of material taught in a non-native language can be particularly difficult in sciences and where English language preparation in schools, does not arm university students with the understanding and knowledge required to process the content of a lecture. This can also occur in courses delivered on-line, where reading texts in English can be a challenge to students with a lack of expertise in this area. Galloway, (2017) names subjects most frequently taught in English as sciences, technology, maths and engineering. As noted the texts used are often produced in the English language and the author states that ninety four per cent of top level research is conducted solely in the English language, meaning that those who wish to follow a career in the STEM areas need to use and understand English. This she says has been shown to make staff simplify the content to allow for students’ poor language skills. However, these students tended to be less adversely affected by EMI than students in areas such as social sciences, where more elaborate abilities in reading and writing is required, in order to produce work for assessment. In addition, males found in general EMI to be a greater challenge than females (Kamasak, et al. 2021).

### **Conclusion**

At present there seems to be a rise in strong feelings against the use of EMI in many countries, but there is a high demand from university administrators, who see it as a way of improving income and from some students, who believe it will aid employment prospects. However, in the national context there is real concern over the effects of EMI on national languages and cultures. More research on the use of EMI needs to be undertaken, as there is real concern that the culture of some countries could be widely changed if its use spreads out of universities into schools, signage and national languages. Certainly, it appears that students have mixed feelings about the use of EMI; positive where it brings better employment opportunities, but a cause for concern, where their lack of deep knowledge of English may well affect their ability to understand content. For staff in higher education, already

under severe pressure to perform in their area of research, as well as using innovative, face to face and distance learning, the pressures may be even greater. Without them having a good command of English, clear explanations and helping students to understand what they are learning are impossible; resulting in understandable complaints from students. University planners will feel pressure from students who want bi-lingual delivery, for at least some of the content. Lecturers it seems however, are feeling pressurised to teach in English, to aid their promotion, and their standing amongst their peers. Added to this is the concern of some communities that this is being imposed on them, threatening their own culture in a way that could be judged as colonialist, or echoing the forcing of occupied states to adopt Russian as the language of education, to the detriment of national languages, such as Latvian and Lithuanian for example. However, as seen students want to learn English and maybe the Turkish approach mentioned above may be a possible way forward. However, that is not without cost, as that adds further expense to higher education and above all to students, if the first year is taken up with English language learning. It cannot be ignored however, that being able to communicate well in English is an asset for progress in many spheres of employment and so it is understandable, that both students and staff see the promise, but have to contend with the difficulties if they are to succeed. At present the jury is out as to whether this change will continue to spread. Observing how many native languages have already disappeared, we could see a planet populated by people who use badly spoken English and that understanding could well be compromised by it. It also encourages native English speakers to be lazy and not attempt to be at least to some extent bilingual. As a wide knowledge of languages is known to increase thought processes and understanding of other cultures, then it is to be regretted that so few bother to make the effort, thinking that when they go abroad, they will find English widely spoken. So, they make little effort to use another language and therefore find a real understanding of a different culture harder to achieve.

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# The Application of Data Analytics and Artificial Intelligence for Post-Covid Recovery and a Big Data Smart Future

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## Abstract

The aim of this paper is to identify some of the major impacts of Covid-19 through the lens of the Digital Society, which encompasses the domains of health, education, work and the home. The methodology applied is that of observation, collating primary data on the overall positive and negative characteristics of observable impacts for each domain, extrapolating the lessons to be learned from them. Additionally, secondary research is carried out, reporting the findings of an international virtual roundtable on how Artificial Intelligence (AI) is presently being used in helping fight against Covid-19. Increasingly likely trends in the post Covid-19 digital society, are identified as those of e-health, e-teaching, e-working and Smart Homes. The application of data analytics and AI for post-Covid recovery are considered, and whether their leverage can provide a “Big Data Smart Future”. Conclusions drawn include suggestions for real world applications, for domains observed, and the virus itself. Furthermore, predictions are made regarding the future of these domains in this new digital society. As observations made are limited to those solely from a United Kingdom (UK) perspective, it may not be possible to generalise the observational findings beyond the UK. However, the main implication of the research is; that unless the Digital Divide and consequential Digital Exclusion are addressed, the drive towards the e-society and any kind of big data smart future, could be prohibitive for some, and lead to a two-tier society; the digitally included and the digitally excluded.

*Keywords:* data analytics, artificial intelligence, Covid-19, digital society

## Introduction

The aim of this paper is to identify some of the major impacts of Covid-19 through the lens of the Digital Society, which encompasses the domains of health, education, work and the home. The methodology applied is that of observation, with observations made limited to those solely from a United Kingdom (UK) perspective. Observable impacts for each domain are catalogued and appraised in terms of their overall positive and negative characteristics, extrapolating the lessons to be learned from them. In addition, the findings of an international virtual roundtable on how Artificial Intelligence (AI) is presently being used in helping fight against Covid-19 are discussed. Finally, conclusions are drawn on the application of data analytics and AI for post-Covid recovery and whether their leverage can provide a “Big Data Smart Future”, with suggestions for real world applications, for domains

observed and the virus itself. Furthermore, predictions are made regarding the future of these domains in any new digital society.

### ***Big Data, AI, Analytics and the Digital Society***

Big Data, Artificial Intelligence (AI) and Analytics are now integral parts of the Digital Society. Big data are commonly described as massive heterogeneous data (unstructured, semi-structured and structured) sets, not solvable (manageable data analysis) using conventional data models, such as relational databases. McKinsey Global Institute (Neaga and Hao, 2013) suggests models for big data characteristics based on the source, with the main key characteristics being those of Volume, Velocity, Variety and Value, plus the characteristic of Veracity. Additional characteristics are those of Variability and Complexity (SAS, 2012).

Big data originates from multiple, often ad hoc sources, and can be a by-product of other things; data stored in conventional databases, in public, private, hybrid or community clouds (Chang and Wills, 2013, pp. 233-234). It may be gleaned through social media interactions, or sensor data generated as a result of the Internet of Things (IoT) (Palmer, 2015a, p. 14), for example, Hive (BritishGas, 2015), a Smart Meter which permits the remote control of heating in the home via the internet. Embedded “things” lead to the generation and usually the recording of significant amounts of data (often from sensors) that are amenable to analytics. Analytics can exploit data held in the cloud and cloud storage, adding public cloud data to private cloud data (Gordon, 2013). Many technologies and data sources can be combined to be more pervasive and intrusive, e.g., CCTV (Closed Circuit Television) and GPS (Global Positioning Satellite).

Artificial Intelligence is an umbrella term for a multi-disciplinary approach to making things smarter (intelligent); Interaction Design (formerly known as Human-Computer Interaction (HCI) and originally known as the Man-Machine Interface (MMI)), Natural Language Processing, Knowledge-Based Systems, Robotics, Machine Learning (ML). ML is often used wrongly as a synonym for AI. Arguably, the main problems that AI addresses are viewed to be those of Knowledge Representation and Search, or Search and more Search. Practical applications of AI include search engines, speech recognition, industrial robots, Computer-Aided Learning (CAL), and interfaces such as Alexa.

The original term CAL, rather than e-Learning is deliberately listed because it is more accurate and it aimed to model human learning. Currently, most e-Learning systems are still more web-enabled database than knowledge-based. Human learning (competence achievement) appears to involve the taking in of raw data with a specific goal, organising the data so that it has meaning, and analysing this information (compare and contrast, applying elements of Bloom’s (1956) taxonomy) to a more structured form, namely knowledge (Graham, 2014). Machine Learning aims to emulate human learning through deep learning, Artificial Neural Networks (ANNs), and the realisation of meta-knowledge. Such knowledge or expertise is the basis of knowledge-based systems and heuristic knowledge models.

Analytics refers to the analysis of data to identify patterns or anomalies, and so to provide descriptions, diagnoses, prescriptions, or to make predictions, using techniques such as machine learning, e.g., ANNs, regression, etc. Analytics can be described by their use; Descriptive, Diagnostic, Prescriptive or Predictive, or categorised by their data format and origin; Text analytics, Speech analytics, Video/image analytics and Combined analytics (Marr, 2015, pp. 105-149). Value is obtained by the application of analytics to big data, effectively reducing the state

space, “converting” the data into information (contemporary), or knowledge (future predictive) by making it domain specific. Analytic techniques may lead to the application of established models, such as mathematical (possibly statistical) models or decision trees (which may be part of a knowledge-based model), post processing (filtering, etc.). Analytics are essentially the application of a set of processes (algorithms) and technologies (systems), plus people (skills), to make sense of data (Heger, 2014). For example, ML algorithms are a process of learning a model of the world to predict future outcomes. The type of analytics used is based on the outcome, e.g., classification or clustering (if the outcome is discrete) for a numerical regression problem. Not all big data is stored, as it is not normally possible or desirable.

The data driven approach of big data analytics has led to the epistemology of knowledge itself being challenged, from theory-based hypothesis and experiment driven, to data synthesis and mining with two perspectives on data; data as research objects and data as scientific methodology. Pale et. al. (Cate, 2016) argue that big data is a new approach to scientific inquiry in which data collection and mining alone (without theories) is a legitimate form of scientific enquiry.

Current applications of analytics include medical applications, such as the Human Genome Project, with Genomics becoming increasingly important (Palmer, 2015). One domain source of big data analytics has apparently been utilised successfully for another unrelated domain; the use of an earthquake aftershocks mathematical prediction model applied to crime prediction in Los Angeles (MIT, 2013), possibly establishing patterns analogous to fractals (Graham, 2017).

There can be unforeseen consequences of analytics: A proposal by the UK Health Minister in 2017 suggesting that all newborns be DNA tested (Smith, 2017); with the claimed justification being for improved health care (genomics). Such altruism could be viewed with suspicion after the (Google) DeepMind fiasco, where private, confidential patient records were used for the development of commercial software (Streams). Newborns are not capable of giving informed consent and their parents (and society) may not conceive any future data harm, moreover, such a database containing the nation’s DNA data would be feared to be an infringement of privacy. It is the transformation of data to information and knowledge through analytics and the fusion of data where issues of ethics become prevalent.

The Digital Society describes the digitisation, by the use of technology, of society in all its components; such as in the home, in the workplace, in the community, etc. The digital society is ubiquitous; however, for those people where the necessary technology required to support it is absent, a Digital Divide is created. Probably the greatest manifestation of the digital divide is “being on-line”, i.e., having access to the digital resources that exists through the internet. In general, the digital divide tends to be most acute for older age groups and those in relative poverty, without the financial means to afford either the technologies (laptops, smart phones, etc.), or the infrastructure (specifically broadband); this lack of access is known as Digital Exclusion.

### **Covid-19**

Covid-19 is a new corona virus, known to be a zoonotic disease; the deadly microbes of the disease jumped the species barrier from animals into humans, before human-to-human transmission. There is some debate surrounding its origins, whether the virus came from a Wet Market or escaped from a laboratory in Wuhan

in China. Covid-19 is highly infectious, with serious or deadly consequences largely for human hosts over eighty years of age. A peculiarity of Covid-19 is that, unlike other corona viruses such as influenza, the very young appear mostly impervious to the virus and are often asymptomatic if infected. The latter attribute is a major problem as it can be spread unknowingly. This factor was a significant enabler in the virus becoming a global pandemic. Political influences may have also played a part, with data and information provided being delayed or incomplete.

Several countries, notably New Zealand and South Korea, responded quickly to the outbreak of Covid-19 by closing their borders, restricting movement and implementing successful test-trace and isolate regimes. This was driven in part by their previous experience with other corona viruses, like the Middle East Respiratory Syndrome (MERS) and the Severe Acute Respiratory Syndrome (SARS).

There have been several significant events since Covid-19 became a global pandemic:

1. The appearance of new variants like those originating in the UK, Brazil and South Africa, and instances of second and third waves of infection and consequential lockdowns.
2. The rapid development and approval of vaccines; seven at the time of writing this paper.
3. The apparently successful national vaccination programmes of adult populations (over 16 or 18 years of age), in countries like Israel, with the UK not far behind.
4. The identification of a “Long Covid” syndrome for some Covid-19 survivors.

Some vaccines have been developed using the traditional approach of using an element of the actual virus or antibodies. Vaccines have also been developed using the application of genomic sequencing with vaccines mimicking the protein spike of the virus so that the human body can produce an immune response, such as the production of antibodies to this genetic information, delivered using the cold virus (“emptied” of its genetic material) for example.

## Methodology

The methodology applied is that of both secondary research (literature, mainly online due to the pandemic) and primary research in the form of observation. The observable impacts of Covid-19 are provided from a synthesis of multiple sources, too numerous to reference individually.

It is impractical to consider all domains, so discussion will be limited to the impact of Covid-19 on some aspects of the domains of health, education, work and the home. The observations made are confined to the United Kingdom (UK) which is comprised of the nations of England, Scotland, Wales (Great Britain) and Northern Ireland. Notable geo-political factors specific to the UK:

- i) Great Britain is an island.
- ii) The UK, mainly England and London, is a transport hub (people and goods transit through the UK). Heathrow in London was once the busiest airport in Europe.
- iii) The majority of the UK’s population resides in the cities. England is the largest most densely populated nation.
- iv) The UK has a national health service (NHS).

- v) The political decisions and actions by the respective devolved parliaments revolving around Covid-19 across the UK nations have often been unilateral. Discrimination between scientific and political decisions is seldom clear cut.
- vi) As England has the largest population (and therefore, the available data is more granular), as well as being home to the UK Parliament, observations made are biased towards England.

The observational limitations are in part addressed later by the discussion of findings from an international roundtable.

## Results

### ***Observed impacts of Covid-19 on Health***

Outside of the hospital environment, which has been predominantly Covid-19 centric often to the detrimental exclusion of other health demands, there has been a minor revolution in primary care (General Practice). Although General Practitioners (GPs) and, in particular, their staff are now involved in the vaccination roll out, major changes have surreptitiously taken place in health care:

GPs have moved to e-health, with most appointments being on-line or by telephone in the first instance at least.

Many GPs are therefore home working to a large extent.

There has been a huge reduction in face-to-face (f2f) consultations.

The reduction in f2f consultations has consequently led to a reduction in the number of (hospital and other) referrals for non-Covid patients.

All communications with GPs begin with the screening out of patients with or without Covid by directing them to web or to telephone services, such as the number 111 telephone service for non-Covid symptoms; the number 119 telephone service now exists for patients exhibiting Covid symptoms or having been in contact with potential Covid sufferers. The few remaining or persistent patients may then proceed to book an e-consultation (on-line or telephone) with a GP.

In emergencies, rather than telephone the emergency number (999) there is now a requirement to dial 111 to be given an Accident and Emergency (A&E) “appointment”!

In summary, the positive impacts of on-line consultations may be greater accessibility and convenience for patients with the appropriate technology. The negative impacts of on-line consultations are that they highlight the digital divide, with impoverished Computer Mediated Communication (CMC) in comparison to f2f for diagnoses. There’s a lack of Human-Human Interaction (HHI) and the exacerbation of mental health issues due to health service exclusion. In addition to increased big data collection through session capture and a second-class service for patients without the technologies required (digital exclusion). The societal implications are the expansion of e-health.

For health analytics exemplars, e.g., Google DeepMind, or Data Centres, e.g., Care.data, the positive impacts relate to the fact that often data already exists in the form of legacy systems/data, with the mining of such data applying knowledge-based systems (heuristic) or statistical models for genomics, etc. The

storage and analysis of private personal medical records (EPRs – Electronic Patient Records) in data centres can be useful for the potential improvement of health care. New Covid-19 associated data being used for test and trace, and recognition of variants using genomic sequencing. The negative impacts are, however, access to, and exploitation of, personal information and medical records without consent by commercial organisations (Burton, 2017). Privacy is a significant issue, as true anonymity cannot be guaranteed, in addition to control and exploitation of private, confidential data in data centres, especially due to the policies of patient opt out, not opt in (Palmer, 2015). Test and trace data invites surveillance. There's currently a lack of GDPR enforcement (Computing, 2021c). The societal implications of such exemplars are the expansion of e-health and Genomics, plus the continuation of test (track) and trace.

The use of simulation or modelling for health, can impact positively for the simulation of viruses and the epidemiology. Although there may not be any direct negative impacts in the use of modelling and simulation, model-based decisions could be. The societal implications are the expansion of use of simulation and modelling.

### ***Observed impacts of Covid-19 on Education***

With the exception of children of “key workers” (e.g., nurses, police, refuse workers, etc.) and vulnerable children (a term which more recently includes children without access to technology like laptops), during times of lockdown, children are being taught not f2f at school, but remotely and online at home with the coopting of parents who may additionally be home-working (to be discussed later).

The main impacts of Covid-19 relate to the digital divide and the outstanding issues regarding e-learning. The issues surrounding e-learning are well known; however, the sudden reliance on its deployment and therefore the need for internet resources in the home, has highlighted the digital divide and digital exclusion. Many children do not have access to the technologies needed to support any e-learning; laptops, broadband, etc. Further, it has been argued that e-learning does not exist; in reality it is only e-delivery or e-teaching (Graham 2018).

On-line teaching is often of poor quality, more web-enabled database than knowledge based. CMC is impoverished in comparison with f2f interaction. Schools, teachers and children have been required to make teaching on-line without the necessary history or experience.

Due to the desperate circumstances, the sudden haste may often result in schools just putting their class materials on-line, with no real design involved.

The educational day of children is no longer strictly timetabled or structured.

Parents are having to act as surrogate teachers to their children who may be of different ages or abilities, and may, of course, number more than one.

In addition, parents may be both home-working and home-schooling.

The social implications are enormous. Children obtain far more than academic skills; they learn to make friends, socialise; in short, become valued members of society. The estimated cost of the disruption to the education of children is believed to run into the millions of pounds.

In 2020, computer algorithms were employed to “calculate” examination results. The algorithms were shown to be biased towards more affluent geographical areas and schools. These grades were later replaced by teacher assessment, but it is highly likely that there was some grade inflation. There was, realistically, no fair way to assess students. With the exception of professional qualification components, examinations for 2021 are now to be abandoned and purely teacher assessment is to be used for the grading of pupils, with moderation measures to try and ameliorate grade inflation.

University students may be nearer the independent learner ideal, but they also have been forced to learn on-line from home, often whilst still paying for unused accommodation and paying full fees. There is little, if any, f2f teaching and no genuine student experience to speak of.

Impacts are both quantitative and qualitative. Quantitative impacts tend to be financial. Qualitative impacts do have real, often hidden financial costs and are perhaps more important; those of a lost generation, their education and well-being, especially their mental health.

In education, the divides in society have been brought to the fore; digital, social and financial. It should be stated that children in many private and independent schools have been largely unaffected by the pandemic by being able to provide all the technologies needed, or they have been able to operate due to having small class sizes or having student boarders.

In summary, the positive impacts of on-line teaching may be greater accessibility and convenience for pupils and students with the appropriate technology. The negative impacts are that it highlights the digital divide, impoverished CMC in comparison to f2f; screen freezing, loss of immediate whole class feedback, etc. Lack of hhi and mental health issues due to educational exclusion and loss of routine. Increased big data collection (session capture) and a second-class service or loss of education for pupils and students without the technologies required (digital exclusion). The societal implications are the expansion of e-teaching.

### ***Observed impacts of Covid-19 on Work***

The greatest impact of Covid-19 on the world of work has happened during periods of total lockdown when, with the exception of key workers, customer-facing jobs such as hospitality have been furloughed, and all other work has been moved on-line where possible. Like education, the move of business to remote and on-line working has been accelerated. Prior to the pandemic, businesses were already being “gigificated” (Braganza and Chen, 2021), adopting the model of the gig economy. In order to merely survive during lockdown, businesses like retail have, in most cases, moved on-line and the hospitality industry, for e.g., restaurants, has become take-away via apps. During the pandemic, hotels have been used for the homeless, and more recently used for the enforced isolation of international travellers. Zoos, gyms and the like, have offered virtual (remote) experiences.

On-line shopping has increased the demand for physical deliveries. Not all retailers have survived, some businesses losing their physical shops with only their on-line brand being sustained, the final nails in the coffin of the traditional

(physical) High Street appear to have been hammered in. In contrast, essential shops, unaffected by lockdown, for instance shops selling goods including (but not necessarily exclusively) food, have profited from both clicks and mortar, in some cases to the further detriment of non-essential, physical shops. Entertainment venues like cinemas and theatres, as well as travel agents, airlines, zoos and gyms, now have a more precarious existence.

Obviously, there are logistical impacts linked directly with more businesses becoming on-line, due to the vast increase in the demand for delivery services and the use of drones. The global pandemic has also led to more local sourcing of goods where possible. Delivery drivers are key workers who are at greater risk of contracting Covid-19 due to the face-to-face nature of their work, and there has been a higher incidence among drivers and transport staff contracting the virus. (On a more tangential note, there has been a greater demand for cardboard, described as beige gold).

In direct contrast with goods, human transport (travel) has reduced at the same time goods transport has surged. Consequently, at the start of the lockdown the lack of traffic due to the absence of school and business travel has meant less congested roads and a positive environmental impact.

Similar to education, the quantitative impacts are mostly financial and visible. The qualitative impacts of lost work patterns, socialising in the work place and mental health are incalculable. Furthermore, it should be remembered that some parents are having to both home-school and home-work concurrently with limited time and technological resources.

In summary, the positive impacts of on-line working are: Greater accessibility and convenience for employers and employees, with the appropriate technology and amenable to remote working, as well as the expansion of an on-line presence for business. Less or no commuting to a place of work. Less transport, so less pollution. Possible housing and transport cost savings. Savings in costs of office space. The negative impacts of on-line working are: Highlights the digital divide. Impoverished CMC in comparison to f2f for immediate feedback. Lack of hhi. Mental health issues due to exclusion and loss of routine. Increased big data collection (session capture). Second class service or loss of business for employers and employees without the technologies required, or businesses not compatible with remote working (digital exclusion). Lack of separation between home and work. Loss of support industries; cafes, newsagents, etc. Overall, the societal implications are the expansion of e-working.

E-working has led to the greater use of sensors and drones for logistics, with the further application of Radio Frequency Identification (RFID) for goods and medicines and remote delivery by drone. The negative impacts include tracking and tracing of individuals as well as goods, as well as health and safety issues regarding the use of drones. The societal implications are issues of mass surveillance and privacy, and the increased use of drones.

Whilst mobile communications and technologies for e-working, can be used positively: GPS can be combined with other technologies, like smart phones, for notifying individuals who have been in close proximity to Covid-19 positive

cases, there are negative impacts and societal implications, namely, real time mass surveillance and privacy issues.

Surveillance via CCTV can be positive; for example, it can be used to monitor the well-being of babies in the home and the elderly in care homes, as well as the health of hospital patients (Computing, 2021), it also has negative applications when CCTV is combined with drones, making the technology mobile. CCTV when enhanced with face recognition software can allow movements of individuals to be monitored (tracked/traced). The societal implications are the expansion of e-surveillance and a truly Orwellian society (Orwell, 1949), with the location and activities of the population continually observed, recorded and monitored.

### ***Observed impacts of Covid-19 on the Home***

As has been mentioned already, the home has for some become the classroom and the office; during periods of lockdown, it may also have been perceived mentally to be a place of incarceration. As well as the imposition of the new demands of e-health, e-education and e-work in using technologies for on-line medical consultations, on-line lessons or remote working, there are now additional demands for on-line connectivity in the home, for smart devices for leisure; virtual gyms, streaming of films and television, communication forums and virtual meetings, plus the increasing push for the adoption of smart meters and such like. The pandemic has resulted in an unprecedented expansion of the use of smart technologies, electronic communications and logistics. There have been savings from reduced travel to offices and the use of office buildings, both financial and environmental. Electronic communications have allowed daily activities to continue to some degree, even exercise can be “smart”. The use of cash, partly due to more direct or on-line payments and more on-line shopping, but also as a direct result of the need to avoid infection spread, has been significantly reduced.

Life in the home lately revolves more around the laptop or Smart TV; watching streamed classes or television, meeting, working, shopping, and having health consultations on-line. Households without facilities are hugely disadvantaged, however, for other households the divisions between the home life and everything else is now completely blurred. As Tree Hill, the CITL CEO states: “We risk creating a society that only connects on-screen” (Computing Daily Update, 2021).

There are positive impacts for on-line leisure, e.g., Peloton, like the creation of virtual (exercise) communities, again with greater accessibility and convenience for those with the appropriate technologies. The negative impacts are: Highlights the digital divide. Impoverished CMC in comparison to f2f. Lack of hhi. Increased big data collection (session capture). Societal implications are the expansion of e-leisure.

For on-line media, e.g., Microsoft’s OneDrive, Netflix, Smart Televisions, the positive impacts include the external collation and sharing of personal artefacts (photographs, movies, music and data). Equally, the negative impacts relate to the fact that the ownership of data may not be clear. Photographs, etc. could be exploited by marketing companies or used by paedophiles. Data can be fused for profiling of individuals by organisations and governments. Data fusion could also be

used for identity theft, fraud, and other e-crimes. The societal implications are the expansion of e-media.

With regard to social media: e.g., Facebook, Twitter, Zoom, these platforms can enable remote socialising. The negative impacts include obtaining intimate knowledge of individuals by commercial organisations, with additional data accrued through likes and dislikes, in addition to cyber-bullying, profiling and control (often by suggestion, e.g., up-selling). There are massive security issues if data is lost or hacked. The societal implications are the expansion of the e-society.

On-line shopping can be positive in terms of convenience, with less (click and collect) or no travel to shops. Less individual transportation, so less pollution. Negative impacts are a greater demand for (physical) delivery services and the demise of the physical High Street and the shopping experience, plus big data generation. Societal implications are the expansion of e-shopping.

Smart devices for the home, e.g., smart meters like Hive (BritishGas, 2015), can have positive impacts by inferring health conditions and falls from their usage for elderly care home residents (Computing, 2021). Negative impacts are that they can identify periods of home occupancy; infer employment from usage hours and unwarranted knowledge of personal health from average temperature. The remote control of devices via the internet, could allow devices and data to be controlled by parties other than legitimate users, such as hackers or hostile governments. The societal implications are the move towards Smart Homes.

Digital exclusion is applicable to all domain exemplars in the home.

### ***Current applications of Analytics and AI to Covid-19***

The use of AI to help scientists in their mission to beat the Coronavirus pandemic was discussed at a virtual roundtable organised by the International Telecommunication Union (ITU), a summary of this discussion follows (Computing, 2021b).

Soo Jun Park, Assistant Vice President, ETRI (Electronics and Telecommunications Research Institute, South Korea), explained how the technology was employed in his country, using the lessons learned during the MERS outbreak of 2015. He described how, at the time, South Korea was the worst-hit region besides the Middle East and that they didn't then know how to cope with infectious diseases. In hindsight, one key problem was "that at that time the government concealed all the information. It didn't release data about patients, hospital capacity, or anything. That exponentially increased the number of infected patients". The key lesson was about making the data widely available. "We learned that to cope with infectious disease, openness is key, it's not just about gathering the data. You have to let people know what's happening, and let them know the truth about what's going on. We changed laws to accommodate that. Korea had our first confirmed case [of COVID-19] in January 2020, a lady who'd arrived from Wuhan. From that moment the government reacted very quickly, based on our previous experience. We also had the right IT infrastructure in place. We have very sophisticated medical systems, with universal health insurance for everyone. Those things combined helped us handle the pandemic". The infrastructure included a smart quarantine system which gathered information on arrivals from countries where infectious diseases had occurred, tracking and monitoring those diseases during the quaran-

tine period; the data was also shared with medical institutions. South Korea has a self-health check app for new arrivals, contact tracing, and an AI-driven COVID-19 X-RAY and CT image screening.

Moez Draief, a global chief scientist and VP of data science and engineering at Capgemini added that AI is also used in background research. "We're also using AI in the background, where it sifts through thousands of medical papers for relevant information, and helps our understanding of any potential adverse effects of any drugs we're developing". He added that collaboration with regulators is also important, and it is something which the UK could perhaps learn from. "In Europe the regulators are very open to engagement to help innovation progress, there's an understanding that we have to work together. Scientists need to know where the regulator is happy for innovation to happen. And the regulator needs to anticipate where the innovation is likely to happen. We need this to avoid issues occurring down the line where either side is surprised. For instance, contact tracing in France is done hand-in-hand with the regulator to understand how it should be done". He went on to discuss how AI can help with any anti-vaccination sentiment: "We are engaging to understand the arguments and which parts of the population are sceptical about vaccines and why. There's a lot of fake news out there. We have a project where we're looking at communities who have taken cancer drugs, and enabling them to interact, and to have tools to recommend people for them to talk to, to create a dialogue rather than an echo chamber. This is where AI can help, not to solve the problem but at least to facilitate the dialogue".

Another contributor to the forum, Ulla Jasper, Policy Lead from the Botnar Foundation (a philanthropic foundation based in Switzerland), added that more work needs to be done to enable data sharing on a global scale. "There are lots of initiatives and voluntary codes, but too little concerted effort. Not that we need to arrive at a global one-size-fits-all data governance framework, but instead how can we share data across borders? The flow of data during Covid has not been perfect. We're not necessarily looking for one big solution, but we need to find sub-fields where we can see progress more easily. Like data sharing in public health emergencies".

In a similar tone, Fred Werner, head of public engagement at the ITU called for greater data sharing. "There's more data now than ever before. But that doesn't lead to a greater exchange of data and collaboration. I've been in lots of different meetings where data is always the crux of the issue. Someone will ask who has data, and everyone raises their hands. Then someone asks who's willing to share it? And everyone looks at their shoes. So working out how to share it safely and securely is critical. There's not a lack of open source data, but you look at the basics like; is it discoverable, is it labelled correctly, is it freely available or licensed, or peer to peer? These are all bottlenecks".

The roundtable discussion concluded by stating the need to identify and acknowledge the issues raised; having now taken the first step towards solving them, the time to accelerate the next steps is now.

## Discussion

Post Covid-19, the following trends are increasingly likely to become reality in the digital society, through lockdown acceleration:

- Home-based, on-line and remote primary health care, with initial f2f consultations being a rarity. Pre-consultation use of on-line query systems, such as NHS Direct, or the telephone service 111. Many more on-line, remote hospital consultations. Greater use of Genomics and analytics.
- Home-based, on-line and remote learning. Blended learning, already a given for universities, has now become a part of school life due to the pandemic. School and university closures are possible, as well as the expansion of e-Universities.
- Home-based, on-line and remote working to some degree where and when possible, providing time and cost savings for employers (office space costs, meetings, increased productivity, for example), likely to be less beneficial initially for employees beyond commuting in most cases, although home location options may be more flexible in the long run. Reduced road traffic could mean that motorways are no longer required to be “Smart”, with the hard shoulder being reinstated.
- Home-based, on-line and remote shopping and banking. The further demise of physical shops and cash.
- Home-based, on-line and remote leisure; virtual gyms, music and film streaming, social media.

The move towards e-health in England will be in part led by NHSX, which is “a joint unit bringing together teams from the Department of Health and Social Care and NHS England and NHS Improvement to drive the digital transformation of care” (nhsx, 2021). Genomics and new innovations in vaccine research during the pandemic are now being used to produce pill versions of vaccines, and vaccines that, rather than only targeting the spikes on the virus’s surface, target the virus’s nucleocapsid, the shell that contains the virus’s genetic material. Because this shell is much harder for the virus to change, it is harder for the virus to mutate against a vaccine, hopefully leading to a universal vaccine that works against new, more resistant, variants (Nottingham University, 2021). The pandemic may have also spurred research on the first vaccine for Aids and other illnesses like Malaria.

It has been reported (Computing, 2021a) that firms as diverse as technology behemoth Google and investment giant Schroders have stated that employees need never return to the office, and that the coronavirus pandemic has left a lasting legacy of permanent change in employee and consumer behaviours. In 2020, Amazon’s sales leapt 40%. Similarly, it was reported (BBC, 2021) that for Asda, on-line shopping with them had been accelerated by 10 years, and they would be looking to reduce customer front-facing staff and back-office staff involved in cash transactions, employing more delivery drivers and order pickers.

In applying analytics and AI to Covid-19, the roundtable discussion highlighted the need for the early, safe and secure access to data (correctly labelled, etc.), local and international collaboration, with global data sharing in public health emergencies, the strengths of having a national health service, and good communications with regulators and the scientific community. AI having been employed for background research on relevant information on the adverse effects of any developed drugs, by sifting through medical papers as well as AI-driven contact tracing,

a self-health check app (for arrivals), Covid-19 X-ray and CT imaging. AI was also deployed for identifying anti-vaccination sentiments, understanding the arguments and which parts of the population are sceptical about vaccination and why, with AI facilitating the addressing of fake news by creating dialogues with cancer drugs and other communities.

The negative impacts of Covid-19 itself on society are not always tangible. There are many more incalculable costs of the virus beyond death and infection statistics, such as the disruption of primary care and education in the widest sense. These intangibles, such as the impacts for mental health, loss of daily routine, lack of human-human interaction, non-Covid related deaths and diagnoses (harder to quantify), shine a light on the digital divide, educational, work, social and health inequalities. Although the economy may well bounce back in the future, these negative consequences could result in a lost generation, the young paying the costs in terms of their education and mental health, in addition to the long-term national debt.

Back in 2013, Curran (Sumner, 2013, p. 16) argued that “data centres will be the engine rooms driving the ‘Fourth Industrial Revolution’, which will see the internet of things, and big data transform the way modern businesses operate and societies function”; the pandemic has massively accelerated this transformation. All of the observed trends are likely to require improved logistics, better communications technologies and generate considerably more big data; their use raises serious ethical issues (Chessell, 2014; CloverETL, 2017; de Lama, 2016, p. 10; Veitch, 2017). As well as the benefits of big data and analytics, there are real concerns about data harm (Cate, 2016, p. 17). During the pandemic, in addition to curtailing freedoms, laws have been changed to permit the unfettered access to some data, raising issues of data harm and whether or not data protection may be fully reinstated (Computing, 2021c).

## **Conclusions**

The domains of Health, Education, Work and the Home are all interconnected in the Digital Society. During periods of lockdown, the home has become the classroom, the office, the cinema and the gym for some people, whilst others have been totally excluded. From the trends identified, it can be seen that the main effect of Covid-19 on society has been the acceleration of its digitisation, with the rapid, often untested expansion of e-health and Genomics, e-teaching, e-working, e-logistics, e-communications, e-leisure, e-shopping and Smart Homes.

The pandemic, especially during times of lockdown, has demonstrated the requirements for moving to the digital society, such as providing the necessary infrastructure to support it, and these are the lessons which need to be learned in this new reality, if the whole of society is to be included.

Analytics and AI can provide leverage for post-Covid-19 recovery. AI and analytics can be specifically applied to future pandemics. Big data analytics has been employed mostly for diagnostic analytics and the analysis of current infection outbreaks for test and contact trace, often using a form of reverse engineering. Predictive analytics could be exploited to predict future outbreaks, both when and

where, using Covid-19 data as test data. Likewise, AI, namely machine learning, could be used to determine future variants and new viruses by applying genetic algorithms. If successful models can be built applying genetic algorithms, then this self-organising approach could be extended to other diseases and illnesses; there are many possibilities for this application development.

AI can, and should be, used to improve e-teaching, making it truly knowledge-based. Analytics and AI are already an intrinsic part of business, logistics and communications.

Neither data analytics nor artificial intelligence can directly bring about social change beyond providing data and knowledge to support that change. Post Covid, the demand for greater integration of technology will act as a catalyst for Smart(er) Homes, Smart(er) Working, Smart(er) Schools and Universities, Smart(er) Transport, and so on, to Smart(er) Cities, with the UK heading for a fully Digital, or e-Society. This will be enabled by the further generation and analysis of big data, as the pandemic has massively increased the amount of big data captured, especially medical and logistical data. AI will also be embedded in many more activities in order to deliver the Smart Cities and a Contactless Society using Dynamic Analytics.

The advent of the Big Data Smart Future through AI, analytics, the IoT and robotics, could lead to challenges to the epistemology of knowledge, the automation of intellect and the loss of human ingenuity, allowing humanity to sleep walk into its own intellectual demise. AI and analytics must be additions to, not a replacement for, methods of scientific inquiry. Society is not threatened by big science or AI, but is threatened by the ill-considered automation and digitisation of every aspect of human life. The ethical dilemma for big science is balancing the positive possibilities against the potential for data harm. Information is power, as has been demonstrated fully by the pandemic, and the digitisation of society ensures that things are recorded in perpetuity. The pandemic has also meant the realisation of what is important as human beings; humans are basically tactile and social animals, and society is essential to learning, to work, to health and well-being; there is no substitution for physical human contact (there would be no humans in the long run!).

In the post-pandemic future digital society, suggested predictions over the next ten years include the absence of GPs in primary care in their current role. Because of the move to e-health during the pandemic, GPs have often been found to be more of an impediment or barrier to secondary care, rather than an interface to it, the interface now effectively digitised. GPs will likely have to find a new role, providing more f2f contact, if they are to be of added value, possibly as a part of hubs with other health professionals e.g., dentists, where physical interaction is a must. Secondary care is unlikely to change immediately beyond having a more direct, digital interface to it, with the later application of AI, analytics and genomics for diagnoses and prognoses being standard practice, perhaps also the increased involvement of robotics.

Contrasting with GPs, the value of teachers, mainly because of their social, not just their academic contributions to the education of society, has been made abundantly clear. Digitisation of school education beyond support (blended

learning), is not desirable or necessarily financially attractive. However, the future of Higher Education, is more open to being digitised, with more on-line universities, as there may be a stronger business case for e-education in this sector.

For e-work, a balance between the benefits of on-line versus conventional work and work environments will be settled on by employers on a case-by-case basis. The automation of many aspects of work will no doubt continue at pace, and society will need to be retrained to “fit in”. There are financial ramifications for the automation of employment, essentially how taxation will be raised to pay for new services and training.

The futures of e-work, e-education and e-health, all overlap with that of the Smart Home. Whilst the Smart Home could be the embodiment of the e-society and all its parts (work, education, health, leisure, entertainment, communication, etc.), it may simply be undesirable. The total digitisation of the home proving to a step too far, with screen stacking and a Big Brother feel, as home is felt by many to be a sanctuary and their castle (no matter how humble). Regardless of this sentiment, perhaps regrettably, it is more probable than not that Smart Homes will be the future reality. At the end of the decade, Smart Homes will direct the digitisation of society; filled with smart sensors and interfaces, they will constitute hubs for all activities; work, leisure, etc. New homes will be designed to be part of Smart Cities which can be physically remote because of e-working (more akin to Smart Villages), and will not require garages, with smart (driverless) cars available for door-to-door transport. More consideration should therefore be given to the environment, particularly, the need for green and social spaces for HHI and mental health, if this brave new world is to be embraced. There may be many benefits of an e-society, but the costs are likely to be our personal autonomy and privacy if adequate care is not taken.

Acknowledging the research limitations (UK bias), society appears to be heading towards becoming a fully digital or e society. Unless the current digital divide and the resulting digital exclusion is resolved, this unstoppable momentum towards the e-society could lead to two parallel societies; one connected and one isolated underclass.

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