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Information Technology Challenges Faced during the Covid-19 Pandemic in Higher Education

Dr Parin Somani[1]
[1]*Independent Academic Scholar, United Kingdom*

Abstract: Information technology (IT) systems have primarily been used as a supplement to traditional teaching methodologies prior to the coronavirus pandemic. With the closures of higher education institutions resulting from lockdown restrictions, IT mediums were used creating a rapid shift from face-to- face learning to e-learning. However, this sudden transition resulted in IT challenges being faced by students to continue education. This study aims to identify the IT challenges faced by students in higher education. There is an endeavor to recommend solutions to facilitate students to continue education, towards positive sustainable progression post pandemic. A systematic literature review by means of a thorough literature search is carried out in this study using published and grey literature sources. Results have identified the following challenges that are discussed in this study: A rapid transition to e-learning from remote locations to continue education; cloud computing; and security challenges.
Keywords: IT, Covid-19, E-learning, Cloud computing, Security

I. INTRODUCTION

Higher education institutions are vital to societal development and to produce well educated, global citizens [1]. Individuals are taught beliefs, values, morals, and habits that constitute to the development of societies globally [2]. Primarily, higher education institutions have always used methods of face-to-face instruction to teach students, where students would be categorized into groups determined by their age and learning abilities. Educators would stand at the front of the classroom and direct valuable information to their students through verbal means, often utilizing blackboards, white boards, or projectors to provide visual cues. The traditional method of educating students, used verbal and non-verbal cues to ensure students were actively listening and understanding what was being relayed by the educator [3]. Same material was imparted to all students who were expected to memorize the teachings and pass examinations held in a live situation in the presence of other students. The traditional system of educating students has been successful as students acquired the results to continue further education or contribute to society through employment. Hence, throughout history this medium of teaching students has gradually progressed over approximately a century. It has passed through the motions of educational essentialism and educational perennialism to educational progressivism [4]. However, the 1963 the vocational educational act permitted technology to be utilized within schools [5]. Since then, information technology (IT) systems were used as a supplement to traditional teaching methodologies. The use of IT within education provided educators with the means of introducing another form of learning to progress learners. Higher education institutions used IT for part time distance learning courses for students that needed the flexibility to continue education [6]. However, the recommended method of teaching students included physical face-to-face interaction, which was suspended due to the coronavirus (covid-19) pandemic.

Covid-19 is a deadly communicable virus which has resulted in global catastrophes [7] affecting social, economic, and political factors. Two international conveyances, two hundred and ten countries and territories across the world have been affected [8]. Hence a public health emergency of international concern was declared on 30th January by the World Health Organization (WHO) altering nations to the seriousness of the virus and implications of human health. Particularly as close contact between individuals increases spread of the deadly virus through droplets of saliva or nasal discharge of an infected individual [9] is inhaled or transferred into a non-infected individuals' eyes, nose or mouth [10]. In the endeavor to control the covid-19 and limit the rapid spread to protect global societies from death and contracting the virus, governing bodies decided to work together and implement lockdown measures. Therefore, social distancing regulations, self-isolation and wearing personal protective equipment (PPE) were enforced resulting in the closure of non-essential businesses, organisations, and institutions [11]. This created an impact upon higher education institutions as they faced physical closures, ultimately changing the dynamics of teaching, and learning pedagogies for students. In total approximately 1.2 billion learners in 186 countries globally have been affected due to school closures during the pandemic [12]. This created immense uncertainty pertaining to sustainability of higher education institutions and disruption of student learning objectives [13]. Fortunately, residing in the era of technological revolution and IT mediums, higher education institutions went through a rapid shift towards using IT facilities to progress student education. However, this resulted in IT challenges being faced by students to continue education.

Objectives

This study aims to identify the Information Technology challenges faced by students in higher education. There is an endeavor to recommend solutions to facilitate students to continue education, towards positive sustainable progression post pandemic.

II. METHODOLOGY

A systematic literature review by means of a thorough literature search is carried out in this study using published and grey literature sources. Literature is identified, extracted from, analyzed, evaluated, and interpreted. The following electronic databases are searched including Google Scholar, SCOPUS, Springer, and JSTOR. The following keywords are utilized in the initial search: Information technology, Higher education, Students, Education, Challenges, Covid-19. Several literature sources are identified; hence the following exclusion criteria is devised:

- Literature irrelevant to Information technology and higher education is overlooked
- Literature focusing on institutions apart from higher educational institutions is not used
- Literature presented in other languages apart from English is excluded
- Literature that is older with information presented in newer studies are rejected
- Literature that does not include sufficient technical information regarding their approach is ignored

A total of thirty-eight literary sources have been selected and shortlisted to provide a focus on the study. Upon close examination two literature sources are duplicated and discarded. All the abstracts and introductions of literature sources are closely analyzed, and one literature sources are removed as it does not meet the criteria. Further detailed examination has led to another literary source to be eliminated. This has resulted in a total of thirty-four primary literature sources to be used in this study.

III. RESULTS AND DISCUSSION

Results have identified the following challenges including: a rapid transition e-learning from home to continue education; cloud computing; and security challenges.

E-learning

Higher education institution closures resulted in a rapid transition to the use of IT facilities permitting students to seek education from remote locations. This required appropriate hardware, software and internet connectivity to access learning materials provided by higher education institutions [14]. This has not been possible for students belonging to lower socio-economic backgrounds due to insufficient funding, thereby constituting to terminate their educational process or deferring the year [13]. Stable internet connection has been a challenging factor for students that have been studying from home, as learning materials provided by higher education institutions can only be accessed through the internet. Therefore, for students residing in rural areas access to the internet has been poor or not available. This has impeded upon their ability to acquire knowledge; particularly as electronic teaching pedagogies all involve a stable internet connection. This can result in frustration and additional mental press on the student's ability to confidently acquire education [15]. The inability to attend educational institutions, disruption of daily routines, lack of digital competence and social disconnection has contributed to heightened mental health implications amongst students [16]. Approximately 83% of students with pre-existing mental health issues have experienced exacerbated symptoms during the covid-19 pandemic [17]. While 25% of students with no prexisting mental health challenges have reported issues [18]. Higher education institutions should use effective and efficient communication methods to ensure their students are connected to them and other peers to provide some form of support. This can be implemented through the use of IT facilities and electronic learning platforms.

Higher education institutions have been utilising e-learning programs as a medium through which education can continue. The use of interactive video conferencing software allows visual and audio stimulation connecting educators and students onto one platform. Through this method, students can see their educator in the same way the educator can observe students when cameras are switched on to gage verbal and non-verbal communication, replicating the closest to a traditional situation [3]. The diverse learning materials accessed using IT, provide students with the flexibility to access pre-recorded tutorials that they missed and learn at a convenient time for them. Students can access learning tools like presentations, texts, associate weblinks, virtual assessments[19]. Simultaneously they can send emails and partake in live chat sessions, send voice notes, participate in blogs, and utilize social media platforms like Facebook, Twitter, LinkedIn amongst others to stay connected. Higher education institutions have utilized interactive videoconferencing software like zoom, Microsoft Teams, Google Meet, and others [13] which possesses multiple functions to educate students in a live

situation. When students want to ask questions, they can use the 'hand raise' function and wait for the educator to acknowledge a response, students can use emoji to express their emotions and the 'chat' function can be used to interact with other students during the session. To create smaller group discussions, educators have been using the 'breakout room' function through which they can assess knowledge gaps and help students accordingly. Therefore, IT can drive student interest when utilized in the correct manner, for example during virtual lectures educators have been able to devise virtual polls or questionnaires to consolidate student understanding [20]. The utilization of IT through these methods has enabled the continuation of education during the pandemic.

Cloud computing

IT is continually progressing therefore it is the prerogative of higher education institutions to stay updated with novel advancements and understand how they can be utilized to help progress student education. Cloud computing can be described as a distribution model that permits the independent access of services and applications to be accessed from space and time within a large, centered infrastructure [21]. Cloud computing has been utilized in many sectors including financial, health, military, automotive, insurance and higher education [21]. Cloud computing is a means by which higher education institutions with restricted financial sources can utilize cloud applications to manage and increase academic efficiency, student performance and teaching effectiveness. It provides computer services that are faster, flexible, and economically feasible including the use of a database, server, network, software, storage, analyzing and storing information over the cloud [22]. It is a model that that been built on existing technologies like grid computing and virtualization, allowing the formation of advanced and scalable application through a scalable and reliable infrastructure. Wikipedia, Hotmail, Twitter, and Google are some platforms that have experience in cloud computing allowing accesses to information via the internet from any location at any time of the day [23]. The data generated by individuals on the applications are put within the cloud which is then accessed through the interface which is the mobile device. Therefore, sources and services can be accessed without exerting effort, managing data and limited interaction with the service provider [24]. Through this medium, business applications can be perceived as sophisticated services which can be accessed over a network. During the covid-19 pandemic there has been an increase in the array of information generated, stored, and shared within electronic environments. Simultaneously the access to information from countries globally can be at any time of the day particularly as students enrolled within universities comprise of national and international students. It is important for all universities to make use of cloud computing as they are at the forefront of education and research [25]. Universities aim to develop their scientific and technical knowledge, they also train students to serve societies, enhance the intellectual power and cultural awareness of students but also create a common culture and standard forming the bases of societal norms. To achieve these elements, higher education institutions face numerous challenges including financial implications, access to hardware and software although in the long term these are cost-effective measures. It provides a bases through which students can participate in personalised learning, economical, measurable, accessible, reduced carbon emissions and standardization. In contrast, challenges of cloud computing include compliance issues, security, reliability, a lack of support and skills, cloud policies, complexities [26]. The United Nations Educational, Science and Cultural Organization has recommended online applications comprising of Google Classroom, Blackboard, ClassDojo and CenturyTech as some of the named applications that can be used in education. Although other apps also include Dropbox, Google Apps for Education and Microsoft Office 365 amongst others [27]. Cloud computing is being used within some universities and with technological progression, it is likely that the implementation of cloud computing will result in increased use by higher education institution students globally. Most higher education institutions are utilizingvirtualization technology despite most half of the IT departments in universities contain a cloud architecture [21].

Security challenges

Where IT is concerned, higher education institutions face numerous security challenges as they are deemed as beneficial targets for cyber-attacks particularly as they have been victims of such scams previously [28]. Higher education institutions contain vast amounts of data and research that is sensitive and valuable making it a target for cyber criminals and hackers [29]. When individuals attempt to carry out cyber-attacks research has revealed that they need a motivation, an intention and threat events. Table 1 [29] illustrates an overview of the threats encountered by higher education institutions. It has revealed that financial gain is the dominant motive of criminals who carry out cyber-crimes, while Intelligence and Political are the motives of State-sponsored Cyber Espionage, human errors, opportunists, chaotic actor hacktivists, insider are all mentioned.

Threat	Motivation	Intention	Threat events
Cyber-crime	Financial	Unauthorized access, Deny Access Infrastructure hijack	Malware, Hacking, Social engineering, Abuse, Botnets, Stolen Credentials. Fraud
State sponsored espionage	Intelligence, Political	Unauthorized access, Data gathering	Sophisticated attacks: Social engineering, Tailored malware, Persistent access, credential harvesting
Human errors	Carelessness	N/A	Data loss, Data leakage
Opportunists	Self-assertion, Fun	Exploitation, Infrastructure hijack	Hacking, Copyright violations, DDoS
Chaotic actors Hacktivists	Ideology, Political	Damage reputation, Sabotage	DDoS, Spear-phish, Website hacking
Insider	Grudge	Sabotage	Rights abuse, Physical destruction, Data leakage, Denial of Service

Table 1 [29]

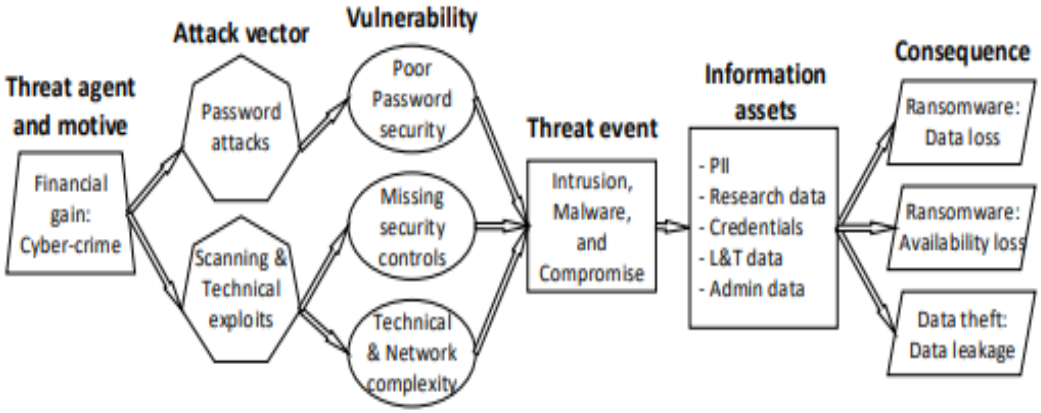

Figure 1 [29]

Figure 1 carried out within the same study has illustrated the motivation of financial gain carried out through cyber-crime. The criminal attacks through the password or scans and technically exploits finding vulnerable points creating a threat to obtain information assess resulting in ransomware data loss, a loss of data availability or leaking the data. During the covid-19 pandemic educational institutions underwent the following attacks: ransomware, internet of all things, phishing, cloud, blockchain cryptocurrency, machine learning AI, software vulnerabilities, and BYOD policies [30]. By understanding the security challenges, solutions can be implemented to protect students and higher education institutions from vulnerabilities. This can include stronger passwords and frequent change; filter emails so than unrecognized emails are not opened. Anti-virus software should be made available and an array of security solutions to remediate the damage including restoring lost data. Both educators and students should be educated on IT health ensuring the data is continually updated, and what to do in an event of identifying malicious emails. Students may benefit from downloading the security software on their own devise as recommended by higher education institutions they attend, helping to protect the network. Therefore, it is advantageous for higher education institutions to adopt a multi-layered approach so that all users have appropriate training to minimize damage should the occasion arise.

IV. CONCLUSION

Many disparities have been highlighted illustrating digital inequalities using IT. Higher education institutions can raise awareness and provide coping strategies to facilitate students experiencing mental health challenges, including identification strategies and coping mechanisms. E-learning modules can be integrated within learning materials to support students and small community based initiatives can facilitate this process. Cloud computing service models are being adopted by higher education institutions, it is an important element as online methods of educating students become more prevelent during the covid-19 pandemic. Particualry as a new normal world has not been reached with continuous societal fluctuations as lockdown restrictions are being

eased within societies globally. The use of cloud computing can allow problems to be solved efficiently and at a faster rate which is particularly useful during the covid-19 pandemic when students are facing uncertainty creating an impact towards negative mental health. Although higher education institutions use cloud computing, it is not used to its full capacity and many individuals require more knowledge on fuctionalities and how it can be used to facilitate higher education institutions. Cloud computing can be successful if higher education institutions consent to utilising their financial resources to invest in the appropriate IT equipment and comit to using it correctly due to the long term benefits. Awareness levels can be raised so that compliance levels linked to higher education structure can impprove offering adequate support by the administration team. Financial support should be offered to higher education institutions to aid the purchasing of adequate hardware and software to progress this endeavour, as well as maintaining and repairing the IT systems. Through percevierence, IT can be subject to being restructured within the cloud environenmt. Through conducting research and development initatives on cloud computing, higher education institutions can obtain more information on how this will help students in the future. Awareness on security challenges and needs to be adressed in higher education institution so that appropriate protection strategies can be implemented to ease security challenges in the new normal.

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