Institutionalizing Technologies in South African Universities: The Imperatives in the Fourth Industrial Revolution Era

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Abstract

This study investigated the essentials for institutionalising technologies for teaching and learning across the three types of universities in South Africa. This was intending to determine the skills required for teaching and learning in the 4IR era. Survey design using structured interviews was adopted for the study. The population consisted of all the Executive Deans/Deans of Faculties in twenty-six (26) South African Universities. A total of twenty-two (22) Universities were purposefully selected to allow fair representation to make the findings generalizable.

Seventy (70) Executive Deans/Deans participated in the online data collection via Microsoft Teams and Zoom.

Findings revealed that the universities in the Republic deployed fifty-seven different technologies to facilitate their teaching and learning activities, and teaching platforms had been supplemented with new technologies such as WhatsApp, Zoom, and MS Teams. Although resistance had been experienced in the past and most faculties had also not been provided with the institutional guidelines for embedding 4IR in their activities, the teaching staff is competent to moderately competent in the use of existing technologies for teaching because most faculties had provided training in an on-going basis. Improvements in the standard and quality of teaching and learning were observed, and the roles of the industry partners and the community of practice had been highly beneficial.

The study concludes that while Universities are settled to adopt blended learning as the strategy to implement the convergence between human and machines in the era of the fourth industrial revolution, there is a need to have a national policy in place that deals with funding (special grant) to plug the gap on the digital divide.

Key Words: Higher Education, Fourth Industrial Revolution, South Africa

1. Introduction

The reality of the fourth industrial revolution had been brought to the fore by the global pandemic (Covid -19), which pervaded and disrupted all sectors of the world's economy in the year 2020, many institutions of higher learning across continents had consequently witnessed a measure of hiccups. At the moment, there is a dearth of empirical evidence on the experience of universities in South Africa in assimilating and institutionalising technologies for teaching and learning. Therefore, this study sought to investigate the experience of institutionalising technology for teaching and learning in South African universities. This will provide reliable data and information that would enable policy-makers and relevant stakeholders to take appropriate steps in advancing education in the country in the era of the fourth industrial revolution.

Education has been identified as a veritable vehicle for popularising technological innovation, and the use of technologies in the institutions of higher learning is intrinsic to the advancement of education (Dunn & Kennedy, 2019; Siddiqui, Thomas & Phd, 2020). Not only do technologies aid learning, they serve both as basic tools as well as the medium for transmitting it. While the usefulness of the ever-evolving technologies as tools for advancing teaching and learning cannot be over-emphasised (Harris, Al-Bataineh & Al-Bataineh, 2016; Cloete, (2017), a shift from the traditional mode of teaching and learning to either a complete technology mode of teaching or a gradual blend of both the traditional and the use of technologies seemed to have been greeted with mix feelings among the academics, especially in the emerging economies (Szadziewska & Kujawski, 2017). This is evident in the number of higher education institutions that have embraced the online teachings in developed economies against emerging economies (Aduwa-Ogiegbaen & Iyamu (2005; Taneri & Seferoglu, 2013). Before the global pandemic, efforts made by various universities, either by a few visionary techno-savvy academics or initiated by the university administrations, had been met with multiple reactions (Ozdamli, 2017).

The research questions addressed by the study on the use of technologies for teaching and learning include the availability of technologies, staff training, the competence of staff, new acquisition, value derivation, challenges, 4IR strategy, skills plan, key personnel, industry partnership, the inclusion of 4IR technologies in the curriculum, the sufficiency of technological tools with students, anticipated challenges and, additional support needed by faculties in the universities while revamping technology infrastructure. The rest of the paper is

subdivided into a literature review, the methodology discussion, the results presentation, and conclusions and recommendations for policy implications.

2. Literature Review

In the history of the world, nothing else seems to bring about further transformation in the knowledge industry than technology. It is a double edge tool for discovering and creating knowledge (Taneri & Seferoglu, 2013). According to Topp, Mortenson, and Grandgenett (2006), investment in appropriate equipment, definite goals, and proper training are paramount to institutionalizing technology. Several factors for making institutionalising technology a reality. Extant literature categorises the factors into two. On the one hand are the institutional factors include infrastructure, technology equipment, policy, etc. On the one hand, there are individual/personal factors that are mostly attitudinal in nature (Ozdamli, 2017; Amoozegar, Daud, Mahmud & Jalil, 2017).

2.1 Common Constraints to Technology Implementation

Makura (2014) noted that efforts towards investment in technological equipment in tertiary institutions across South Africa have been unsuccessful in many instances because they mostly rely on the government for funding. Rather than investing the university budget, the big challenge experienced by entities in rolling out technology-based learning and teaching, was to fund it from their meagre budget.

Compatibility has been perceived as an impediment to implementing technology-based teaching and learning, especially in higher institutions located in rural areas (Johnson, Jacovina, Russell & Soto, 2016). Rogers (2003) and Black et al. (2011) describe this as a situation where an innovation is perceived to be inconsistent with the existing values or cultures as well as the needs of the potential beneficiaries. This problem is commonly attributable to old academics who are largely afraid of interacting with the new technology and prefer a chalk-and-talk system with the students (Altun, 1996).

In South African universities, students with rural origin are perceived to be intellectually incapable of grappling with the use of modern technologies either in the classroom or laboratory. Incompatibility as a barrier to adopting technology for teaching is peculiarly upheld without an empirical proof (Tayyaba, 2012).

Varga (2020) documented the possibility of a drastic reduction in the number of teaching staff that would be required to interact with learners as one of the possible disadvantages of adoption and implementation of institutional-wide technology-based teaching and learning. Senior academic who have perceived such negative outcome could consistently resist institutionalising technology, thereby placing stumbling blocks in the way of transformation.

Some of the constraints to implementing technology in developing economies identified by Woolf, Zualkernan, and Arroyo (2007) and Mhlanga and Moloi (2020) include physical infrastructure, poverty and educational disparity, internet connectivity and cost of internet, which exceeded per capita income in countries like Ethiopia and Bangladesh. In addition to these, lack of experience, infrastructure, and resistance from staff were identified by Ottesen (2007), Khan, Hasan, and Clement (2012) and, Cloete (2017) as inhibiting institutionalising technology for teaching and learning in the educational institutions.

2.2 Basis for Effective Teaching and Learning in the era of 4IR

One of the tools for effective teaching and learning that positively impacts students' learning experience is the use of video as a means of engaging students and over which students have control of the media (Scagnoli, Choo & Tian, 2017; Szadziewska & Kujawski, 2017). The use of video-based flipped class instruction was also found to enhance teaching effectiveness and subject satisfaction in students (Tse, Choi & Tang, 2017). According to Barker and Ansorge (2014), robotic technology was instrumental in increasing of scores of in and after-school programmes.

Mobile-based learning using handheld devices is another commonly used technology that is affordable by students in most instances. It enhances accessibility to learning sites and materials with fewer barriers irrespective of time and location (Chang & Hwang, 2018; Moorthy et al, 2019).

Learning with the 4IR technologies, such as augmented reality, proves to reduce extraneous cognitive load, improve learning achievements, and increase students' motivation compared to the traditional learning approach (Harris, Al-Bataineh & Al-Bataineh, 2016; Lai, Chen & Lee, 2018). Chin and Wang (2021) found that Augmented Reality (AR) mobile touring improves students’ ability to memorise the learning achievements. Rabella (2018) argued that diverse

backgrounds and strong mixes of skills including technical, cognitive, metacognitive and socioemotional competence are needed to develop students for the era of the 4IR.

Ozdamli (2017) and Rabella (2018) emphasised teachers' technological knowledge and confidence in facilitating actual teaching as critical factors to consider in assessing staff competence. While it could be argued that instructors have a key role in the implementation of technology-based teaching and learning (Hew & Brush 2007; Yıldırım 2007), evidence from literature has shown the effectiveness of training and working with small cohorts of teachers in a collegial manner to plan and implement the use of the digital tool for teaching in the classrooms such that resistance to adopt such technology could be minimised (Stieler-Hunt & Jones, 2018). Altun (1996) identified training of staff members to operate the new technologies, investment in the relevant technologies, and appropriate inclusion in the curriculum as the first stage of implementation.

2.3 All-inclusive Academic Curriculum

Curriculum reform and policy development are key to translating from the 19th Century practice of traditional education to the 21st century ICT-induced digital literacy to meet up the demand of the 4IR (Editorial, 2016). According to Altun (1996), change propelled by advent of new technologies must be strategically implemented by education institutions by striking a balance between the curriculum and the needs of the society. Change and shift in the educational curriculum are paramount features of the industrial revolution with the first industrial revolution announcement of "The new Education" and the dramatic shift from the dominant classical education and adoption of German university model for postgraduate research across the United States (Penprase 2018). The changes associated with the second industrial revolution ("New Economy") included a broader representation of veterans, creation of community colleges and expansion of the research mission of universities through federal funding thereby shifting the incentive structures and curriculum in the US for decades.

In response to the third industrial revolution (computerization and web-based interconnectivity), reform in STEM education embraced an interdisciplinary curriculum, emphasizing collaboration. This was found in Soka University of America, which emphasized 'global citizens' and Duke University in China, focusing on 'rooted globalism'. The 4IR brought with it the convergence of exponential technologies, which according to the World

Economic Forum (WEF) would create a massive societal change and shifts in employment and education (Penprase, 2018).

Whittier and Lara (2007) had earlier established positive contribution to lecturers' teaching experience and students' learning experience within faculty with the inclusion of mandatory use of technology in the curriculum. Menon and Castrillón (2019) emphasise the central role of curriculum reform for epistemological transformation. Research has proved that technology can improve students' learning outcomes with the support of good instructors and quality instructions (Tamim et al, 2011; Burns, 2014). This emphasises the danger of absolute reliance on the availability of the tools without a pedagogical foundation. The study conducted by Light (2009) found drastic changes in teachers' knowledge, beliefs, and attitudes; changes in students' engagement with content and use of technological tools; accordingly, changes also occurred in the relationships among students, teachers and their parents, all in relation to shifts in pedagogical paradigms which must be rooted in curricular frameworks.

In the same vein, OECD (2016) advocated for aligning a skills-based curriculum with technology. Academic institutions are bound to reimagine and redesign the traditional educational system's content before the spontaneous change necessitated by 4IR. The impact of education in responding correctly to the pervasive moves in 4IR has implications for economic and global competitiveness.

2.4 Policy Intervention

On the part of the policy-makers, evidence from country-based research and experiences had proved the central role of national policy in institutionalising technology. As pointed out by Burns (2014), Cross and Adam (2007), educational institutions on their own cannot promote a country-wide practice of the use of technology without an approved national policy framework on the use of ICT in education.

Countries like Singapore and Britain have well-established national structure in favour of ICT and technology-based teaching and learning which could be referenced for providing leadership in this regard. Without such support, it has been observed that teachers who choose to use technology to aid teaching and learning have only done so oh their own volition while several others who choose not to cannot be forced against their will.

On this background, that Burns (2014) proposed incentivising tutors as a veritable strategy to embark on successful technology institutionalisation. Citing the cases of Netherlands, Britain,

Singapore, and Korea, the incentive in the form of a pay rise and promotion have been employed to encourage academics to engage with the students using appropriate technologies (OECD, 2016).

The practice of distributing one laptop per student was implemented by Afghan government in order to close the gaps between researchers need and the need for national appropriation of the benefits of technology (Woolf, Zualkernan & Arroyo, 2007). This could be more relevant in the case of South Africa where issues of competition, inter-institutional cooperation, public/private partnerships have been closely linked with poverty, inequality, illiteracy, skills development etc which would necessitate compromise in the choice and emphasis of the national ICT policy to be adopted if a reasonable balance is envisaged (Cross & Adam, 2007). While South African higher education seems to be witnessing the increased use of technologies to support teaching, the policy initiatives and institutional strategies for purposeful implementation are lacking (Cross & Adam, 2007).

Theoretical underpinning

Rogers (1995) provided deep insight into attitudinal responses of different stakeholders towards innovative changes affecting their interest either professionally or personally. The theory of diffusion of innovation as propounded revealed that adopters of innovation would portray indifference or lack of interest, resulting in resistance, especially when an innovation is perceived to be incompatible with the prevailing culture.

However, Skinner (1971) and Kamaruzaman (2018) noted that the speed of transformation is unprecedented, leaving little or no opportunity to the individual to make choices. To acquire the needed skills, it might be necessary for the educators and students to unlearn the old, under-carpeted skills and learn new concepts, theories, methods and strategies in order to give priority to organised learning, training and development of the future workforce in line with the requirements of the fourth industrial revolution as the bottom line. In recent time, the introduction of robotic teachers has changed the general orientation and age-long scope of technologies in education.

3. Methodology

Prior to the emergence of the challenges posed by the 4IR and its associated technologies, the various education subsectors overseen by EDTP SETA had effectively engaged in regular

assessment and upgrading of the human resources skills to meet the demand from the labour market within the economy.

Some of the recent Subsector Skill Plan (SSP) in the relevant educational institutions noted the importance of urgent intervention of the government and other responsible institutions to consider aligning the current education system with the demand of the 4IR to avoid skill obsolescence and the associated economic problems. According to Penprase (2019), the education sector has consistently and systematically served as the driver of transformations from one industrial revolution to another.

This study is primarily concerned with investigating the essentials for institutionalising technologies and identifying the challenges confronting educational institutions particularly the universities against institutionalising technology for teaching and learning.

The survey design adopted for the study was an interview that requires direct contact with the subjects (respondents) to elicit first-hand information. Accordingly, an interview guide was designed and subjected to face validity. The questions were presented to the authority constituted by ETDP SETA for appropriateness check. The necessary amendment was made to the list of questions after being vetted by experts and subsequently validated and approved for use.

The population for the study consisted of all the Executive Deans/Deans of Faculties in all twenty-six (26) South African Universities. Twenty-two (22) universities were purposefully selected out of 26 Universities comprising of the traditional, comprehensive, and technology. One reason for such selection was to allow fair representation of all fields of specialization in all the categories of the universities across the nine provinces.

Another reason was to enable generalization of the findings of the study. In total 188, Deans of Faculties were contacted via their institutional email on the various institutional websites. After that, several emails were sent as a follow-up. Ethical clearance was obtained for the conduct of the research in all the institutions that participated.

Coincidentally, the data collection period was intercepted with the global upsurge of covid-19, which practically obstructed all physical engagement and contact as a result of national and global restrictions. This necessitated relocating data collection to online platforms using Microsoft Teams and Zoom.

Administratively, the Executive Deans/Deans were encumbered with devising an urgent strategy for rescuing the academic calendar, which could be truncated by COVID-19.

Consequently, some of them could not participate in the online interview. 70 out of 188 total number of the Executive Deans/ Deans were able to participate. The video recording of all the interviews was made and documented appropriately. However, the study focused on 61 respondents who provided sufficient information required for the entire aspects of the interview.

3. **Presentation of Results and Discussions**

Based on the overall objective of the study, this section presents the results with a view to determining and understanding the Technologies available for teaching and learning; Competencies of staff members in using these technologies; Whether the institution has procured any new technology/ies to keep abreast the changing landscape due to the fourth industrial revolution; Whether the institution has provided training of staff member on the use of these technologies; The views of the Executive Deans/ Deans on whether the procured technology is assisting relevant staff members to deliver teaching and effectively; Challenges associated with institutionalizing technology; Whether the institution has received any policy direction from authorities/its shareholders on the fourth industrial revolution; Whether the institution has formulation of 4IR strategy/plan/activities; Whether the institution has designed a skills plan in order to document and respond to the technological needs of its staff members the changing landscape due to the fourth industrial revolution; The extent to which students have sufficient technological infrastructure (particularly at home) to be able to participate meaningfully in teaching and learning, particularly as institutions ramp-up the use of technology in order to meet the demands of the fourth industrial revolution; The challenges associated with embedding new technology as the institution revamps its technology infrastructure in order to meet the demands of the fourth industrial revolution; and, Additional support required to deliver the cohort of students ready to enter the world of work powered by technology.

For reasonableness and for generalization of findings, the data from the interview across the faculties and universities were analyzed based on related fields and specialization. Thus, a total of nine group of faculties emerged which include faculty of Education (FOE), faculty of Science (FOS), Engineering and Built Environment (FEBE), faculty of Management Science (FOMS), faculty of Theology (FOT), faculty of Health Sciences (FOHS), faculty of Humanities (FOH), faculty of Law (FOL), Other Academic Faculties (OAF).

4.1 Technologies at the disposal of the respective university faculty

The key motivation for this subsection of the research was to determine technologies available for teaching and learning activities at each faculty in every university that was considered to be interviewed. Researchers requested respondents to reflect on technologies at their faculty's disposal for teaching and learning activities to understand the technologies available for teaching and learning activities.

Table 4.1 – Technologies at the disposal of the respective university faculty

Teaching and learning technology deployed	Technologies available for teaching and learning activities									Technology Deployed Total
	FOE [9]	FOS [8]	FEBE [6]	FOMS [15]	FOT [3]	FOHS [5]	FOL [4]	FOH [7]	OAF [4]	
	N	N	N	N	N	N	N	N	N	
Cellphone	0	0	6	0	0	0	0	1	0	7
Computing Equipment/ Laptop/Tablet/iPad	3	0	2	6	1	1	1	4	1	19
Data/Wi-Fi	4	1	3	6	2	1	1	0	0	18
Document Cameras	1	0	1	2		0	1	0	1	6
Synchronised Learning Management System/Sakai	2	1	1	4	1	1	0	2	1	13
Learning Management System (Module Technologies)	5	5	2	7	1	2	4	2	2	30
Learning Management System (Blackboard)	3	4	4	6	1	1	0	2	1	22
Zoom	4	2	2	8	2	2	3	6	1	30
MS Package/ Microsoft Teams/BI Tools	4	4	1	14	3	5	2	4	2	39
Whiteboards broadcast	2	0	0	0	1	0	1	0	0	4
WhatsApp	3	2	3	8	2	1	1	4	1	25
YouTube/Videos (video studios and Peneulta video management system)	1	2	1	3	0	2	1	1	1	12
Supervision Room	1	0	0	0	0	0	0		0	1
Projectors	2	0	2	2	0	0	0	1	0	7
Google package/GoogleMeet/Gmail/Googledoc	1	0	0	3	1	2	3	2	0	12
Podcasts	1	0	0	0	0	0	1	1	0	3
Camtasia	1	0	0	1	0	0	1	0	0	3
Screen-o-matic	1	0	0	0	0	0	1	0	0	2
Smart-board	1	0	0	1	0	0	0	0	1	3
Visualizers	1	0	0	0	0	0	0	0	0	1
Light board	1	0	0	0	0	0	0	0	0	1
One button studio	1	0	0	0	0	0	0	0	0	1
Virtual Reality	0	1	2	0	0	0	0	0	0	3
Telegram	0	1	0	0	0	0	0	0	0	1
Televisions	0	0	1	0	0	0	0	0	0	1

3D Printing/Lab	0	0	1	1	0	0	0	0	1	3
Augmented/Virtual Reality	0	0	1	1	0	1	0	0	1	4
Cloud Computing	0	0	1	0	0	0	0	0	0	1
Artificial Intelligence	0	0	1	0	0	0	0	0	0	1
Data Science Algorithms Technology	0	0	1	0	0	0	0	0	0	1
Cleanroom/high fidelity room/simulation lab	0	0	1	0	0	1	0	0	0	2
Atomic Layer Deposition	0	0	1	0	0	0	0	0	0	1
Unkempt Internet	0	0	1	0	0	0	0	0	0	1
Multimedia (twitter)/Outside broadcast unit	0	0	1	1	0	0	0	0	2	4
Servers Platforms	0	0	1	0	0	0	0	0	0	1
Information Screen	0	0	1	0	0	0	0	0	0	1
Facebook	0	0	1	1	0	0	0	0	1	3
Remote computer access	0	0	1	0	0	0	0	0	0	1
Bigbluebutton	0	0	0	1	0	0	0	1	0	2
Signupgenius	0	0	0	1	0	0	0	0	0	1
NexusLexus	0	0	0	1	0	0	0	0	0	1
Elibrary Resources	0	0	0	1	0	0	0	0	1	2
Adobe connect	0	0	0	1	0	0	0	0	0	1
Bloomberg Terminal	0	0	0	1	0	0	0	0	0	1
Powtoons	0	0	0	1	0	0	0	0	0	1
IoT	0	0	0	1	0	0	0	0	0	1
Robotics	0	0	0	1	0	0	0	0	0	1
Sensor Jackets	0	0	0	1	0	0	0	0	0	1
Drone technology	0	0	0	1	0	0	0	0	0	1
360 degree camera/Go Pro Video Camera/Hi-Definition Camera	0	0	0	0	0	2	0	2	1	5
Literature and language facilities and software	0	0	0	0	0	0	0	0	1	1
Skype	0	0	0	0	1	0	0	1	0	2
Simulation assessment tool limiting assessor bias/Simulation Technologies	0	0	0	0	0	2	0	0	0	2
My progress App	0	0	0	0	0	1	0	0	0	1
Flipgrid/Fliproom	0	0	0	0	0	2	0	0	0	2
Cisco Webex	0	0	0	0	0	1	0	0	0	1
Mytutor	0	0	0	0	0	0	0	1	0	1

Source: ETDP SETA Report (2021)

Results indicate that universities deployed fifty-seven different technologies to facilitate their teaching and learning activities. This includes Learning Management Systems, MS Package, Google, WhatsApp, Camtasia, smartboard, Lightboard, Virtual Reality/ Augmented Reality, Artificial Intelligence, Simulation Laboratories, High Fidelity Rooms, and Facebook among other technologies. The most widely used technology across faculties and universities is the learning management system (LMS) which include different variants such as Module

technologies (30), blackboard (22) and Sakai (13) in most cases. All the faculties (100%) used LMS. The choice of the variant deployed by each faculty/university was dependent on the need and skill of the teaching staff. It was also clear from the study that academic faculties change from the use of one variant of LMS to another as deemed necessary. Next to LMS is MS Package/ Microsoft Teams/BI Tools which was used by about 64% (39) of the faculties which participated in the study. Other important technologies employed are zoom which was used by 49% (30) and WhatsApp used by about 41% (25) of the faculties. Among the very important but least employed technologies are the Internet of Things, Robotics, Sensor Jackets, and Drone technology. These sets of technology require the expertise of relevant staff in handling them.

4.2 Competency of staff members in using the existing technology

The amount of skills possessed by academic staff in using the relevant technology for teaching and learning is critical to the quality of education offered to both undergraduate and graduate students in the era of the 4IR. The purpose of this aspect of the study was to determine how competent the members of the individual faculties were in the use of the existing technology. To determine this, researchers requested the Executive Deans/Deans to reflect on the competence of staff members in using the technologies at the disposal.

Table 4.2 – Competency of staff members in using the existing technology

Scale	Competency of staff members								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
Competent	4	3	3	4	1	1	3	2	4
Moderately competent	5	3	3	10	1	4	1	5	0
Not competent (Did not reflect)	0	2	0	1	1	0	0	0	0
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% Competent	44	38	50	27	33	20	75	29	100
% Moderately competent	56	38	50	67	33	80	25	71	0
%Not competent (Did not reflect)	0	24	0	6	33	0	0	0	0

Source: ETDP SETA Report (2021)

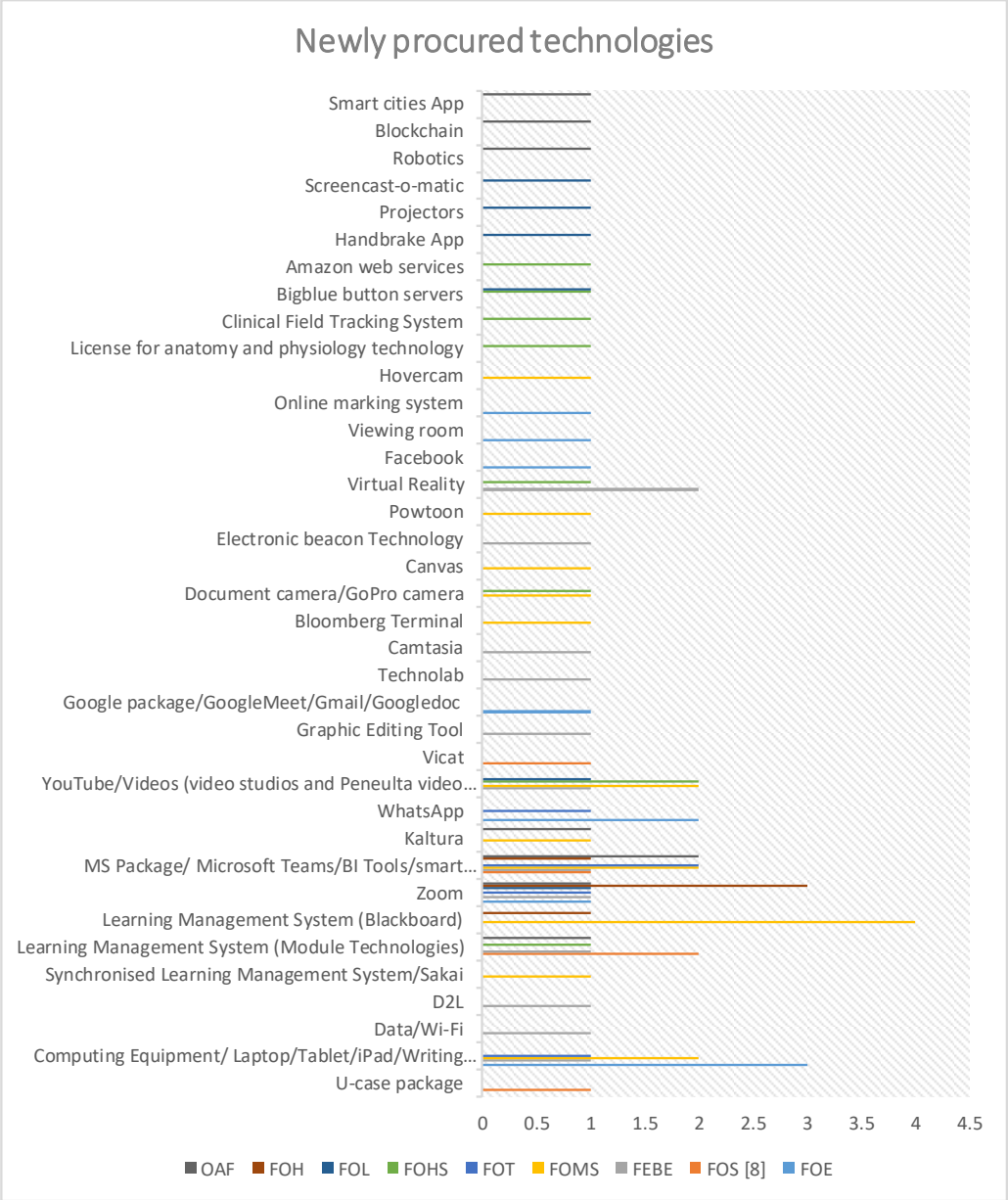
The result in Table 4.2 indicates that most Executive Deans/ Deans believe that the teaching staff is competent to moderately competent in the use of existing technologies for teaching. Accordingly, other academic faculties which include Agriculture, Arts and Design, Mathematics and Natural Sciences and Information Technology and Governance which recorded the highest level of competence (100%). Next to this was the law faculty with 75% record of competence and 25% moderately competence. Apart from faculty of Engineering and Built of Environment which sits on the average of competence (50%) and moderately

competence (50%), faculty members in the faculties of Health Sciences, Management Sciences, and Education were largely moderately competent. The respondents emphasized the centrality of continuous training provided on teaching and learning technologies under normal circumstances. This success was in part attributed to the community of practices as pivotal in dispensing training to staff members that required it. It is of interest to the researchers to determine whether the existing technology in the faculties under study was sufficient to cope with the demand for teaching engagement considering the trend of technological advancement or that there were new procurements made to meet those needs.

4.3 Procurement of new technologies to keep abreast with technological advances

The reality of the 4IR necessitates keeping abreast of the changing landscape to ensure up to date engagement with teaching and learning in the institutions of higher learning. Researchers sought to determine whether the institution has procured any new technology/ies in this regard.

Figure 4.1 – Procurement of new technologies to keep abreast with technological advances



Source: ETDP SETA Report (2021)

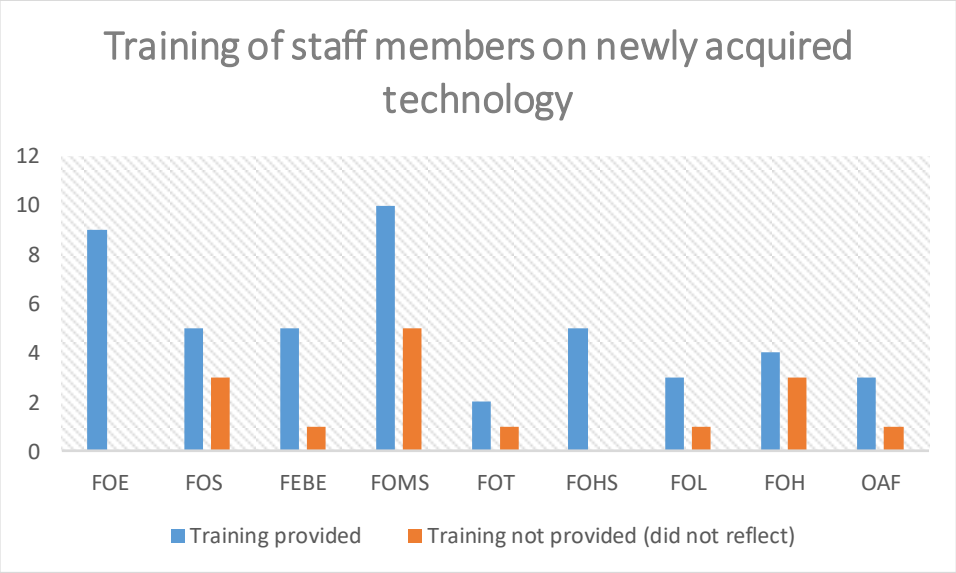
As shown in figure 4.1, the results demonstrate that there was not as much technology that was recently procured. Executive Deans/Deans indicated that their universities supplemented their teaching platforms by introducing teaching platforms such as WhatsApp, Zoom, and MS Teams. Investments were largely made on procurement of MS Package/ Microsoft Teams/BI Tools/smart classrooms, Zoom technology, Computing Equipment/ Laptop/Tablet/iPad/Writing pads, YouTube/Videos (video studios and Peneulta video management system)/ Psychiatric videos and lesson plan app. Among the least newly purchased technology were Electronic Beacon Tech, Online marking system, Hovercam and Bloomberg terminal among others. Information from the respondents indicated that most of the needed technology had been put in place to accommodate blended learning. However,

faculties that did not have enough tools to drive online learning were propelled to make new or additional procurements at the global pandemic outbreak to keep abreast of teaching and learning. Another important investigation in relation to deploying technological tools for teaching and learning is the provision of training opportunities for staff.

4.4 Training of staff members to work on (operate) the newly acquired technology

The main aim of the question around training was to determine whether universities had provided training of staff members on the use of the newly procured technologies or not. Researchers requested the Executive Deans/Deans to indicate whether the training had been provided or not.

Figure 4.4 – Training of relevant staff to work with (operate) new technologies



Source: ETDP SETA Report (2021)

Interestingly, most faculties as could be seen in figure 2, had provided training on the newly acquired technology to the relevant employees. The uniform practice as revealed by the Executive Deans/Deans is that training is generally provided on an ongoing basis in all the universities across the nation. However, it is noteworthy that the Faculty of Education and the Faculty Health Sciences excelled (100%) all others in training staff members due to certain peculiarities. Faculty of education seemed to uphold humanising pedagogy practice which places the student at the centre of education and thereby ignites passion in teaching staff to acquire the requisite skills and work very hard to ensure that students achieve the learning outcomes. In the same vein, a vast majority of Health Sciences graduates deal directly with human lives. Therefore, staff training was of utmost priority to ensure quality learning outcomes are achieved in students as the final product in the labour market. Collected data

further suggest that training was not applicable where there was no training provided because there had not been any new technology that was procured. Further, it is imperative to consider the value derivable from the additionally acquired technology to determine their real worth.

4.5 Value proposition and relevance of the newly procured technology

Researchers requested the Executive Deans/Deans to discuss whether procured technology assists relevant staff members in delivering teaching and learning effectively. This was intending to determine whether the respondents saw the newly acquired technology as the value add to its teaching and learning process.

Table 4.5 – Value creation of new technology in assisting staff members to deliver teaching and learning effectively

Training	Training of staff members on new technologies								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
Value created	6	4	4	11	3	5	3	6	2
Value not created (did not reflect)	3	4	2	4	0	0	1	1	2
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% Value created	67	50	67	73	100	100	75	86	50
% Value not created	33	50	33	27	0	0	25	14	50

Source: ETDP SETA Report (2021)

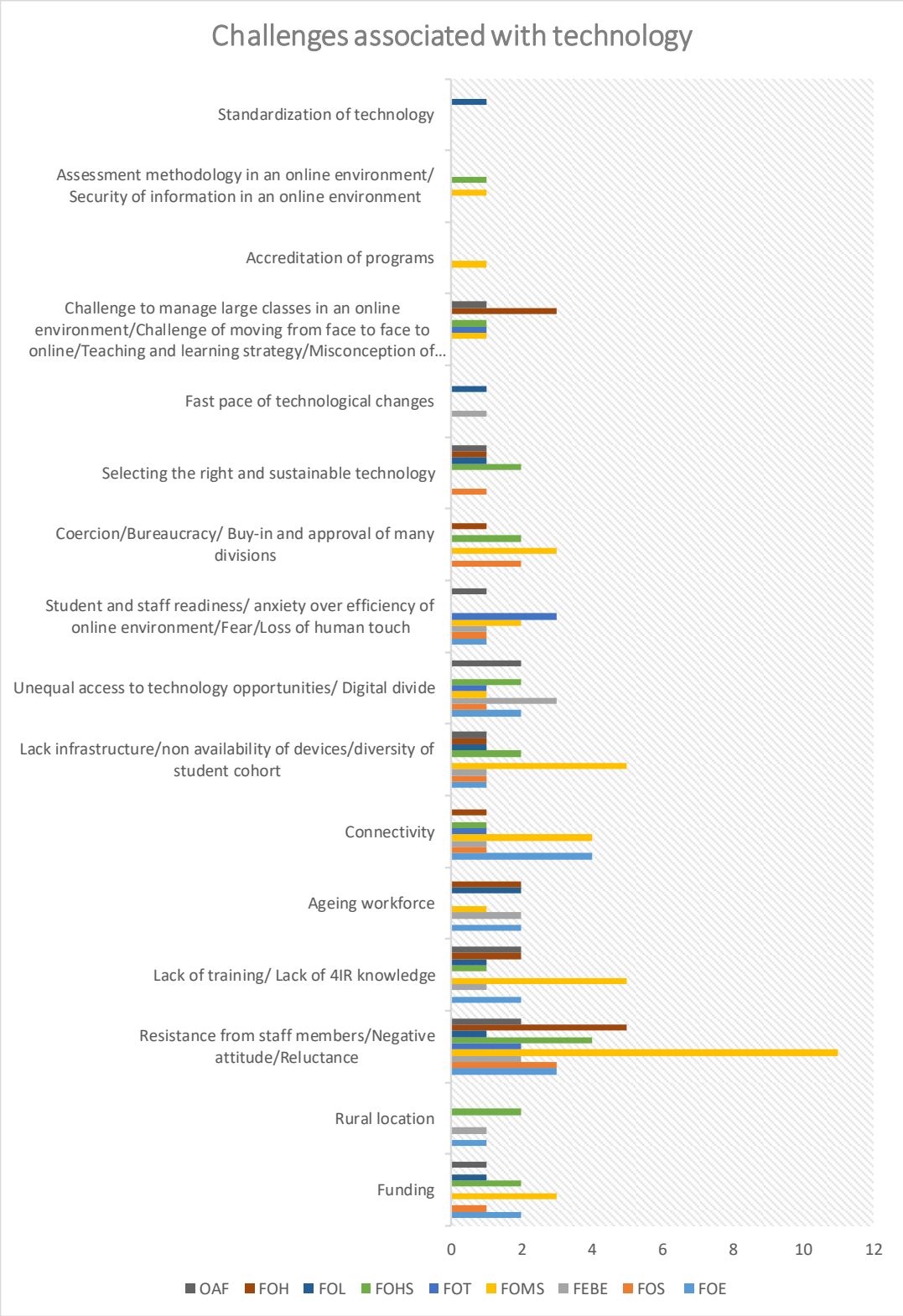
Table 4.5 indicates that most Executive Deans/ Deans were convinced that the newly added technology has added value in their teaching and learning. The major themes that emerged from the interviews with Executive Deans/ Deans that derived value from the utilization of technology include the observed improvement in the standard and quality of teaching and learning, improved performance by students, positive feedback from lecturers and students, continuity with classes even under-lockdown conditions, reduction in cases of application for sick leave and missing scheduled assessments, and the ability to do more online than the traditional classes. Beyond the value derivable from the use of newly procured technology by other academic faculties, Faculty of Theology as well as Faculty of Health Science had 100% value. The services of both faculties extended beyond the students' community during the condition of lock-down necessitated by covid-19 during which period the interview was conducted. Religious organisations in relation to FOT were able to conduct their spiritual services under the stringent rules and regulations on social distancing with the aid of technological tools while more patients were successfully reached under the same condition by trained students from Health sciences using various 4IR technologies such as Psychiatric videos and lesson plan app, Clinical Field Tracking System, License for anatomy and

physiology technology, and Virtual Reality among others. Introducing and institutionalizing technology was not without challenges which shall be considered in the next subsection of the analysis.

4.6 Challenges associated with institutionalizing technology

With this question, researchers sought to determine and understand challenges being faced by academic faculties as they attempt to make technology part of teaching and learning activities within their universities.

Figure 4.6 – Challenges associated with institutionalizing technology



Source: ETDP SETA Report (2021)

Obviously, the Executive Deans/Deans' responses revealed that they were mostly concerned about staff members' resistance/the negative attitude/and the reluctance to adopt technology. Resistance to change became the leading challenge to institutionalising technologies for

teaching and learning in South African Universities as revealed by 54% (33) of the academic leaders. This behavioural problem manifested in diverse forms among different classes of academic and teachers. One form of resistance triggered by the initial perception of forceful imposition of technology for teaching by non-science-based disciplines. This could be understood from the subtle affiliation of the term technology to STEM subjects. From this perspective, emphasising the importance of the use of technology to academics in other fields was general viewed as subtle imposition of science on other fields of human endeavour.

Resistance also arose from older staff who were quite fearful of using technology which to them was foreign and as a result, a lot of people refused to welcome the idea of using it. Negative attitudes towards institutionalising technology was also rooted in deliberate choice of conflicting set of technology by Staff members who always want to use something else. As such, there was a need to get staff buy-in. This was followed by the lack of training/ lack of 4IR knowledge by staff members. In this regard, the Executive Deans/Deans were concerned that staff members might not be able to function in the era of advanced technologies.

The lack of infrastructure/non-availability of devices was also identified as one of the major concerns, particularly for students as universities had diverse student cohorts. On the available of infrastructure, although, the statistics shows only 21% of the executive Deans attested to it as a serious problem, the steps taken by the universities to salvage the academic calendar during the pandemic revealed the gravity of this challenges.

Generally, students are believed to be in possession of mobile phones. This, however, would not be sufficient where students are required to engage in writing programmes which cannot be easily done on cell phones. To worsen the situation, the academic leaders through the interview emphasised that not all the mobile phones in possession of the students are android, which aggravates the perceived inequality among the student's populace.

Accordingly, this was linked to the potential to result in unequal access to technology opportunities/ digital divide (about 20%) among those students who can afford and those who cannot afford it. Funding (16%) was also noted among other limitations/challenges faced by institutions of higher learning in a bid to institutionalize technology. Lack of 4IR knowledge had been identified as one of the challenges of institutionalizing technology as earlier indicated. Sequel to that, the effort of the faculties/universities towards formulating and implementing 4IR strategy in the current era was examined by the study.

4. 7. Formulation and implementation of 4IR Strategy

4.7.1 Formulation of the 4IR Strategy within the university

Considering the relevance of strategy formulation towards the achievement of organizational goals, researchers sought to determine and understand whether the universities that participated in the study had formulated the 4IR strategy either at the faculty level or university-wide.

Table 4.7.1 – Formulation of the 4IR Strategy

Strategy	Formulation of the 4IR strategy								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
4IR strategy formulated	2	1	2	3	0	0	0	2	1
4IR strategy not formulated (did not indicate)	4	7	4	8	0	2	3	3	1
4IR strategy not formulated as a separate strategy; however, it is embedded in the existing policy	3	0	0	4	3	3	1	2	2
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% 4IR strategy formulated	22	12	33	20	0	0	0	29	25
% 4IR strategy not formulated (did not indicate)	44	88	67	53	0	40	75	42	25
% 4IR strategy not formulated as a separate strategy, however, it is embedded in the existing policy	34	0	0	27	100	60	25	29	50

Source: ETDP SETA Report (2021)

Generally, the result of the study as shown in Table 4.7.1 indicated that majority of interviewed Executive Deans/Deans (>52%) were not aware of the existence of any fourth industrial revolution institutional strategy in their institutions. Only 18% of the respondents confirmed institutional existence of 4IR strategy in their universities while about 30% of the Faculties that participated had 4IR embedded in the existing policy rather than as a separate strategy. Overall, more than 47% of the respondents have 4IR strategy reflected in their institutional policy either as a stand-alone or embedded in the existing policy. This shows the rate of responsiveness of universities in the Republic to the changing landscape in the digital world.

4.7.2 4IR activities within the faculty

With the pervasive application of 4IR technology across all fields of human endeavour, the researchers sought to determine whether or not 4IR related activities are ongoing at the faculty level and overseen by the universities. Participants were asked if their faculties had received any direction at the institutional level to embed 4IR in its activities. The result is presented in table 4.7.2.

Table 4.7.2 – 4IR activities within the faculty

Activities	Institutional guidelines on activities								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
Institutional guidelines provided	3	1	1	5	0	0	1	1	1
Institutional guidelines not provided (did not indicate)	5	6	2	7	1	2	3	5	2
Faculty formulated its own initiatives	1	1	3	3	2	3	0	1	1
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% Institutional guidelines provided	33	13	17	33	0	0	25	14	25
% Institutional guidelines not provided (did not indicate)	56	74	33	47	33	40	75	72	50
% Faculty formulated its own initiatives	11	13	50	20	67	60	0	14	25

Source: ETDP SETA Report (2021)

In the same manner, only few institutions had 4IR strategy formulated (refer to table 4.7.1), majority of the Executive Deans/Deans also indicated that they had not been provided with the institutional guidelines for embedding 4IR in their activities at the faculty level. However, in the absence of institutional guidelines, about 25% of the Executive Deans/Deans had their faculties respond to the rapid technological advancement by incorporating 4IR structured activities into their programmes at the faculty level, not minding whether or not their institution had provided any clear guidelines to them. This is in a bid to ensure that they remain relevant in the technology-driven era.

Contrary to this, a deeper revelation from the study revolves around the reluctance/unwillingness of the faculty of science and faculty of Engineering and Built Environment to be guided into the digital world by any definite policy or strategy as they believe that could stiffen innovation. Rather, some of them have taken the lead in the 4IR space and are providing leadership at the national level as well as comparing favourably with competitors in the global space. They are comfortable that their institutions had not enforced any 4IR policy on their activities and they could freely respond innovatively to any evolutionary change or challenge posed by digital world.

It is observed however, considering the role played by policy in providing definite direction, the lack of institutional guidelines on the fourth industrial revolution could result in non-standardized activities from different university faculties. Further, there could be difficulties in measuring the impact of these activities to the institutional strategy. Given the possible impact

that guidelines could have on attainment of organisational goals, respondents were further interviewed on the relationship they have with industry partners as they strive to translate and integrate the 4IR practices into the curriculum. Questions on this form of relationship is analysed in the subsequent subsections.

4.8.1 Guidance from industry partners and association on the inclusion of technology in the curriculum

As earlier noted, the Executive Deans/Deans were requested to indicate if their institution had received guidance from the industry partners and related associations on technology inclusion in some parts of the curriculum. The main aim of this investigation was to determine whether SA Universities engage with industry partners and associations, and whether such engagements yield the benefits of teaching the up to date information and what the industry requires.

Table 4.8.1 – Guidance from industry partners and relevant associations

Guidelines	Sourcing of guidelines from industry partners and associations								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
Industry partners/associations guidelines provided	7	5	6	12	1	5	3	4	4
Industry partners/associations guidelines not provided (did not indicate)	2	3	0	3	2	0	1	3	0
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% Industry partners/associations guidelines provided	78	62	100	80	33	100	75	57	100
% Industry partners/associations guidelines not provided (did not indicate)	22	38	0	20	67	0	25	43	0

Source: ETDP SETA Report (2021)

As can be seen in table 4.8.1, majority of the Executive Deans/Deans indicated that universities had a lot of interaction with the industry Partners and many of the faculties like Engineering and Built Environment, Health Sciences and other academic faculties, are completely guided (100%) by Industries. The participants frequently made reference to the practice of formulating the advisory boards as mandated by their faculties/universities, which would ordinarily consist of industry partners, associations and other academics. During the advisory board meetings, industry developments are discussed and inputs are solicited. The faculty of Theology (33%) seems to have the least influence by the industry players.

4.8.2 Incorporation of the guidance from industry partners and association on the inclusion of technology in the curriculum

As a follow up to the question of receiving guidance from the players in the industry, the Executive Deans/Deans were requested to indicate if their institution had incorporated the received guidance from the industry partners and related associations on technology inclusion in some parts of the curriculum. The result here is a useful measure of transfer of knowledge from the industry and the extent to which the practical knowledge is translated into manageable modules for teaching and learning.

Table 4.8.2 – Incorporation of the guidance from industry partners and relevant associations

Category	Incorporation of the guidelines on the curriculum								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
The faculty has incorporated the provided guidelines	4	4	4	12	0	5	2	0	4
The faculty has not incorporated the provided guidelines (did not indicate)	5	4	2	3	3	0	2	7	0
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% The faculty has incorporated the provided guidelines	44	50	67	80	0	100	50	0	100
% The faculty has not incorporated the provided guidelines (did not indicate)	56	50	33	20	100	0	50	100	0

Source: ETDP SETA Report (2021)

During the interview, some Executive Deans/Deans indicated that, as a place of thought leadership, their universities were at the forefront in the development of best practice, and that they were at the coalface of cutting-edge technological innovation. This advanced best practice was shared, incorporated into the curriculum and shared within the industry. It is worthy of note that the faculty of health sciences and other academic faculty had completely (100%) integrated the advice and suggestions from the association into the curriculum, whereas, faculty of Theology (0%) and faculty of Humanities (0%) had indicated that they had not incorporated any guidance from industry partners or relevant associations in their curriculum/ activities. Again, there seems to be different belief when it comes to inclusion of technology into the curriculum. While the faculty of Theology and the faculty of humanities both have engagements with the industry players, the faculty of Theology is of the view that the onus to bring technology into the curriculum lies entirely with the faculty while the Executive Deans/Deans in the faculty of Humanities seem to be bias with regards to bringing technology into the curriculum.

4.9 Awareness of emerging technologies

The essence of this aspect of the research was to establish the level of awareness of any new emerging technologies necessary to prepare students for the world of work through their interactions of the universities with the industry partners and related associations. The expectation is that technology will have a role.

Table 4.9 – Awareness of emerging technologies

Category	Awareness of emerging technologies								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
The faculty is aware of emerging technologies	6	5	4	9	2	3	2	2	3
The faculty is not aware of emerging technologies (did not indicate)	3	3	2	6	1	2	2	5	1
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% The faculty is aware of emerging technologies	67	62	67	60	67	60	50	29	75
% The faculty is aware of emerging technologies (did not indicate)	33	38	33	40	33	40	50	71	25

Source: ETDP SETA Report (2021)

All the faculties with the exception of faculty of Humanities (33%) were largely aware of emerging technologies in the area of their specialization. Faculty of Law was sitting on the average of 50% awareness of emerging technologies in that space. New technology indicated for example include 3D printing (FEBE), internet of things (FOMS), big data (FOS), white board (FOE) among others

The central theme that emerged from this subsection of the research is that the universities that aware of emerging technologies were in contact with their advisory boards, consisting of academic and industry partners. Further, these universities have close working relationships with industry associations. The role of the internal staff members as pioneers in technology innovation was also emphasized by the respondents. The internal staff members were pivotal in conducting technology awareness within their respective faculties.

It is not enough to be aware of the new technology that could drive innovation in the respective fields of study in the universities, it is equally important to invest in the relevant technology in a pragmatic way. The next subsection focuses on aligning the technology needs of the faculty with the university specifications through the ICT department.

4.10 Interactions between the faculty and the institutional ICT departments regarding the technology needs

The ICT department constitutes the institutional structure through which technology could be sourced in most of the sampled universities. The research interest here is to ascertain whether or not the faculty through the Executive Deans/Deans or other responsible officers had communicated their technology needs to the institutional ICT departments as part of their response strategy and equipping them to be resourced to operate in a technology-driven environment.

Table 4.10 – Communication of the faculty's technology needs to the relevant structures in response to the advances in technology

Category	Communication of the faculty's technology needs								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
The faculty has communicated its technology needs	5	6	3	7	3	4	2	5	3
The faculty has not communicated its technology needs (did not indicate)	4	2	3	8	0	1	2	2	1
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% The faculty has communicated its technology needs	56	75	50	47	100	80	50	71	75
% The faculty has not communicated its technology needs (did not indicate)	44	25	50	53	0	20	50	29	25

Source: ETDP SETA Report (2021)

As clearly presented in table 4.10, a sizeable number of Executive Deans/Deans had communicated their needs to the ICT support departments within their institution as part of their response strategy and to be equipped with relevant technology needed to operate in in the 4IR era. Although, some Executive Deans/Deans indicated that they had not communicated their needs to the ICT support departments, this was either because they were currently satisfied with what they had or that the staff that needed specific technology were yet to present the requisition for processing. It was clear that the communication was on the basis of need.

Importantly, respondents also made reference to project funding that they have access to as some had received a substantial grant from the Department of Higher Education as an example for huge investment in 4IR Technologies. Having established the arrangement for the procurement of the technology need, the next important issue considered by the researchers was identifying the specialists in the respective fields who could drive the use of the technology at the faculty level.

4.11 Identification of the key personnel to operate the training needs of staff members

Having recognized the centrality of the role of experts with requisite skills for driving innovation in the era of the 4IR, it is imperative to establish whether universities have identified the key personnel that would spearhead the move in the faculty towards the demand of 4IR. The research question formulated on this subject was for Executive Deans/Deans to indicate if they had identified the potential technology matter experts (growing their timber) who will operate the envisaged technology, whether acquired or to be acquired as part of their response strategy and equipping them to be resourced to operate in a technology-driven environment.

Table 4.11 – Identification of the key personnel to be trained to operate the envisaged technologies as part of the strategy to respond to the changing environment

Category	Identification of key personnel to operate technologies								
	FOE [9]	**FOS [8]**	**FEBE [6]**	**FOMS [15]**	**FOT [3]**	**FOHS [5]**	**FOL [4]**	**FOH [7]**	**OAF [4]**
The faculty has identified key personnel to operate the envisaged technology	6	6	2	11	2	5	3	3	2
The faculty has not identified key personnel to operate the envisaged technology (did not indicate)	3	2	4	4	1	0	1	4	2
Total Responses	**9**	**8**	**6**	**15**	**3**	**5**	**4**	**7**	**4**
% The faculty has identified key personnel to operate the envisaged technology	67	75	33	73	67	100	75	43	50
% The faculty has not identified key personnel to operate the envisaged technology (did not indicate)	33	25	67	27	33	0	25	57	50

Source: ETDP SETA Report (2021)

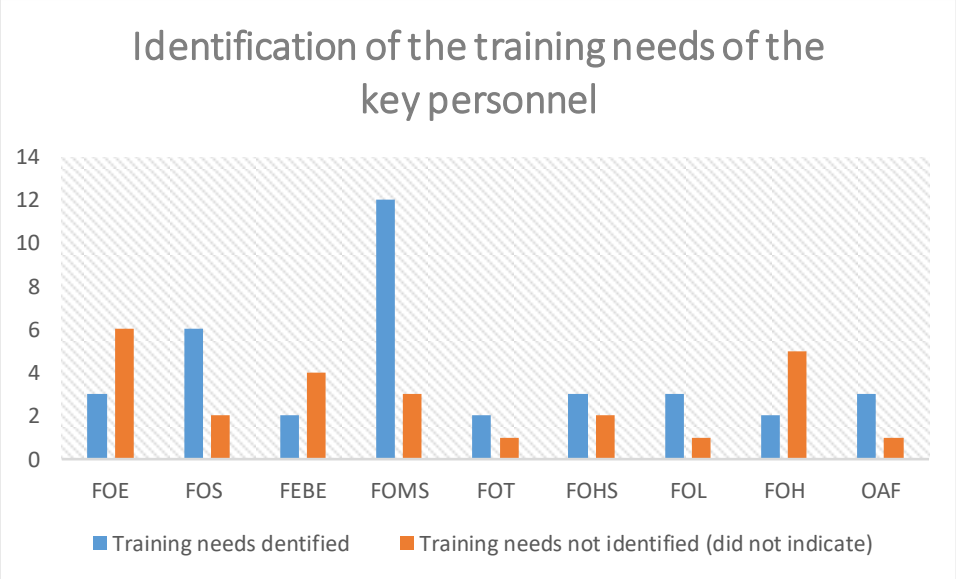
A sizeable number of faculties identified the training needs of relevant staff members as part of their response strategy. For example, the faculty of Health Sciences with 100% indicator in this regard had identified core team and groups of experts for specific projects. Such include in some instances, permanent staff to operate 3D printing and supporting with students, Graphic Designers and E-learning designers among others. Additionally, the centre for teaching and learning and the user area personnel were being considered key personnel by respondents. However, some Executive Deans/ Deans indicated that they had not identified the training needs.

The risk of not identifying key personnel for training purposes is that even if the technology were to be procured, it would find relevant staff members not yet ready to leverage it. The emerging themes for those that indicated that they had not identified the training needs were around the lack of the tools to detect emerging technologies.

In those universities which indicated that they had identified the training needs of relevant staff members as part of their response strategy, they utilized performance management tools where employees are asked to identify their own training needs. Through this process, the key personnel would also identify their training needs.

Researcher sought to determine whether the faculty had identified the training needs of their staff members as part of their response strategy towards equipping them to operate in a technology-driven environment.

Figure 4.12 – Identification of the training needs of relevant staff members



Source: ETDP SETA Report (2021)

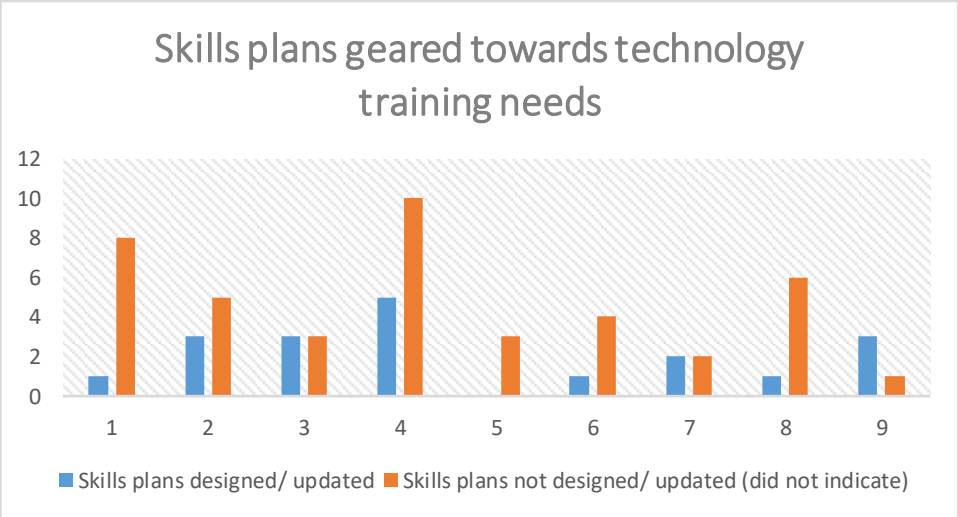
Most of the faculties Such as faculty of Management Science (80%), Faculty of Science (75%) and Faculty of Law (75%) and other academic faculties (75%), have made concerted efforts in identifying the training need of the members of staff to enable them acquire specific skills needed to leverage on the benefits offered with the use of technology. Most of the universities/faculties in this category which indicated that they had identified the training needs of relevant staff members as part of their response strategy, utilized performance management tools where employees are asked to identify their own training needs while in some others, the training needs would have been identified through the collaboration/benchmarking with other universities. However, one of the prominent faculties which scored low in term of identifying the training needs of their key personnel, Engineering and Built Environment (33%), seems to be at the core of leading the 4IR technology. The faculty had indicated that they have highly knowledgeable staff members such as Computer and Data Scientists who on their own do

identify training need and also train other staff. On many occasions, the staff had sought training opportunity outside the country with the support of the faculty. To hedge the risk of not having a mechanism to identify emerging and technologies which could be responsible for inability to identify the training need of staff, some universities are putting together task teams to investigate the whole concept of the fourth industrial revolution technologies and related skills.

4.13 Skills plans formulated to respond to the technological needs of staff members

The need to design and/or update the skills of the teaching staff in the era of the fourth industrial revolution cannot be overemphasized. To this end, the Executive Deans/Deans were posed with the question seeking to determine whether their faculty had designed a skills plan (or updated the existing plans) to document and respond to the technological needs of its staff members in the changing landscape due to the 4IR. The result is presented in figure 4.3.

Figure 4.13 – Skills plans geared towards addressing the technological skills needs of staff members



Source:

Order of faculties: 1(FOE), 2(FOS), 3(FEBE), 4(FOMS), 5(FOT), 6(FOHS), 7(FOL), 8(FOH) and 9(OAF)

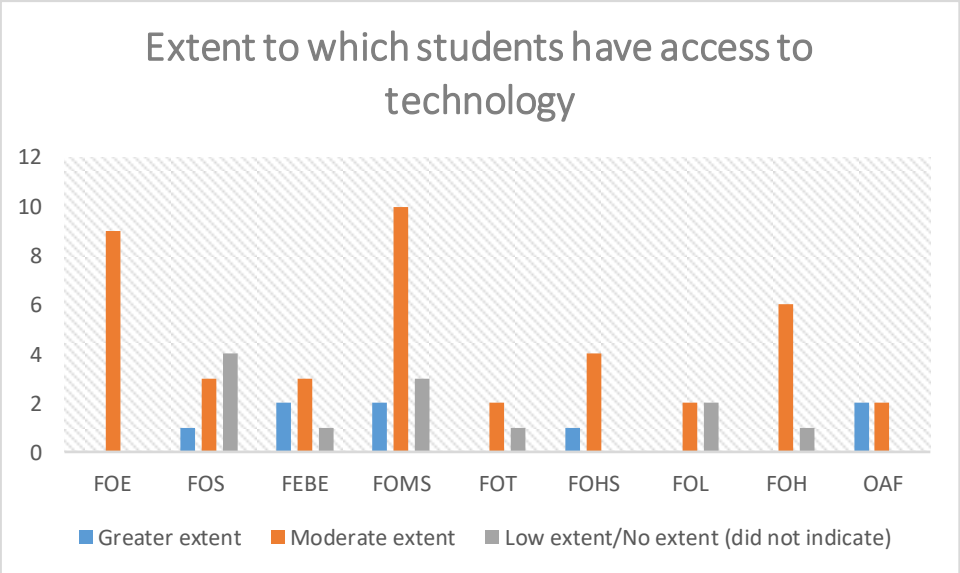
In general, faculties indicated that they had not formulated any skills plans to document and respond to its staff members' technological needs. This is evident in faculty of Theology (0%), faculty of Education (11%), faculty of Humanities and faculty of Health Sciences (20%) among others. The general concern here is that the lack of skills plans may lead to a lack of planning for training, which subsequently means that staff members may not be in a position to interact with technology and may not be able to impart the necessary skills necessary for their students to succeed in the technology-driven economy.

What is encouraging is that some Executive Deans/Deans who were interviewed have put together skills plans to document and respond to the staff members' technological needs. Key themes emerging in this regard are institutional arrangements between the faculty and the ICT support departments. As soon as the technology training needs are identified, they are logged with the ICT department, and within the three months, the ICT department is expected to arrange the required training. Other universities have a practice where there are no formal skills plans, but individual professional development plans. In these individual professional development plans, emerging skills, such as skills associated with operating emerging technologies, are updated. This occurs every year.

6.14. Access to technology infrastructure by students for meaningful participation in teaching and learning

Having dealt with the questions on the technologies at the disposal the faculty, staff training, competence of staff, incorporation of the advice of industry leaders into the academic curriculum and skills plan among others, it was important to assess the extent of access which the students have to the relevant technologies to enable them participate meaningfully in teaching and learning in the 4IR era. The findings on this is presented in figure 6.14.

Figure 6.14 – Access to technology infrastructure by students for meaningful participation in teaching and learning



Source: ETDP SETA Report (2021)

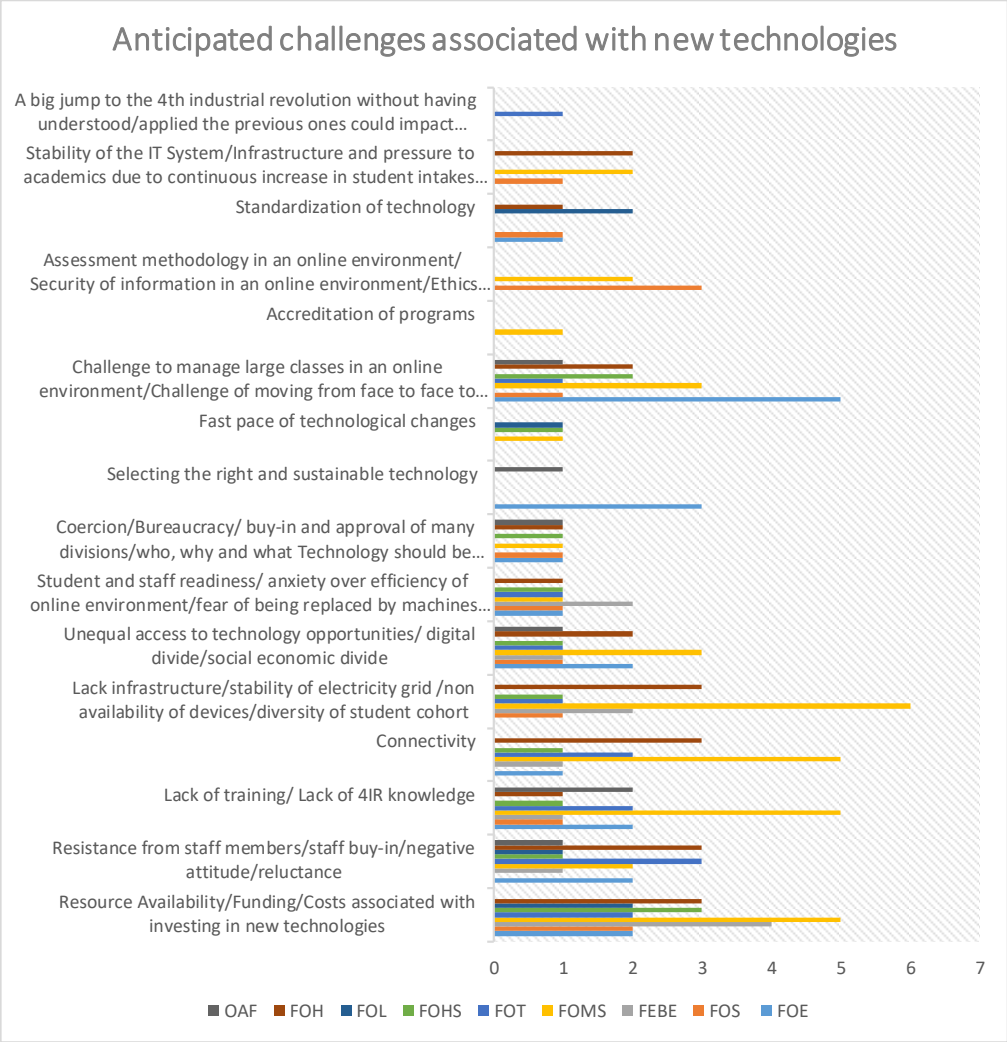
Only 13% of the Executive Deans/Deans indicated that the students had access to sufficient technology to forge ahead with learning, whereas, more than 67% of them believed that the technologies to which students had access to, was moderately sufficient. In this regard, the explanation was that within the corridors of the campus, students could participate meaningfully as there is connectivity (Wi-Fi), laboratory equipment, library resources, etc. The moment the student left the grounds of the campus, a host of other issues emerge such as the lack of access to data, laboratory equipment and other tools which are centrally allocated within each Department, Faculty and the Universities at large. The extreme cases (about 20%) occurred where the students do not have personal devices and/or reside in remote locations or the universities are located in remote locations where electricity and internet access were not consistent.

This situation has become better as some of the educational sites were zero-rated. Also, other universities have developed a virtual private network otherwise referred to as a VPN for students to access the internet from home. This was done on a reverse spelling scenario where the students do not have to have data to access the internet. The participants are of the view that students should be trained on new learning platforms such as MS Teams, Zoom, and other related platforms so that they can participate meaningfully in teaching and learning.

6.15 Anticipated challenges as Faculty ramp-up their technology use

In addition to the question on the challenges experienced in institutionalizing technology by the faculties in the past, the Executive Deans/Deans were requested to provide a forward-looking assessment of the potential challenges that their institutions could experience as they ramp-up their technology use. The respondents highlighted key sixteen issues noted in Figure 6.15.

Figure 6.15 – Anticipated challenges associated with embedding new technology



The respondents expressed a general concern relating to the big jump to the 4th industrial revolution without understanding/applying the previous industrial revolution, impacting performance. Issues raised as possible future challenges relate to Resource Availability/Funding/Costs associated with investing in new technologies (< 38%), Lack of training/ Lack of 4IR knowledge (>24%), Challenge to manage large classes in an online environment/Challenge of moving from face to face to online/Teaching and learning strategy/Misconception of online teaching/Technologies with no pedagogies linked to them/Teaching practices could be at risk (>24%), Resistance from staff members/staff buy-in/negative attitude/reluctance 23%), Lack infrastructure/stability of electricity grid /non availability of devices/diversity of student cohort (23%), Unequal access to technology opportunities/ digital divide/social economic divide (>19%) among others.

6.16. Additional support required to deliver the cohort of students ready to enter the next phase of education, likely to be powered by technology

To finalize the study on institutionalising technology in the South African Universities, the Executive Deans/Deans were asked to identify the essential needs as additional support required to teach and deliver the cohort of students ready to enter the world of work powered by technology.

As indicated by the participants of this study, the most pressing support needed by universities to enable them deliver the cohort of students ready to enter the next phase of education, likely to be powered by technology include general training (capacity development) on 4IR related technologies for staff members to enhance collaboration between human and machine (57%); Connectivity; the need for connectivity is also linked with the need for Technology (including, e-resources, proctoring technology) and physical infrastructure (26%). There is need for National policy /Funding (special grant) to plug the gap on digital divide (for different cohorts of students) (25%), General training on 4IR Technology (digital literacy) related technologies/ computational skills/Entrepreneurial skills/data analytics for students (24%), and a path to strengthen the stakeholder relations, particularly with industry to benefit from the sharing of information on emerging technology needs and related skills (19%). Continuous dedicated support for students to address queries on related technologies and ethics (proctoring technologies) (10%) is another need.

Among the least mentioned but critical support needed are Change management specialists/psychologist to assist the staff members and students to cope with the rapid technological changes(<5%), Experienced technology skills auditors to match the skills and required technology (technology/soft skills audit and technology needs) (<5%), a path to strengthen the stakeholder relations, particularly with government to influence the regulatory framework so that there is flexibility to combine soft and technical skills into qualifications, so that institutions can deliver relevant talent to the labour market (<5%), and Sharing of best practice when it comes to technology infrastructure and skills among SA universities (<5%) among other needs.

Conclusion, Recommendations and Policy Implication.

The study focused on implementing technology in South African Universities. Data collected through the study reveals that a significant quantum of teaching technologies had been procured prior the global pandemic and teaching staff are moderately competent in the use of those existing technologies for teaching. Where new technologies were procured to keep abreast of the ever-evolving demand of the 4IR, training was generally provided on an ongoing basis as

part of their response strategy for equipping them so that they are ready to operate in a technology-driven environment.

In spite of the various challenges associated with institutionalising technology in the Universities, the major themes that emerged from the interviews with Executive Deans/ Deans that derived value from the utilization of technology include the observed improvement in the standard and quality of teaching and learning, positive feedback from lecturers and students, continuity with classes even under-lockdown conditions, and the ability to do more online than the traditional classes.

However, the Executive Dean/Dean expressed a concern relating to the big jump to the 4th industrial revolution without understanding/applying the previous industrial revolution, impacting performance. This implies that challenges such as connectivity, lack infrastructure/stability of electricity grid /non-availability of devices/diversity of student cohort, unequal access to technology opportunities/ digital divide/social, economic divide, student and staff readiness/ anxiety over the efficiency of online environment/fear of being replaced by machines /loss of human touch, funding/costs associated with investing in new technologies and the resistance from staff were among other hosts of issues that could slow down the overall success of deploying 4IR technologies for teaching and learning in the country.

The study concludes that while Universities are settled to adopt blended learning as the strategy to implement the convergence between human and machines in the era of the fourth industrial revolution, there is need to have a national policy in place that deals with funding (special grant) to plug the gap on digital divide (for different cohorts of students).

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