



## Structural Implications of Digital Device Usage During Emergency Online Learning: A Case of a South African University

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**ABSTRACT** Digital devices are at the same time a tool for social collaboration, individual learning resource and can also be a valuable utility for higher education to develop and promote new teaching and learning models during and post pandemic. The objective of the study was to investigate the negative ramifications of digital devices purchased during online sessions at a rural university in Gauteng, South Africa. This study adopted a retrospective facility based review approach for the period January to May 2021. The respondents of this study consisted of registered undergraduate and postgraduate students for the 2021 academic calendar. The study findings revealed that of the 750 procured laptop brands, 315 laptops were returned to the information communication and technology, student technical support service department, 292 (92.7%) were CNX brand, followed by 15 (4.76%) AS brand, and the laptops, which were least returned were 8 (2.54%) LNV brands. The issues associated with the various laptop brands were battery failure 209 (66.35%), and hardware failure 42 (13.33%). The study concludes that the university should have a purchasing team inclusive of the information communication and technology and computer science in field experts for the laptop brands to safeguard the efficiency of online learning during the pandemic. Findings from this paper are expected to play a key role for information communication and technology policy implementation and evaluation of digital device usage during online sessions and other university activities, university decision making for procurement of laptops for emergency online learning during future pandemics.

### INTRODUCTION

Digital devices are at the same time a tool for social interaction, an individual learning resource and can also be a valuable aid in the context of higher education to develop and promote new teaching and learning models during and post pandemic (Beaunoyer et al. 2020; Badawy et al. 2022). March 2020 dawned a new normal in South Africa, when everything came to a halt due to the COVID-19 pandemic (Kulal and Nayak 2020). The restrictions of social distancing, wearing of masks, and minimising contact rendered traditional teaching models infeasible (Sasan and Baritua 2022). Higher Education Institutions were constrained to make an emergency transit to online learning platforms (Adnan and Anwar 2020; Dhawan 2020). Urban universities were flexible to the online transition due to adequate information communication and technology (ICT) facilities, and a small proportion

of students without funding (that is, most students had access to digital devices) among others (Ali 2020; Firmansyah et al. 2021). However, delays in transfer to online platforms were observed for most rural universities due to a plethora of constraints that include students from low socioeconomic levels, few students with digital devices, and having adequate information communication and technology power to sustain the emergency online learning, to name a few (Simamora 2020; Azionya and Nhedzi 2021; Mathrani et al. 2022). The academic calendar for these institutions was compromised, and as a result, reactive measures had to be provoked in a rush to safeguard the academic year and commence with online learning.

Digital devices (laptops, tablets, personal computers, mobile phones, and so on) definitively optimise daily activities and transform human daily lives. They have become some kind of personal assistants powered by internet connectivity (Iivari et al. 2020). However, multifaceted challenges are encountered with these digital devices, which include battery and hardware failure, among others. Studies concerning battery failure reported

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that when charging the battery continually without allowing it to fully deplete, the battery eventually forgets that the capacity has not been used optimally. It depletes faster than usual when used (Jouhara et al. 2019; Saleh 2021; Wang et al. 2021). Given that the students mostly use the laptop devices for academic and non-academic (texting, surfing the internet, and games) purposes, depletion of battery should be an imminent consequence (Vahedi et al. 2021). Padilla et al. (2019) report that the negative ramifications of battery failure include overcharging, and battery defect occurring over time.

During the emergency online learning, overcharging was expected given that the online classes on average, took place for over 4 hours a day. It thus propels students to leave laptops on a charger and reduce the remaining useful life of the laptop (Hasib et al. 2021). Gonzales et al. (2020) reported a prevalence of 20 percent concerning hardware failure, and more especially, as they report that the hardware was broken for 20 percent of the college students. Another study by Kouhi et al. (2022) also reported that out of 254 procedures, only 252 were successful, yielding a 0.7 percent hardware failure rate. The inequalities experienced during the pandemic are highlighted by Maphalala et al. (2021) and Mpungose (2021). They report that unequal access to digital technology, online teaching paradigms and understanding of the learning management systems affected students negatively and impeded their academic performance. The mental state of students in disadvantaged institutions as a result of digital inequalities, poor connectivity and feeling was left negatively affected (Marongwe and Garidzirai 2021; Gumede and Badriparsad 2022).

A study by Motala and Menon (2020) report that social inequalities (financial constraints) compound to the challenges faced by students in online settings, as students need to decide between procuring food or data for online learning due to unaffordability. Widodo et al. (2020) established that most students in universities were not ready for the emergency transition to online learning platforms. Thus, the reason for the lack of knowledge about the platforms before even attempting the content covered occurred. Gurajena et al. (2021) highlight that technological, pedagogical and low socioeconomic status are some of the constraints faced during the pandemic. Poor connectivity, digital device malfunction and financial status during

the COVID-19 pandemic resulted in increased perceived stress among students (Delicano 2021). In another study, gender inequalities were highlighted as barriers in online session attendance, as females were more likely to attend in contrast to male students (Sarkar et al. 2021). Kulal and Nayal (2020) report that teacher preparedness and knowledge of the learning management systems (LMS) lagged in online sessions. They further alluded that institutions needed emergency workshops to conduct focused sessions on the usage and operations of the LMS to safeguard the quality of online teaching and learning sessions.

The aforementioned underpinnings alluded to by the authors addressed challenges of remote learning, which includes, amongst others, digital device inequalities, social and socioeconomic statuses, teachers' and learners' preparedness as drawbacks of online learning. However, some motives and root causes underpinning the technical challenges encountered with using the digital devices for online learning have not been adequately cross-examined. Hence, this study intends to fill the gap by addressing the following study objectives.

### Objectives

The objectives of this study are:

1. To determine structural implications (that is, the influence of the digital devices used in learning facilitation on the performance structure or experiences of students) of digital devices used by students during eLearning sessions.
2. To assess the effects of digital devices faults on the cognitive paradigms of students during an eLearning session.

### METHODOLOGY

The study investigated the structural implications of digital device usage during online sessions at a rural university, located in Pretoria, Gauteng Province, South Africa. The university houses over 5000 students inclusive of undergraduate and postgraduate students in five schools. This study adopted a retrospective facility based review approach for the period January to May 2021. The respondents of this study were laptops used by registered undergraduate and postgraduate students for the 2021 academic calendar. To

select the sample, records of all students who returned the laptops during the period of the study were included. The study excluded those laptops that did not have defects during the period of the study. A total of 750 laptops of three categories procured by the procurement office in collaboration with the centre for university teaching and learning (CUTL) were issued out to students who applied for the laptop dispensation. To avoid the POPI Act in South Africa, which prohibits actual use of name or identification, pseudonyms (CNX, AS and LNV) are used. The first category was SMARTBOOK 3 CNX 14 Intel Core i3 laptop with Windows 10 operating system, the second category was the AS X515MA-C41G0W laptop, and the third category was the LNV S145-15 IGM laptop (Idea-pad) Type 81MX Windows 10 operating system. Their sub samples were 450 CNX, 250 AS, and 50 LNV. Of these, 315 laptop records (which included eight (8) LNV, 292 CNX and 15 AS) were reviewed by the researchers during the study period and the defects after assessment were transcribed into a Microsoft Excel spreadsheet for analysis. Anonymity and confidentiality of the brands and the institution under study was ensured to protect the privacy of the service providers for the various laptop brands and to avoid conflict of interest. The questionnaire, which the students filled in included demographic profiles, problem category (that is, laptop, tablet, or other), problem description, laptop brand, and serial number amongst others. The questionnaire was piloted by the ICT department and given to experts in the field to ensure validity and reliability of the tool. The researchers reviewed the questionnaires and captured the information systematically in a Microsoft Excel spreadsheet. Later, the data were analysed using the software package for social sciences (SPSS) version 20. The categorical data were analysed using frequency tables, and to assess association chi-square test was used with p-value <0.05 indicating significance. Furthermore, thematic content analysis technique was used to create themes (Braun and Clarke 2006) for the different laptop brands defect. The researchers first read through the transcripts several times to identify emerging themes that provided an understanding of the defects experienced. After reading all transcripts, a list of similar topics was compiled, and grouped as per the theme.

**RESULTS**

A total of 750 laptops were issued out to students during the COVID-19 emergency online learning dispensation. Of these, about 42 percent (315) were returned to the ICT department due to defects. The defective laptops comprised 292 of the 450 CNX brand, followed by 15 of the 250 AS brand, and the laptops that were least returned were 8 of the 50 LNV brand. The results are summarised in Table 1.

**Table 1: Summary of Laptop brands**

<i>Laptop brand</i>	<i>Issues (n(%))</i>	<i>Total laptops issued (n(%))</i>
CNX	292 (92.70%)	450 (60%)
AS	15 (4.76%)	250 (33.33%)
LNV	8 (2.54%)	50 (6.67%)

Table 2 outlines the 12 student groups who were the beneficiaries of the COVID-19 laptop dispensation scheme for emergency online learning, and which group was affected the most. The results show that the 2018 group with 64 (20.32%) students returned the CNX laptop brand due to technical issues experienced during online sessions, followed by the 2020 group of which 59 (18.73%) also received mostly CNX laptops and the group who received fewest laptops was the 2010 group (0.32%). From the results, it can be seen that due to high purchase of the CNX brand, most of the students across the different groups returned the laptops for various defects. The results are summarised in Table 2.

**Table 2: Summary of returned laptop brands for different groups**

<i>Student year of registration</i>	<i>CNX</i>	<i>LNV</i>	<i>AS</i>	<i>Total</i>
2010	1	0	0	1
2011	2	0	0	2
2012	7	0	0	7
2013	5	0	0	5
2014	13	0	0	13
2015	28	0	0	28
2016	31	1	0	32
2017	42	0	0	42
2018	61	1	1	64
2019	43	2	0	45
2020	53	2	4	59
2021	6	2	10	18
<i>Total</i>	292	8	15	315

From the 315 defective laptops reviewed by the researchers, 315 laptops issues emerged and were further grouped into 10 categories/themes. These categories were beyond the university ICT department to resolve and had to be returned immediately to the manufacturer. The results in Table 3 revealed that from the 750 laptops purchased for students, 209 (27.87%) had an issue with battery failure, while 42 (5.6%) had issues with hardware failure. The complaints of factory fault (0.1%) did not contribute much. The results together with Table 2 in contrast to the total number of laptops (see Table 1) issued suggest that the group that was severely affected by the laptop battery failure amongst other defects was the 2018 group and brand, which contributed to high laptop defects was CNX since it was distributed in large proportions to the student in contrast to other brands. Table 3 summarizes the laptop defects reviewed from three laptop brands.

**Table 3: Summary of laptop issues by different laptop brands**

Laptop issue	Laptop brands		
	CNX (n = 450)	AS (n = 250)	LNV (n = 50)
Battery failure	200	7	2
Charging block	5	1	-
Damaged screen	11	1	1
Factory fault	1	-	-
Fan failure	7	-	-
Hardware failure	35	5	2
Keyboard failure	11	-	2
Mic failure	3	-	-
Software failure	5	1	1
Touch pad failure	14	-	-

The study went on to investigate the significance between each laptop issue against the laptop brand under the following study assumptions:

Assumption (1a): All laptops brands have similar faultier issues.

Assumption (1b): All laptop brands have different faultier issues.

Assumption (1c): Laptop brand is associated with laptop issue.

Table 4 reveals that there is an association between the laptop brand and laptop issue. The main laptop issue (out of the 750 laptops distributed to students), which was dominant among the brands was battery failure with 209 laptops including 200

CNX laptops, 7 AS, and 2 LNV brands affected ( $p$ -value = 0.009), followed by hardware failure having 42 laptops inclusive of 35 CNX, 5 AS and 2 LNV brands flagged ( $p$ -value = 0.037). The study also revealed that keyboard failure was also a significant laptop issue, although few laptops (13) were reported (that is, 11 CNX, and 2 LNV,  $p$ -value = 0.008). Regarding assumption (1b), the results show that the laptop brands had almost similar laptop issues, however, since CNX was distributed the most, most defects were observed for CNX, followed by AS. The LNV brand which was least distributed seems to be the laptop with least issues experienced during online learning. The uneven distribution of the laptop brands is inconclusive of the brand to be procured in bulk for the students by the university. Furthermore, the results also showed that laptop issues and laptop brand are associated with  $p$ -value < 0.05 and thus agreeing with assumption (1c). The results show that the CNX brand which was distributed the most had most issues and adversely affected the experience of students' online classes. They further put their academic performance at risk.

**Table 4: Summary of test of associations between laptop brand and laptop issues**

Laptop issue	Laptop brands			
	AS (n = 250)	CNX (n = 450)	LNV (n = 50)	$p$ - value
Battery failure	7	200	2	0.009
Charging block	1	5	-	0.399
Damaged screen	1	11	1	0.415
Factory fault	-	1	-	0.961
Fan failure	-	7	-	0.754
Hardware failure	5	35	2	0.037
Keyboard failure	-	11	2	0.008
Mic failure	-	3	-	0.888
Software failure	1	5	1	0.061
Touchpad failure	-	14	-	0.562

Pearson chi 2(18) = 29.1367;  $p$ -value = 0.047

## DISCUSSION

The study investigated the structural implications of digital device usage during online sessions. A total of 750 laptop brands consisting of 450 CNX, 250 AS and 50 LNV laptops were given to students to do emergency online learning due to COVID-19 regulations prohibited on campus attendance. The criteria and motivation for pur-

chasing the laptop brands were not documented in the records together with how the laptop brands were issued out to students. Of these, a total of 315 (42%) laptops (292 CNX, 15 AS and 8 LNV) were returned by students and flagged as having technical issues during the study period, the CNX brand was distributed the most to the students in contrast to other brands, hence, the reason why most of the students' laptops were returned for defects, this might have the case if there was even distribution of the laptop brands. Similar study by Selvaraj et al. (2021) reported that the negative ramifications of online learning was poor internet connectivity which affected 36.3 percent of the participants, technical issues (17.2%) of the students, and limited data (32.2%). In this study, poor internet connectivity and limited data were not reported in the questionnaire, given that the majority of them are from disadvantaged backgrounds and reside in deep rural villages in South Africa where internet connectivity is a perpetual issue. These challenges might have compounded the negative ramification of laptop defects.

Regarding battery failure as a defect, 209 (27.87%) of the 750 laptops procured had battery failure. One of the participants reported, "*Laptop is not working without a charger*" to highlight the negative experiences of the laptop device during online learning. Another participant said, "*Laptop switches off randomly*". Studies concerning battery failure reported that when you keep charging the battery without allowing it to fully deplete, the battery eventually forgets that the capacity has not been used optimally and depletes faster than usual when used (Jouhara et al. 2019; Saleh 2021; Wang et al. 2021). Given that the students use the laptop devices for academic and non-academic (texting, surfing the internet, and games) purposes, depletion of battery should be an imminent consequence (Vahedi et al. 2021). Another issue which affects the longevity of the battery lifespan is the overheating of the digital device, which participants in this have alluded to that laptops were overheating, this was also reported by Dolgunsöz and Yildirim (2021). Padilla et al. (2019) report that the negative ramification of battery failure includes over charging, and battery defect occurring overtime. In this study, overcharging was expected given that the online classes on an average took place for over 4 hours a day, thus propelling students to leave the laptop on a charger and reducing the remaining useful life of the laptop (Hasib et al. 2021).

Around 42 (5.6%) of the laptops returned had hardware failure. Similar study by Gonzales et al. (2020) reported a high prevalence of 20 percent concerning hardware, more especially, they reported that the hardware was broken for 20 percent of the college students. Another study by Kouhi et al. (2022) also reported that out of 254 procedures only 252 were successful, yielding a low 0.7 percent failure rate, which was mainly due to hardware failure. To affirm the severity of hardware failure one of the participants said, "*Hard drive is not detected*" and another one said, "*Hard drive damaged*". However, in this study the reasons for such a high failure rate were not documented in the records.

The high prevalence of technical issues reported in this study pose a serious threat to the academic calendar compounded by poor ICT facilities (Bariu 2020; Kundu et al. 2020; Ntorukiri et al. 2021), and unpreparedness (Alea et al. 2020; El Refae et al. 2021) amongst others. In this study the structural implications of defective digital device usage in online sessions compromised students' academic performance, who were already affected by the social and socioeconomic issues given that they are from disadvantaged backgrounds.

Social inequalities, teacher and learner preparedness, social ills and technological understanding were not documented in the historical records reviewed. The authors expect such high disparities in the aforementioned anomalies, due to the nature of the rural universities in South Africa. Marongwe and Garidzirai (2021) and Gumede and Badriparsad (2022) extrapolated some of these impairments in a rural university setting, and outlined a framework to alleviate them during a pandemic. The laptop technical issues not only exposed the social and digital inequalities among the students, but they also highlighted the negative ramifications of learner experiences during online sessions as they were left behind. These students who experienced hardships with poor functioning laptop devices were of low socioeconomic status (Avanesian et al. 2021; Cunha et al. 2021).

## CONCLUSION

This study investigated the structural implications of digital device usage during online sessions. A total of 750 laptops procured by the procurement office in collaboration with the centre for

university teaching and learning were issued out to students who applied for the COVID-19 laptop dispensation. The laptop brands consisted of 450 CNX, 250 AS and 50 LNV. Of these, 315 laptop records (which included eight (8) LNV, 292 CNX and 15 AS) were reviewed by the researchers during the study period and flagged as having technical defects. The study revealed the negative ramifications of students' online learning experiences due to laptop technical issues. Input from ICT specialists could have had a significant impact in creating a framework for effective online sessions. However, this study noted that ICT specialists were not effectively involved in advising during the procurement of laptops for emergency online learning. Hence, the adverse structural implications were experienced. The study concludes that the university should have a purchasing team inclusive of ICT and computer science field experts for the laptop brands to safeguard the efficiency of online learning during the pandemic. Findings from this paper are expected to play a key role for information communication and technology policy implementation and evaluation of digital device usage during online sessions and other university activities, university decision making for procurement of laptops for emergency online learning during future pandemics.

### RECOMMENDATIONS

The results of the study show that out of the 750 laptops distributed to students, the brand which showed most technical issues was CNX laptop with 292 (38.89%) in contrast to other brands, since it was the one distributed the most. There needs to be a good association between the University and the manufacturers to speed up the process when these laptops are returned for repair. Another recommendation is that the department of the Center of University Teaching and Learning in collaboration with ICT and computer science should look into this matter by finding robust methods to speed up the process of laptop returns during repair from the manufacturer, since the lags affect the online learning experiences of the students. Also, this matter should be investigated further to understand the reasons behind unevenness in procurement of students' laptops and the criteria used for purchasing the brands. Collabora-

tion between ICT specialists, computer scientists and procurement offices to develop a framework for failure minimisation of digital devices, procurement of strong digital device brands is also critical.

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