Emergency remote teaching and learning during COVID-19 pandemic: Efficacy of a four-stage model

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Abstract: The COVID-19 pandemic created the need for a global change in tertiary education. Universities that traditionally relied on contact with students in physical classrooms were forced to consider modes of remote teaching to mitigate the risks of infection due to physical proximity. This study evaluates the emergency remote teaching implemented within the Department of Information Technology at the Durban University of Technology, South Africa. An emergency remote teaching model with four stages consisting of: preparation, synchronous and asynchronous teaching and learning, e-assessments and reflections are described, analysed and evaluated with reference to both lecturers and students. The evaluation is performed using both qualitative and quantitative research methods. Qualitative analysis was

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performed on 29 sources using content analysis. 229 initial codes were identified and first categorized into 13 subcategories and finally to the four categories synonymous with the adopted four-stage emergency remote teaching model: preparation (135 references), asynchronous and synchronous teaching and learning (67 references), e-assessments (25 references) and reflections (8 references). Quantitative data on the use of the learning management system from 2019 to 2020 evaluated the results of the applied changes in practice. From the results, it was evident that students and lecturers invested much time in the learning management system with 13 tools being adopted by the 49 analysed subjects. The learning management system was used extensively for communication, assessment and dissemination of subject content. The comparative results of the data from the 2019 and 2020 academic years showed that the majority of the 2020 subjects' final results were statistically higher than the 2019 results. Results of analysis revealed the success of the implementation of the four-stage emergency remote teaching model.

Keywords: Emergency remote teaching; multimodal remote teaching and learning; higher education; COVID-19 pandemic; emergency remote education; remote learning.

I. Introduction

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2), commonly known as COVID-19, has crippled health organizations worldwide infecting over 365 million people with over 5.5 million fatalities globally by the beginning of 2022. Countries adopted various measures to reduce the number of infections such as social distancing, countrywide lockdowns and travel restrictions with these resulting in a reduced workforce in many sectors including education.[1] The restrictions have had unavoidable, detrimental effects on many sectors but especially on education. The majority of governments around the world were forced to decide on a near total closure of all educational institutes so as to reduce the risk of spreading COVID-19. This temporary closure affected the global education system, leading to the disruption of teaching and learning activities.

The declaration of a national lockdown by the South African government, which was effective from March 26, 2020, forced all stakeholders within the country's educational system to consider alternate solutions as a response to the crisis. Many South African universities chose to adopt a flexible, remote learning, multimodal approach as a strategy which would allow academic

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[1] Ahmed Al-Jabir et al., "Impact of the Coronavirus (Covid-19) Pandemic on Surgical Practice-Part 1," *International Journal of Surgery* 79 (2020): 234, https://doi.org/10.1016/j.ijsu.2020.05.022.

activities to continue. It is important to note that many universities and centres of education had never before been exposed to remote learning.[2,3] The internet based multimodal concept, which gained popularity in the early 2000s and is practiced by institutions, combines text, audio and visual elements as a means of reshaping the traditional approach of face-to-face teaching and learning.[4]

The current growth in advanced digital technologies facilitated the smooth adoption of internet based multimodal teaching and learning by many academic institutions, especially in the higher education sector. Diverse approaches were implemented by institutions to achieve multimodality. Delivery of the current curriculum was converted to an online platform with the focus being on the online environment instead of on online pedagogy.[5] The implementation of a multimodal remote teaching and learning approach facilitates easy access to subject contents through multiple formats and supports the continued progression of the prescribed learning activities and outcomes.[6] It also supports and benefits all students regardless of their economic or cultural background. The unexpected replacement of the traditional face-to-face instructional mode with a remote, multimodal approach has however caused many challenges. These challenges are due to social diversity and inequality which exist in several factors such as "gender, culture, social economic status, race and geopolitical context".[7]

Despite the challenges faced by institutions, educators and students the disruptions provided opportunities for innovation in several contexts including the initiation of multimodal remote teaching and learning approaches, the identification of associated challenges and the evaluation of

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[2] Abdulrahman Essa Al Lily et al., "Distance Education as a Response to Pandemics: Coronavirus and Arab Culture," *Technology in Society* 63 (2020): 101317, https://doi.org/ https://doi.org/10.1016/j.techsoc.2020.101317.

[3] Najmul Hasan and Yukun Bao, "Impact of "E-Learning Crack-up" Perception on Psychological Distress among College Students During Covid-19 Pandemic: A Mediating Role of "Fear of Academic Year Loss"," Children and Youth Services Review 118 (2020): 105355, https://doi.org/10.1016/j.ijsu.2020.05.002.

[4] Stéphanie Philippe et al., "Multimodal Teaching, Learning and Training in Virtual Reality: A Review and Case Study," *Virtual Reality & Intelligent Hardware* 2, no. 5 (2020): 421-42, https://doi.org/10.1016/j.vrih.2020.07.008.

[5] Abdalellah O Mohmmed et al., "Emergency Remote Teaching During Coronavirus Pandemic: The Current Trend and Future Directive at Middle East College Oman," *Innovative Infrastructure Solutions* 5, no. 3 (2020): 1-11, https://doi.org/10.1007/s41062-020-00326-7.

[6] Laura Czerniewicz et al., "A Wake-up Call: Equity, Inequality and Covid-19 Emergency Remote Teaching and Learning," *Postdigital Science and Education* (2020): 1-22, https://doi.org/10.1007/s42438-020-00187-4.

[7] Czerniewicz et al., "A Wake-Up Call," 1-22.

their implementation. A multimodal remote teaching and learning approach is usually embarked on due to a planned shift to an online pedagogy appropriately designed by experts with supporting technologies to meet its long term purpose. However, due to institutions requiring a speedy shift to the new approach because of an unexpected situation, the abrupt transition is rather characterized as Emergency Remote Teaching (ERT). Emergency Remote Teaching involves remote teaching or delivery of material that would normally be delivered in a face-to-face manner. The primary objective of ERT is to provide reliable access to teaching as a temporary measure through creative solutions.[8] Literature acknowledges the wide acceptance of ERT as an approach during the COVID-19 pandemic. An ERT model was implemented during the COVID-19 outbreak by the Mechanical Engineering department at Middle East College where both synchronous and asynchronous modes of delivery were combined.[9] The model consisted of a transformation framework with simultaneous execution of a curriculum transformation phase and a staff development phase. Instructional delivery took the form of online and recorded lectures, voice-over PowerPoint, asynchronous sessions through social media platforms and synchronous sessions via MS Teams. During the same pandemic, a school in Greece provided educational continuity through the adoption of a 5-phase process model for virtual learning that combines both synchronous and asynchronous modes.[10] The focus of this model was on students' and teachers' support, assessments and grading and reflection as a response to the disruption. A crisis driven conceptual framework, specifically designed for remote or distance education during times of calamity was proposed by Al Lily[11] with a focus on the Arab region. The framework highlights the ramifications associated with: pedagogy and psychology; procedure and logic; and society and culture.

The model adopted by Halat et al.,[12] also used synchronous and asynchronous modes of content delivery but incorporated YouTube videos to simulate laboratory based experiments. Students submitted their reports for

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[8] Charles Hodges et al., "The Difference between Emergency Remote Teaching and Online Learning," *Educause review* 27 (2020): 1-12.

[9] Mohmmed et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.

[10] Richard E Ferdig et al., Teaching, Technology, and Teacher Education During the Covid-19 Pandemic: Stories from the Field, (Waynesville, NC, USA: Association for the Advancement of Computing in Education (AACE), 2020), https://www.learntechlib.org/p/216903/.

[11] Al Lily et al, "Distance education as a response to pandemic,".

[12] Halat et al., "Highlights from a Model for Remote Delivery of Pharmacy Laboratory Courses: Design, Implementation and Student Feedback: Innovation in Learning Assessment," Pharmacy Education (2020): 49-51, https://doi.org/10.46542/pe.2020.202.4951.

summative assessment through Google classroom. The study conducted by Chaka[13] examines the approaches to emergency online learning in 64 universities in the USA and 21 South African universities where the common components to ERT strategies included online tools that offer asynchronous and synchronous teaching, a 24/7 platform such as a learning management system (LMS), resources, guides and training on the use of LMS tools and the transition to ERT for both staff and students. Institutions also made provisions to provide additional equipment where necessary and provide zero-rated sites to support students' access to the available resources. Amin and Hanna[14] found that the most commonly used online tools during the pandemic were video conferencing, LMS's and online messaging services with WhatsApp being the most preferred mode of communication.

According to Bozkurt et al.,[15] ERT is more an obligation than an option with the aim being to approach the situation with different strategies and priorities. Significant factors to be considered when adopting an ERT model include: consideration of the target group, the availability of technological infrastructure and geopolitical, economic and social contexts.[16] Most developed countries are able to change to emergency online teaching and learning approaches seamlessly.[17] However, this is not the case for many developing countries such as South Africa where diverse factors such as students' e-skill level, digital literacy, accessibility to digital devices and internet connectivity hinder the smooth adoption of remote learning.[18] To ensure continuity of instructional delivery, in spite of associated challenges,

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[13] Chaka, Chaka, "Higher Education Institutions and the Use of Online Instruction and Online Tools and Resources During the Covid-19 Outbreak-an Online Review of Selected Us and Sa's Universities," Research Square (2020): 1-46, https://doi.org/10.21203/rs.3.rs-61482/v1.

[14] 14 Amin Fakhrurrazi and Hanna Sundari, "EFL Students' Preferences on Digital Platforms During Emergency Remote Teaching: Video Conference, LMS, or Messenger Application?," Studies in English Language and Education 7, no. 2 (2020): 362-78, https://doi.org/10.24815/siele.v7i2.16929.

[15] Aras Bozkurt et al., "A Global Outlook to the Interruption of Education Due to Covid-19 Pandemic: Navigating in a Time of Uncertainty and Crisis," Asian Journal of Distance Education 15, no. 1 (2020): 1-126, http://www.asianjde.com/ojs/index.php/AsianJDE/article/download/462/307.

[16] Aras Bozkurt and Ramesh C Sharma, "Emergency Remote Teaching in a Time of Global Crisis Due to Coronavirus Pandemic," Asian Journal of Distance Education 15, no. 1 (2020): 1-6, http://www.asianjde.com/ojs/index.php/AsianJDE/article/download/447/297.

[17] Bozkurt et al., "A global outlook to the interruption of education due to COVID-19 pandemic," 1-126.

[18] Matthias Krönke, Africa's Digital Divide and the Promise of E-Learning, Afrobarometer Policy Paper No. 66, (2020), https://www.africaportal.org/documents/20610/pp66-africas_digital_divide_and_the_promise_of_e-learning-afrobarometer_policy_s1oxzDa.pdf.

a remote multimodal flexible teaching and learning approach was adopted across South African universities as a protective measure and as an attempt to save the academic year whilst minimizing the spread of COVID-19 amongst students.

Durban University of Technology (DUT) is one of the 26 public universities in South Africa. Emergency Remote Teaching was implemented at DUT using a multimodal approach as a response to the COVID-19 pandemic. The shift to multimodal-based teaching and learning is a process needing active involvement from students, lecturers and support staff. The ERT approach was expected to occur at a staggering speed causing challenges for both lecturers and students. These challenges stemmed from the unpreparedness of staff and students for the virtual classroom environment, fears relating to losing the year, not being able to cope with remote learning and fear of contracting the disease. The lack of accessibility to and availability of technology was a significant challenge for staff and students. But despite these challenges the willingness of stakeholders to adapt to the new multimodal approach and the technological and training support provided by management assisted with the successful implementation of the approach.

The cardinal objective of this study is to present the four stage emergency multimodal remote teaching and learning model adopted as a tool to maintain the continuity of teaching and learning, including its implementation and evaluation, in the context of DUT in South Africa. The objective was accomplished by mixed method research design which uses both qualitative and quantitative research data. The researchers are of the opinion that the adoption of the emergency multimodal remote teaching and learning model was successful with the results indicating that the lecturers and students were able to progress with their planned activities during the transition to ERT. The study findings support the existing evidence on the implementation of ERT and open up the opportunities in the higher education sector to restructure their pedagogical approach for a suitable multimodal approach to enhance teaching and learning in a similar context.

The remainder of this paper is succinctly summarized as follows: Section II provides an overview of the adopted model. Section III elucidates the materials and methods used in this study while section IV covers the experimental results and discussions. Concluding remarks are provided in section V.

II. An overview of the adopted model

This study considers the implementation of a flexible multimodal approach for emergency remote teaching and learning at DUT as a case

study. The activities undertaken are divided into four stages: preparation, synchronous and asynchronous teaching and learning, e-assessments and reflections. The adopted four-stage ERT model is illustrated in Figure 1.
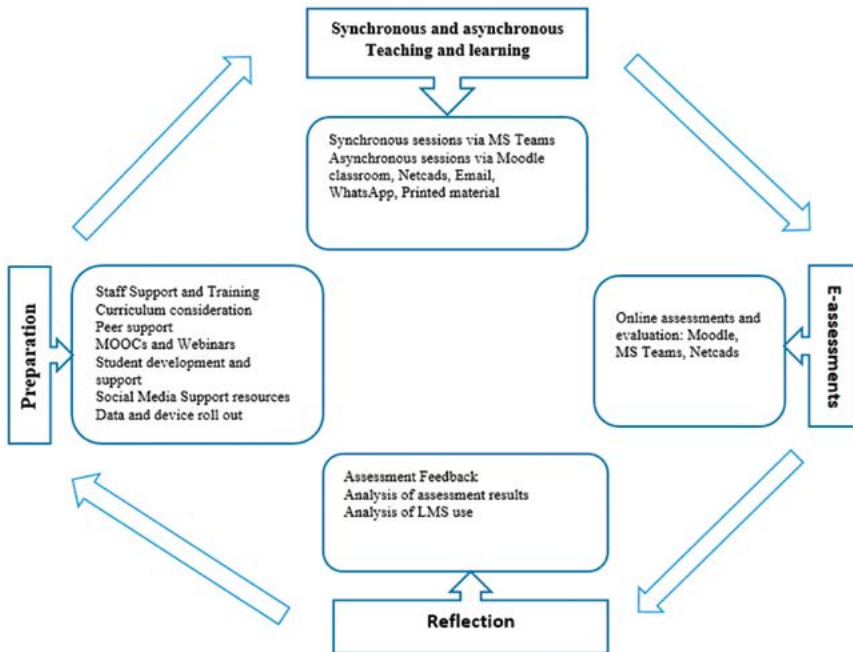
Figure 1

Four-stage emergency multimodal remote teaching and learning model

Preparation is considered an important stage when applying ERT.[19] The study conducted by Rahiem[20] highlights its significance and the importance of providing adequate training and ensuring access to resources for successful implementation of emergency teaching and learning. This initial stage in the adopted model focussed on supporting students and staff for the shift to ERT.

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[19] Unung et al., "Reviewing Online Learning Facing the Covid-19 Outbreak," *Journal of Talent Development and Excellence* 12, no. 3s (2020): 385-92.
[20] Rahiem, "The Emergency Remote Learning Experience of University Students in Indonesia Amidst the Covid-19 Crisis," *International Journal of Learning, Teaching and Educational Research* 19, no. 6 (2020): 1-26, https://doi.org/10.26803/ijlter.19.6.1.

This was achieved by providing support and resources through training initiatives including Massive Open Online Courses (MOOC) and webinars as well as providing data and devices to staff and students.

Synchronous and asynchronous modes of content delivery is considered a significant stage of many ERT models.[21,22,23,24] Dynamic learning, enhanced classroom engagements and the promise of improved relationships between lecturers and students are some of the major benefits of synchronous teaching and learning.[25] With synchronous delivery being reliant on stable internet connectivity and many students experiencing unstable information and communications infrastructures, the asynchronous mode of teaching and learning becomes essential. Flexibility and self-pacing are further advantages of the asynchronous mode of delivery as it allows students access to course materials at their convenience.[26,27] The adopted ERT model implemented synchronous and asynchronous modes of delivery using various platforms such as MS Teams, LMS (Moodle), Netacad, Email, WhatsApp and printed materials. The synchronous mode through MS Teams attempted to recreate traditional face-to-face lectures, enabling interactive teaching and learning. The Moodle LMS was the chosen tool for asynchronous delivery using text, audio and video to disseminate information and announcements for communication. This ensured the adequate provision of materials to support the learning activities. Students were able to communicate with lecturers and gain assistance via MS Teams, Moodle chats, emails and using the WhatsApp platform. Inclusion of synchronous communication using these and other online platforms is an effective method for online teaching and learning.[28]

The assessment of students' performance is an important component of teaching and learning.[29] The third stage of the model encompasses the design and creation of online assessments. Moodle, MS Teams and Netacad were

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[21] Richard et al, "Teaching, technology, and teacher education during the covid-19 pandemic,".

[22] Abdalellah et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.

[23] Hammoudui et al., "A model for remote delivery of pharmacy laboratory," 49-51.

[24] Fakhrurrazi, "EFL Students' Preferences on Digital Platforms," 368-78.

[25] Ahmad Fuad Abdul Rahim, "Guidelines for Online Assessment in Emergency Remote Teaching During the Covid-19 Pandemic," *Education in Medicine Journal* 12, no. 2 (2020): 59-68, https://doi.org/10.21315/eimj2020.12.2.6.

[26] Ahmad Fuad Abdul Rahim, "Guidelines for Online Assessment in Emergency Remote Teaching During the Covid-19 Pandemic," 59-68.

[27] Abdalellah et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.

[28] Fakhrurrazi, "EFL Students' Preferences on Digital Platforms", 362-78.

[29] Ahmad Fuad Abdul Rahim, "Guidelines for Online Assessment in Emergency Remote Teaching During the Covid-19 Pandemic," 59-68.

used for the preparation and evaluation of e-assessments. Synchronous and asynchronous assessment methods including formative and summative assessments, assignments and projects were widely adopted for assessment purposes. Formative assessment methods such as online quizzes assisted in familiarizing students with the e-assessments processes and improved their confidence level during the shift to ERT.

Lack of feedback is identified as an online learning pedagogical challenge,[30] hence the final stage of this model evaluates its implementation and resulting students' academic results. The researchers evaluate both the performance of students as well as the use of the chosen LMS, namely Moodle. The feedback provides insight into the extent to which the LMS tools were used by both lecturers and students with observations being made as to the most frequently used tools and the uses thereof. A comparative analysis is done between the results achieved for modules in the year prior to the implementation of the ERT model and the year of study in which the model was applied. This provides some insight into the successful implementation of the adopted four-stage multimodal approach.

III. Materials and methods

To achieve the study objectives a mixed method research design based on a multiple paradigm position model is employed.[31] The multiple paradigm position model allowed the concurrent application of both qualitative and quantitative methods, hence the results of this study were obtained by the application and analysis of both qualitative and quantitative data. The collective strength of both qualitative and quantitative methods assists to accomplish a better understanding and interpretation of study results.[32,33]

The transition to ERT was unplanned and unavoidable requiring the university to actively respond by providing the necessary resources and support

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[30] Fernando Ferri, Patrizia Grifoni, and Tiziana Guzzo, "Online Learning and Emergency Remote Teaching: Opportunities and Challenges in Emergency Situations," *Societies* 10, no. 4 (2020): 86.

[31] Kathryn, Pole. "Mixed Method Designs: A Review of Strategies for Blending Quantitative and Qualitative Methodologies," *Mid-Western Educational Researcher* 20, no. 4 (2007): 35-38.

[32] Judith Schoonenboom, and R Burke Johnson. "How to Construct a Mixed Methods Research Design," *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie* 69, no. 2 (2017): 107-31.

[33] Jennifer C Greene, Valerie J Caracelli, and Wendy F Graham, "Toward a Conceptual Framework for Mixed-Method Evaluation Designs," *Educational evaluation and policy analysis* 11, no. 3 (1989): 255-74.

to aid the transition of teaching and learning from conventional classroom teaching. The evaluation of the transition to ERT is accomplished by analysing both qualitative and quantitative data concurrently. Announcements, communique and reports that were distributed during the COVID-19 pandemic by management to the Durban University of Technology community were collected as the main qualitative data source. Supplementary manuals, guides and training schedules among other documents, published on the university website during the time of the pandemic were also considered secondary sources of qualitative data. The quantitative data relating to all 2020 semester 2 modules delivered using the adopted multimodal approach was extracted from anonymized logs from the Moodle LMS and from the university's mark system, Integrated Tertiary Software (ITS). Only the data relating to modules and students from the Department of Information Technology were retrieved. This was done with the assistance of relevant administrators and managers using a convenience sampling method, because of accessibility and availability constraints. Level 1 ethical clearance was obtained from the institution's research ethics committee. Although various other tools such as Netacad, MS Teams, WhatsApp and YouTube were also utilized for asynchronous teaching and learning, only Moodle data was selected for the study as it is the official LMS adopted by DUT. Table 1 summarises the data sources for this study with data collection being guided by the four-stage ERT model.

Table 1

List of data sources

Source Type	Example
University website	DUT website
University Communication	Emails to students and staff cohorts from the DUT Pinboard
LMS and ITS data	Anonymized metadata of teaching and learning activities on Moodle, students' academic records
Reports	Technology For Learning (TFL) reports, Centre for Excellence in Learning and Teaching (CELT) reports on student academic development, Teaching Learning and Assessment (TLA) reports, reports from MS Teams sandbox

Qualitative data were analysed using an inductive approach. Content analysis transformed textual data into an organized summary of categories, identifying meaningful units through the systematic classification process of

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coding.[34,35] This method is suitable for all types of text data.[36] NVivo 12 Pro[37] qualitative data analysis software package was used as the analysis tool. To get a preliminary understanding of the data, documents relating to multimodal teaching, learning and assessment, which included reports, guidelines and resources were collectively scanned into **NV**ivo and scoured for most frequently used words. The resulting word cloud, shown in Figure 2, depicts the central focus at the institution namely, students, learning, staff, support and MS teams.

Each document served as a unit of analysis where open coding determined whether a word, phrase or resource relating to teaching or learning had occurred. Each code was named to indicate its influence on the teaching and learning process. The second phase of coding re-examined codes such that related codes were grouped into categories that encapsulate their collective meaning. These became subcategories which were then studied for further similarities and subsequently classified into distinct categories to reflect their role in the adopted model.

Figure 2

Word cloud

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[34] Hsiu-Fang Hsieh and Sarah E Shannon, "Three Approaches to Qualitative Content Analysis," Qualitative health research 15, no. 9 (2005): 1277-88, https://doi.org/10.1177/1049732305276687.

[35] Christen Erlingsson and Petra Brysiewicz, "A Hands-on Guide to Doing Content Analysis," African Journal of Emergency Medicine 7, no. 3 (2017): 93-99, https://doi.org/10.1016/j.afjem.2017.08.001.

[36] Hsiu-Fang and Sarah, "Three approaches to qualitative content analysis," 1277-88.

[37] Nvivo Qualitative Data Analysis Software Version 12.

Quantifiable Moodle and ITS data were analysed using descriptive and inferential statistics so that an understanding of the involvement of students and lecturers could be evaluated. Statistical analysis of the quantitative data was performed using IBM SPSS Statistics version 27.0.[38] The researchers sought to determine the extent to which the asynchronous Moodle platform was being used by lecturers and students in the 49 subjects taught by the department of Information Technology (IT). Of these 49 subjects, 32 subjects are part of programmes owned by the department of IT and the remaining 17 are serviced subjects by other departments of DUT.

Descriptive statistical analysis was used to analyse the Moodle data and to gain insight into the activities employed by both students and staff in accomplishing remote teaching, learning and assessments. As part of the reflection phase of the model, the researchers sought to establish to what extent the adopted ERT model was applied and to further investigate the extent to which the students' final marks were affected by the change. Hence, the ITS data pertaining to the 2019 and 2020 semester 1 results of the 32 subjects which are owned by the department of IT were analysed using inferential statistics. This comparison is accomplished by employing a dependent samples t-test as this is the most popular method in statistics for the evaluation of variances between two samples where data is normally distributed.[39] The authors acknowledge that during 2020, the method of teaching and learning and the approach adopted was not the only factor that could have affected the final results of a student. Other contributing factors include a change in the place of learning, access to devices, connectivity problems, access to infrastructure (including electricity) and many others. It is, however the researchers' opinion that the major change implemented during COVID-19 was the change to the remote multimodal approach therefore this would be the major contributor to any changes that occur in final marks achieved by students.

IV. Results and discussion

IV.1. Evaluation of the ERT model

The 29 documents analysed qualitatively define a total of 229 codes, unveiling 13 subcategories and four categories. The most significant

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[38] IBM SPSS Statistics for Windows, Version 27.

[39] [39] Manfei Xu et al., "The Differences and Similarities between Two-Sample T-Test and Paired T-Test," *Shanghai Archives of Psychiatry* 29, no. 3 (2017): 184-89, https://doi.org/10.11919/j.issn.1002-0829.217070.

subcategories are presented in Table 2. The four main categories are: preparation (135 references); asynchronous and synchronous teaching and learning (67 references); e-assessments (25 references); and reflections (8 references). These categories are directly related to the four stages of the adopted ERT model indicating the relevance of the model shown in Figure 1. Analysis reveals that the highest number of references exist in the first two phases (preparation and synchronous and asynchronous teaching and learning) while subsequent phases (e-assessment and reflection) are referenced to a lesser extent. This is due to the first phases being concerned with planning and training, which are well documented processes while e-assessment and reflection are not as well documented therefore having less qualitative data relating to them.

Table 2

Results derived from content analysis
of supportive documentation provided by the university

Categories	Subcategories	Sources	Frequency	Sample in-text references
Preparation	Care and support related to well being	3	22	"Return To Work Toolkit' information session, followed by an encouraging motivational talk"
	Quick start guides	3	5	"Remote Teaching Quick Guide: Curriculum, Pedagogies and Assessments"
	Links to resources	2	4	"Online Support links"
	Protocols and guidelines	4	30	"Guidelines and Protocols"
	Resources for students	4	45	"student and staff data issues support"
	Support provided to staff	6	29	"Data support helpdesk - staff and students"
Total references = 135				

Categories	Subcategories	Sources	Frequency	Sample in-text references
Asynchronous and synchronous teaching and learning	Technical support	2	7	"Helpdesk for Moodle, Teams and technical issues set up"
	TLA software training	3	14	"Moodle Will Continue To Be The Primary LMS"
	TLA strategies for online	11	46	"Face-face and virtual teaching conditions"
Total references = 67				
E-Assessment training	Assessment settings	4	20	"Moodle Quizzes - A Outline Settings explanations (timing, review, security etc.) "
	Creating assessment questions	3	5	"online questionnaire development"
Total references = 25				
Reflections	Feedback from assessments	1	7	"feedback on the assessment tasks will be important, as students acclimatise to this environment"
	Reflections on best practice	1	1	"Most universities were invited to comment. Substantial responses were received from US; UP and UJ and their feedback was considered for this report"
Total references = 8				

The quantitative analysis undertaken firstly evaluates the extent to which the resources provided in the first two stages of the model were adopted and secondly reports on the effectiveness of the model according to stakeholder use and student academic performance. The analysis is done on data pertaining to the delivery of and student performance in 49 subjects after 11 weeks of 2020

semester 2 lectures. The data was firstly summarized using descriptive statistical methods to reflect the involvement of lecturers and students in the process of delivering the adopted ERT model. Secondly, hypothesis testing was conducted on the students' final assessment results to statistically determine the effect that the adopted model had on students' final marks. This analysis speaks directly to the second purpose of the paper which is to analyse lecturer and student involvement in the delivery and adoption of the model.

IV.1.1. Stage 1: Preparation

The first category, preparation emerges as the most significant category with 135 references identified in the analysed textual data. This is in line with the findings of studies by Varawardina et al.,[40] and Rahiem[41] who likewise reference the importance of this stage and the need for adequate training and access to resources. References in this category confirm the notable efforts made by the university to prepare for the implementation of ERT. From the results, it is evident that preparation included providing initial support and training to staff and students with all of the subcategories in Table 2 referring to at least one of the phrases: "support"; "guides"; "resources"; and "protocols". To enable a quick adaptation by staff and students to the new online teaching and learning environment, quick start guides and links to resources were made available via multiple platforms during the early stages of ERT implementation. Textual resources are of extreme importance for not only the technical assistance they provide but also for the management of the psychological effects which may be caused by an abrupt transition to ERT. Al Lily[42] discusses the psychological challenges that result from new pedagogies which students may not be ready to embrace. These challenges were addressed by the University Wellness Centre which provided much needed support to staff and students remotely through online workshops.

> *The following workshops will be provided via Microsoft teams and the duration of the workshops will be 45 minutes to 1 hour…Psychological First Aid; Self-care during Covid-19; Supporting families during Covid19; Gender-based Violence; Transitioning to online learning…*

Online Counselling and Online Workshops, 24 April 2020.

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[40] Verawardina et al., "Reviewing Online Learning Facing the Covid-19 Outbreak," 285-92

[41] Rahiem, "The Emergency Remote Learning Experience of University Students,"1-26

[42] Al Lily et al, "Distance education as a response to pandemic,".

Software training was provided in the early stages of ERT to ensure students and staff could engage with the LMS, email, MS Teams and student portals. Remote access to software, installed in computer laboratories, was made available to Information Technology staff and students via Azure's Windows Virtual Desktop (WVD). Mobile data and other equipment were also made available to staff and students, without the provision of these e-learning would not have been possible. In addition, students were provided with controlled access to physical laboratories and libraries. Students were notified about the accessibility of campus through university statements:

> *Under alert level 3, a maximum of 33% of the student population will be allowed to return to campus, delivery sites and residences…This will include the following cohorts: …Final year students who require access to laboratories, technical equipment, data, connectivity and access to residence and private accommodation should return…*

University statement, 29 May 2020.

E-learning, would not have been possible without the provision of physical resources such as data and equipment to staff and students, evidence of which is available on multiple university statements to staff and students.

> *The Mobile Network Operators(MNOs) started loading the student's data onto their cellphones this week. The MNOs are Cell C, MTN, Telkom and Vodacom…..The loading of staff data commences on 5 June 2020…*

University statement, 5 June 2020.

IV.1.2. Stage 2: Asynchronous and Synchronous Teaching and Learning

The second category, asynchronous and synchronous teaching, is adequately represented in the data with 67 references as shown in Table 2. To ensure the continuity of academic activities, while remaining focused on a student-centred approach, both synchronous and asynchronous modes of module delivery were initiated. This approach is not new and has been used by other academic institutions for ERT.[43,44,45,46] Training is a key focus of many documents circulated by the university which is confirmed in the word cloud in Figure 2. Various forms of staff and student development initiatives were

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[43] Abdalellah et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.
[44] Hammoudui et al., "A model for remote delivery of pharmacy laboratory," 49-51.
[45] Chaka, "Higher Education Institutions and the Use of Online Instruction," 1-46.
[46] Richard et al, "Teaching, technology, and teacher education during the covid-19 pandemic,".

provided to ensure that both parties were adequately trained to use the LMS and MS Teams software. The analysed data bares evidence to the training (14 references) and support (7 references) provided for synchronous and asynchronous teaching and learning. Online teaching, learning and assessment (TLA) strategies were referenced 46 times in the analysed data which also indicates the support and guidance provided. DUT's Centre for Excellence in Teaching and Learning (CELT) whose primary goal is to contribute to the enhancement of TLA strategies at the university, played a significant role in enhancing student success during the unprecedented situation.

> *All faculties and departments were represented based on the students that came at the Libraries, sent email or WhatsApp support. We supported all departments at DUT with technical queries such as login issues, cannot find modules, cannot upload assignments and other related queries…*

> TFL - 1st term Report, 18 November 2020.

Adequate training and support is an important stage in the transition to remote learning.[47] The technical staff ensured software was accessible and stable with experts providing real-time assistance to staff and students. Significant evidence was found in the data supporting the development of pedagogical skills needed by staff to effectively create content and collaborate with students. For example:

> *The training programme's learning design is underpinned by principles gleaned from universities worldwide, on how to approach a rapid change, from face to face to virtual teaching during a crisis; and the second foundation of the new Moodle course for DUT academics is e-pedagogy best practices…*

> CELT Moodle training report, 4 May 2020.

The results also indicate that multiple modes of content delivery were made available to students, including: narrative PowerPoints; podcasts; discussion groups; YouTube videos; MS Teams live lectures; and the uploading of recorded lectures to Moodle. These show a close resemblance to those modes used and reported by Mohmmed et al.[48] Various platforms such as Blackboard,[49] Google Classroom[50] and Moodle[51] were widely used in ERT to ensure the interaction and engagement of students. Similarly, in this study, the use of

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[47] Chaka, "Higher Education Institutions and the Use of Online Instruction," 1-46.
[48] Mohmmed et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.
[49] Chaka, "Higher Education Institutions and the Use of Online Instruction," 1-46.
[50] Halat et al., "A model for remote delivery of pharmacy laboratory," 49-51.
[51] Mohmmed et al., "Emergency remote teaching during Coronavirus pandemic," 1-11.

the Moodle platform for the content delivery and assessment assisted with students successful engagement with the online class activities. To accommodate student inequalities and the various levels of access to online resources and devices, module content was also delivered via emails, WhatsApp and printed media. The multiple platforms including social media ensured that students were able to access teaching and learning through mediums accessible to them.

The Moodle data analysed in this study indicates the use of 13 different tools for enhancing asynchronous teaching and learning (Table 3), supporting the reliance on the LMS for asynchronous learning. Moodle tools used for the 2020 semester 2 subjects are Forum, Resource, Quiz, Assignment, Folder, Page, URL, Label, Choice group, Chat, LTI, Choice and Book. The extent to which each resource was used is illustrated in Figure 3.

Table 3

Moodle tools used in 2020 semester 2

Tool	Description	Usage
Forum	A tool used to promote discussion, debates, reporting, role-playing, a list of ideas, news analysis, and announcements.	Used by students and lecturers for the exchange of ideas through the posting of comments. These comments can be assessed and mark assigned.
Resource	A tool that includes the ability to upload files.	Used for the distribution of tasks, presentations, and information.
Quiz	Tool for assessing learning with automatic evaluation.	Used for both formative and summative assessments. For evaluating student understanding of concepts.
Assignment	A tool that allows the submission, grading, and feedback of assignments.	Used for the submission of student work for assessment.
Folder	A tool used to organize contents.	Used for information transfer.
Page	A tool used to create a webpage.	Used to display content including plain text, image, audio, video, and embedded code. Pages are more accessible as a word processor isn't needed.

Tool	Description	Usage
URL	The tool allows the insertion of a webpage link.	Used to direct students to articles, tools, and activities that are external to Moodle.
Label	A tool used as a spacer or to add multimedia and text.	Used to add images, multimedia, and text between sections. It can be used to improve the appearance of a course/subject.
Choice Group	A tool that allows students to enrol in one more group as per their choice.	Used to restrict access to certain resources and activities can be restricted.
Chat	Tool for synchronous chat discussion.	Used for interaction with an invited speaker, students can collaborate using the chat, can discuss topics and write together. The chat can be used for questions during an assessment.
Learning Tools Interoperability (LTI)	The tool allows remote users on another site to access specific subjects and activities on the Moodle site.	Used for access and integration with other platforms such as Pearson's MyLab and MyMathLab.
Choice	A tool that enables students to vote, to choose subjects, etc.	Used to quickly test the understanding of a concept by using a single multi-choice question.
Book	A tool used to create a book like structure with pages organized as a series of chapters and subchapters.	Used for communication information in a structured form.

It is evident that Moodle was also used extensively for communication and dissemination of information purposes with all 49 subjects making use of the forum discussion and resource tool (Figure 3). Other tools used by many lecturers for uploading files include folders (used by 26 subjects, 53.06%) and resources (used by all 49 subjects) (Figure 3). These results support the finding of Chaka,[52] who opines that the learning management system has emerged as the dominant platform for ERT in South African Universities.

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[52] Chaka, "Higher Education Institutions and the Use of Online Instruction," 1-46.
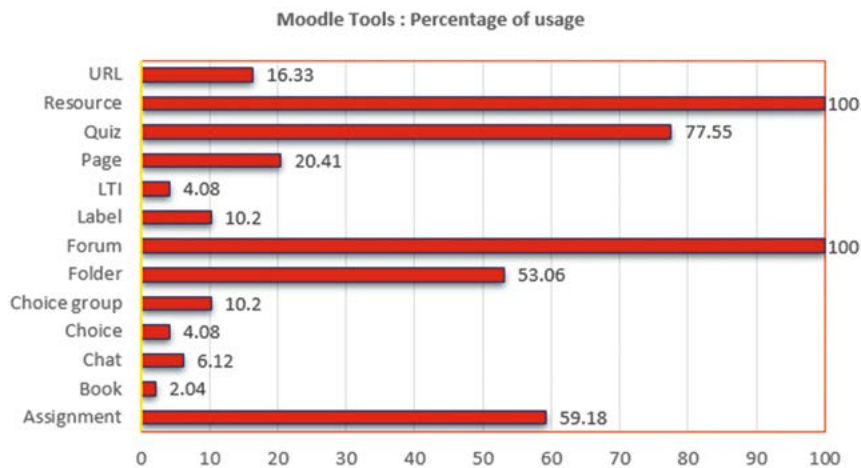
Moodle Tools : Percentage of usage

Figure 3

Percentage usage of Moodle tools

IV.1.3. Stage 3: E-Assessment Training

The third category, E-Assessment training is represented in the data by 25 references (Table 2). This relates to training provided to staff for the development of effective e-assessments. COVID protocols at the time prohibited the gathering of students therefore all assessments were converted to e-assessments. Internal and external experts offered academic staff development sessions aimed at restructuring assessments for an online environment. E-assessment guides and workshops were provided to support academic staff, build in-house capacity and upskill academic staff so they were able to redesign assessments to be suitable for an online environment. The data had references to guides for the use of the e-assessment tools and assistance relating to fine tuning e-assessments such that integrity was maintained and the smooth running of assessments was managed.

> *When students are assessed from a distance, it is even more important not to test knowledge recall only. One can set questions in a way that tests higher order thinking; and tasks can be set that are related to the real world, requiring authentic problem-solving and critical thinking. Open book testing with a time limit, is also advised…*

> DUT e-Assessment Guidelines during
> the Corona crisis_FINAL DRAFT, 12 April 2020.

Regular training sessions provided ongoing support needed by staff as they learnt how to implement Moodle e-assessment tools effectively in their courses:

> *Please scroll down for the training programme taking place in the Team: eLearning Support (Moodle) -- every Tuesday and Thursday from 10-11.30, starting on Tuesday 6 Oct 2020…How to set up an assignment; In-line marking on a pdf from within Moodle; Grading: Simple, direct grading; With a Marking Guide; With a Rubric; How to override attempts; How to set up group assignments...*

Second Semester Moodle Training, 18 October 2020.

The effectiveness of the implemented e-assessments is discussed in the reflection stage where students' assessment results are analysed. This directly represents the students' ability to learn using the ERT environment.

Analysis of Moodle LMS data shows extensive use of the tool for assessment purposes. As can be seen in Figure 3 the quiz tool is used by 77.55% of the subjects (38 of the 49 subjects) while the assignment tool is used by 59.18% (29 subjects).

Table 4 reveals that many subjects (44.9%) make use of both the quiz and assignment tools, while 32.7% of the subjects use only the quiz tool for assessments and 14.3% implement only the assignment tool. The table further reveals that only 8.1% of the subjects (4 subjects) use neither the assignment nor the quiz tools for assessment. These subjects could possibly provide assessments through presentations or assignment submissions on MS Teams or through other certification tools. With 91.2% of the subjects using either the quiz or assignment tools, it is evident that the e-assessment training implemented in the model was successful.

Table 4

Assignment and Quiz tools used

No. of Subjects	% Subjects using Assignment tool only	% Subjects using Quiz tool only	% Subjects using both Assignment and Quiz tools	% Subjects using neither Quiz nor Assignment tools
49	14.3%	32.7%	44.9%	8.1%

IV.1.4. Stage 4: Reflection

The fourth category, reflection is represented in the data by 8 references (Table 2). This stage of the model includes reflection on the model including

best practices and challenges. Internal and external experts provided valuable information for best practices as well as setbacks in the form of reports and training documents which provided academics with an informed view of how they could direct their efforts and improve ERT and assessments. For example, the CELT department of DUT reviewed their experiences helping students to adjust to e-learning:

> *The trendy issue now that we find ourselves have to address, is the issue of computer literacy, ideally we should train students on using the online systems after they have gone through at least one computer basic/skills training, however, that is not the case because some departments do not have the computer skills as one of their modules and some offer it in the next semester or year…*

2020 TFL - 1st term Report, 18 Nov 2020.

The Moodle LMS was the key tool necessary for providing asynchronous learning and e-assessments. The success of the training provided in the prior phases is evident in the data analysis that follows which reports on the extent to which the LMS was used by lecturers and students. Figure 4 presents the total number of different resources used per subject. The degree to which Moodle is relied on and the extent to which it has been adopted by lecturers varies between subjects, with some subjects including as few as four resources in the Moodle classroom while others include 157. Each subject used a good variety of tools or resources for teaching, learning and assessment (Figure 4).
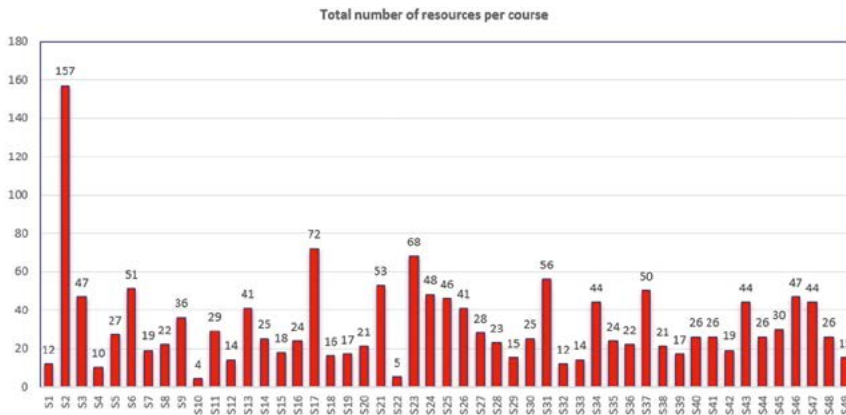

Figure 4

Total number of resources per subject (course)

The number of visits made by students to each tool (Table 5) and the visits made to each Moodle classroom (Table 6) are indicative of the high level of student participation in the asynchronous mode of teaching and learning.

Table 5

Moodle tools visit summary

	AS	Book	Chat	Choice	CG	Folder	Forum	Label	LTI	Page	Quiz	Resource	URL
Median	790	80	54	138	126	473	642	3	70	90	7582	2344	34
Max	10094	80	68	208	881	7868	4531	40	75	1966	114897	62875	180
Min	173	80	37	67	104	21	26	2	65	33	639	101	1

AS=Assignment; CG=Choice Group

The average visits made per student to a subject's Moodle classroom ranged from 9 to 433 with a median of 118 unveiling the heavy reliance that some lecturers have on Moodle LMS while supporting the notion that alternate platforms for learning were used (Table 6). A median of 118 visits per student translates to each student interacting with each of their subject specific Moodle classrooms approximately 11 times per week over the 11 week period being investigated. The students are therefore also heavily reliant on the LMS for learning purposes. The median was used for analysis instead of the mean because the data was not normally distributed therefore using the median is more accurate.[53]

Table 6

Total and average visit to Moodle classroom

S	P	TV	AVG	S	P	TV	AVG	S	P	TV	AVG
S1	308	6660	22	S18	111	15696	141	S35	100	17458	175
S2	71	30778	433	S19	41	381	9	S36	382	9158	24
S3	16	781	49	S20	432	7838	18	S37	26	9723	374
S4	876	162625	186	S21	106	21701	205	S38	569	106133	187

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[53] Harry O Posten, "Robustness of the Two-Sample T-Test," in Robustness of Statistical Methods and Nonparametric Statistics, ed. Dieter Rasch, and Moti Lal Tiku (Springer, 1984), 92-99.

S	P	TV	AVG	S	P	TV	AVG	S	P	TV	AVG
S5	570	35573	62	S22	263	8327	32	S39	18	1532	85
S6	334	10241	31	S23	32	8156	255	S40	36	3586	100
S7	527	18416	35	S24	24	3083	128	S41	318	14975	47
S8	350	11352	32	S25	61	5975	98	S42	161	3843	24
S9	152	15259	100	S26	56	5874	105	S43	60	6824	114
S10	97	3223	33	S27	75	5617	75	S44	308	74409	242
S11	278	19560	70	S28	77	15184	197	S45	118	22587	191
S12	87	7525	86	S29	605	133361	220	S46	125	20288	162
S13	329	20396	62	S30	47	5824	124	S47	54	12621	234
S14	121	10187	84	S31	77	5465	71	S48	313	26290	84
S15	89	12929	145	S32	343	29979	87	S49	316	6766	21
S16	260	6938	27	S33	283	5151	18				
S17	311	76333	245	S34	152	36215	238				

S = Subject; P=Participants; TV = Total Visits; AVG = Average visit per participants.

The most frequently used tool is the quiz followed by resources (Figure 5). Moodle is therefore essential for e-assessment purposes using the quiz as well as for the distribution of materials through the resource tool. Table 5 and Table 6 reveal that although the quiz tool is used by 77.55% of subjects while the forum and resource tools are used by 100% of subjects, the number of visits to the quiz tool (median = 7582 per module) is greater than the visits to the forum and resource (medians per module are 642 and 2344 respectively). The quiz is therefore used more extensively by students for assessments. The assignment tool is also used for assessment purposes with students' visits to the tool (median = 790 per module).

It is evident that the extent to which the LMS platform was used and the various tools adopted differed for each classroom while the data also indicates that the platform is being used for communication, assessment and dissemination of subject content by lecturers and is being visited frequently by students. The presentation of results thus far fulfils the second purpose of the paper in evaluating the involvement of lecturers and students in the ERT model. From the above discussion, it is evident that Moodle has been widely adopted by lecturers and students as a platform for teaching, learning and assessment through an asynchronous mode of delivery.
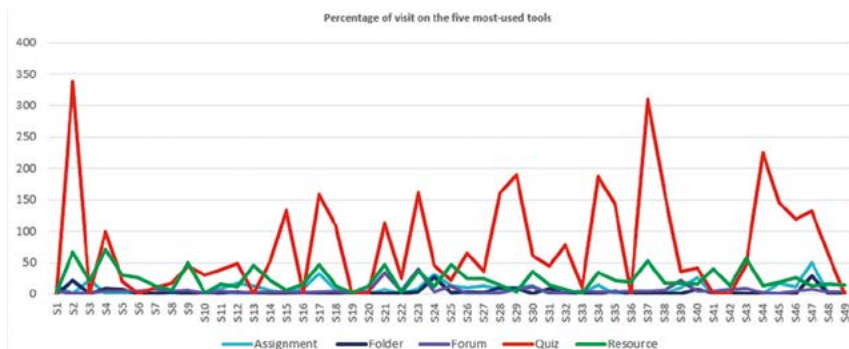
Figure 5

Percentage of the visit to the five most used tools

In an attempt to analyse the effect of the implementation of the ERT model, the authors chose to statistically test the hypothesis that the new approach was successful and attempted to further investigate the extent to which the students' final marks were affected. The data was anonymized with subject codes being assigned to subjects (S1, S2 through to S32). SPSS was used to perform the statistical analysis of the data. The median mark for each subject was calculated for 2019 and 2020. The median was used as a descriptive measure as opposed to the mean as the data within each subject was not normally distributed and presented with values that were beyond the acceptable limits in terms of skewness and kurtosis. Moreover, the median is more robust as it is hardly influenced by outliers.[54] The median values were used in a pairwise analysis between the two datasets. A dependent samples t-test was performed to test the hypothesis that the mean of the medians of the 2020 final semester 1 subject results ($M = 66.25$, $SD = 6.30796$) and the mean of the medians of the 2019 final semester 1 subject results ($M = 62.5944$, $SD = 6.44349$) were equal (Table 7).

Table 7

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	median_2019	62.594	32	6.443	1.139
	median_2020	66.250	32	6.308	1.115

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[54] Frederik Michel Dekking et al., *A Modern Introduction to Probability and Statistics: Understanding Why and How* (London:Springer Science & Business Media, 2005).

Prior to performing analysis, the distribution of scores was examined for normality. The data could be considered normally distributed as the levels of skewness and kurtosis were estimated at 1.519 and 0.2446 respectively for the 2019 data and 1.999 and 1.145 for the 2020 data. These values are within the acceptable range for a t-test (i.e., skew < |2.0| and kurtosis < |9.0|.[55] From the analysis the null hypothesis of equal final marks means is rejected t(31) = -2.682, p = 0.012 (Table 8). Thus the 2020 final marks mean was statistically significantly higher than the 2019 final marks mean for the 32 subjects under review.

Table 8

Paired Samples Test

		Paired Differences					t	df	Sig[a]
		Mean	Std. Deviation	Std. Error Mean	95% Confidence interval				
					Lower	Upper			
Pair 1	median_2019 Median_2020	-3.656	7.710	1.363	-6.435	-0.876	-2.682	31	0.012

Sig = significance; [a] (2-tailed); df=degrees of freedom.

Furthermore, Cohen's d which measures the standardized mean difference of an effect is estimated at -0.474 by using the standard deviation of the mean difference (Table 9). This indicates that a medium practical effect significance exists, based on[56] guidelines.

Table 9

Paired Samples Effect Sizes

			Standardizer[b]	Point Estimate	Lower	Upper
Pair 1	median_2019 Median_2020	Cohen's d	7.710	-0.474	-0.837	-0.105

[b] The denominator used in estimating the effect sizes.

A summary of these results can be seen in Table 10. As per this table, it is evident that 31.35% (10) of the subjects presented with statistical

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[55] Posten, "Robustness of the two-sample t-test," 92-99.
[56] Jacob Cohen, "A Power Primer," Psychological bulletin 112, no. 1 (1992): 155.

insignificance (i.e., p-value>0.05). However, 68.75% (22) of the subjects showed a statistically significant difference with the majority of subjects in 2020 (17 subjects, 53.13%) demonstrating improved results being obtained when compared to 2019 results. Table 10 also demonstrates the discrepancies that exist between the different subjects, with some showing no significant statistical difference in the final marks between 2019 and 2020 while others showing significance either in favor of 2019 or in favor of 2020. Researchers believe that these variations could be due to factors such as the level and type of subjects which is beyond the scope of this study. A further study that investigates the level and type of subject that benefits or suffers most from the multimodal approach may provide extra insight into the research area.

In terms of the aims of the study, the evidence suggests that the adoption of the model resulted in a significant improvement in the majority of the students' results.

Table 10

Mann-Whitney U Test Results

S	2019		2020		Test Stats		
	N	MR	N	MR	MWU	Z	P-value
S1	186	278.65	287	287.00	18944.50	-5.345	0.001*
S2	585	562.08	559	583.41	157409.50	-1.092	0.275
S3	520	334.92	343	579.18	38697.50	-14.091	0.001*
S4	194	190.83	325	301.29	18105.50	-8.125	0.001*
S5	632	500.09	609	746.47	116031.50	-12.108	0.001*
S6	522	463.99	335	374.48	69171.50	-5.170	0.001*
S7	415	234.05	60	265.30	10812.00	-1.649	0.099
S8	199	597.21	804	478.43	61051.50	-5.180	0.001*
S9	316	178.18	37	166.89	5472.00	-0.637	0.524
S10	504	523.15	515	497.13	123150.00	-1.412	0.158
S11	321	278.28	349	388.13	37645.50	-7.343	0.001*
S12	62	80.95	305	204.95	3066.00	-8.394	0.001*
S13	84	116.90	98	69.72	1982.00	-6.027	0.001*
S14	501	431.58	476	549.43	90472.00	-6.527	0.001*

S	2019		2020		Test Stats		
	N	MR	N	MR	MWU	Z	P-value
S15	65	68.99	60	56.51	1560.50	-1.926	0.054
S16	63	48.31	57	73.97	1027.50	-4.038	0.001*
S17	79	94.97	103	88.84	3794.50	-0.778	0.436
S18	519	405.52	390	520.85	75522.50	-6.558	0.001*
S19	302	396.78	480	388.18	70886.50	-0.518	0.604
S20	263	141.81	43	225.00	2580.00	-5.720	0.001*
S21	393	354.54	334	375.13	61913.00	-1.318	0.187
S22	215	149.11	303	337.83	8839.50	-14.146	0.001*
S23	378	306.00	361	437.01	44038.00	-8.342	0.001*
S24	80	73.09	106	108.90	2607.50	-4.507	0.001*
S25	374	282.28	380	471.22	35446.00	-11.916	0.001*
S26	60	150.22	304	188.87	7183.00	-2.603	0.009**
S27	216	143.65	95	184.07	7593.00	-3.655	0.001*
S28	274	191.05	85	144.37	8616.50	-3.626	0.001*
S29	65	67.37	61	59.38	1731.00	-1.229	0.219
S30	64	64.21	58	58.51	1682.50	-0.890	0.373
S31	50	59.94	104	85.94	1722.00	-3.392	0.001*
S32	403	408.04	324	309.22	47537.50	-6.311	0.001*

* p-value < 0.001; ** p-value < 0.05; MR = Mean Rank; MWU = Mann-Whitney U.

V. Conclusion

This study mainly aimed at the presentation and evaluation of the four-stage multimodal remote teaching and learning model implemented by the DUT in response to the COVID-19 pandemic. The entire shift to the ERT model was achieved in the four stages of preparation, synchronous and asynchronous teaching and learning, e-assessments and reflections. The preparation stage ensured that the staff and students gained the necessary skills and resources for transformation to the multimodal emergency remote teaching and learning. Effective teaching, learning and assessment strategies that were required to complete the current academic year were achieved

through the second and third stages of the model: synchronous and asynchronous teaching and learning and e-assessments stages. Finally, the fourth stage aimed at reflecting the best practices by analysing the effect on the academic results of students being taught and assessed during ERT and by analysing the usage of the adopted LMS by students and lecturers.

Both the qualitative and quantitative results indicate that the adopted multimodal emergency remote teaching and learning model was well accepted and adopted by the lecturers and students. The qualitative analysis performed on the analysed documents reports on the extent to which the model was implemented and presents evidence of its' implementation while highlighting how implementation was achieved in each stage of the model. The student activity data from the LMS shows that Moodle was extensively used and it has emerged as a dominant platform for students' interaction and engagement. Despite the diverse information communications technology infrastructures available to each of them, the efforts taken by the lecturers and students in actively participating in all four stages of the adopted ERT model showed an overall improvement in student performance during 2020 compared to 2019 where no disruption to teaching and learning was present. Thus the study results demonstrate the relevance and success of the implementation of the four stage emergency multimodal approach despite all challenges. This study delivers valuable insight into the extensive use of LMS as a dominant platform during the transition to ERT. This provides recommendations to LMS developers for further developments to enhance the design of online classrooms for a successful implementation of multimodal teaching and learning. The findings of this study are not generalizable, but can be used as potential measures for the adaptation of ERT in a similar situation.

Future research could include empirical analysis to establish the perceptions of both lecturers and students to ERT and the four-stage model that was implemented while identifying the challenges experienced. A further study could investigate the type of subject (practical or theoretical) which benefits most from remote learning and which type of subjects are hindered by ERT.

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