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ECONOMICS MASTERS

*Who benefits from online education?
 How the implementation of technology in higher education can result in
 increasing inequalities in higher education institutions*

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Abstract

The existing literature is inconclusive on how technology in education influences student outcomes and whether it will lead to an improvement in tertiary education access. This paper aims to determine whether the implementation of technology in higher education will lead to an improvement in the access to higher education through online education as well as improving student outcomes. In addition, the paper aims to show that implementing technology in higher education could increase existing inequalities amongst students from different backgrounds. The paper will do this by demonstrating the qualitative and quantitative factors which are the underlying reasons for some students doing better in an online setting compared to others. Furthermore, the paper will show that students from advantaged backgrounds with respect to race and income, benefit more from online and blended learning than students from more disadvantaged backgrounds. Therefore, tertiary institutions need to provide caution when establishing blended learning and online education programmes as it could lead to increasing educational inequalities.

Keywords: Blended learning, E-Learning, Higher Education, Education Technology, Online Education, Distance Education, Inequalities in Education.

Abbreviations:

DE	Distance Education
E-Learning	Electronic Learning
ET	Educational Technology
f2f	Face to Face
HEI	Higher Education Institution
HAI	Historically Advantaged Institution
HDI	Historically Disadvantaged Institution
ICT	Information and Communications Technology
LMS	Learning Management System
MOOCs	Massive Online Open Courses
UCT	University of Cape Town
UJ	University of Johannesburg
UWC	University of Western Cape
US	University of Stellenbosch
Wits	University of Witwatersrand
Zululand	University of Zululand

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1. Introduction

Education is seen as one of the key ways to increase intergenerational mobility with respect to educational outcomes and wealth. However, many students are unable to study at prestigious universities due to limited spaces, or other family and financial obligations. In 2018, UCT received applications for study from 35 000 students, with place for only 4200. This translates into 16 applications for 1 available spot¹. These barriers have opened up opportunities for online education as a substitute for traditional teaching in higher education institutions (HEI). Nevertheless, there have been many counter arguments which state that online education could have adverse effects on student's educational outcomes, which could be especially detrimental to students who already come from disadvantaged backgrounds (Xu and Jagers, 2014, Bettinger, Fox, Loeb, & Taylor, 2017; Alpert, Couch, & Harmon, 2016).

A study by van Broekhuizen, 2015 found that students of colour attending a historically advantaged institution (HAIs) were 5 percentage points more likely to be employed than the same student at a historically disadvantaged institution (HDIs). The youth of South Africa, looking to make themselves as employable as possible, tend to apply to the more prestigious universities. At these universities, there are more applicants than places available. Therefore, the demand for attending will be highest at these HAIs (Kleynhans et. al, 2015). As the market forces interact, tertiary institutions with a high demand can raise their fees, subject to legally binding constraints. While less-resourced universities maintain their lower fees to keep their institution competitive. Thus, only an elite few can afford to attend the more prestigious universities.

However, with the continuation of student protests for fees to fall, universities have been mandated by government to reduce or subsidise fees. This has resulted in a need for additional funding and certain universities taking advantage of the market gap by offering more online education programmes (CILT, 2017).

Not only is online education seen as a means to decrease the costs of education provisioning, but it is especially important in providing increased access to tertiary education (Xu and Jagers, 2014). Online education offers individuals the ability to gain a new qualification while still earning an income, supporting their family or being unable to commute to the institution of their choice. Online education offers the ability for more students to attend their selected

¹ <https://www.news.uct.ac.za/article/-2018-01-11-students-admissions-and-registration-2018>

university as there is more “space” available to attend the institution (Xu and Jaggars, 2014, 2016). However, not all institutions have equal resources available to make online education a reality and not all students have the resources available to take advantage of the era of online education.

Previous apartheid policies in South Africa have resulted in HEIs being categorized as either historically advantaged or disadvantaged institutions (HAI/HDI). HAIs tend to have a predominantly White population and have access to more funding and resources when compared to the HDIs. HAIs therefore have more resources available to make use of online learning to broaden their market reach compared to HDIs (CILT, 2017).

It is also important to note that while it is easy to see how online education can increase student access, education outcomes also need to be assessed in the context of online education. Many have cited the detrimental effects of online education on educational outcomes compared to traditional education, and that these effects vary across different subsets of students. For example, we expect a greater proportion of students attending HAIs to have access to technological devices, reliable internet access and technology skills or training, compared to students at HDIs. This allows these students to benefit more on a relative scale compared to HD students when undertaking an online course.

The question this paper then aims to answer firstly is whether using technology in higher education improves student outcomes. The paper then further interrogates which students benefit more from the implementation of technology in higher education. Students from HAIs tend to have access to more resources both in their home and schooling environment. Therefore, they may be more equipped to take advantage of online learning compared to students from HDIs. As a result, online education may not lead to a direct improvement in educational access or outcomes because of the resources required to benefit from it.

For this reason, the paper will focus on the demographics of students in tertiary institutions and how this will influence their resource availability as well as their skill and confidence level in using technology in their learning experience. This analysis will be used to draw conclusions on whether a certain demographic of students is more likely to benefit from the integration of technology in education compared to another demographic of students. These results can be used to infer how different tertiary institutions should set up policy on technology in learning to ensure that all students are able to benefit equally from the funding used for these

programmes. Ideally this would ensure that the HE system in South Africa moves towards reducing rather than increasing persistent inequalities.

For this paper, the implementation of technology in education encompasses online learning as well as blended learning (which has both online and face-to-face components). Furthermore, this paper will focus broadly on the integration of technology into education, with specific sections focusing on blended learning and then online learning.

2. The developments of the online education debate

The integration of technology in education has resulted in an uncontested debate around whether technology in education will promote education access and outcomes and for which demographic of students. Literature argues that logistically students that were not able to attend lectures before due to distance or disabilities can now gain access to university education (Jhurree, 2005). Today these students can obtain access to lecture resources online providing more equality when it comes to education access. However, the counter debate states that financially constrained students may not have access to technological devices or other resources necessary to take advantage of online education (Cloete, 2017).

In the 1990s e-learning², that is, learning facilitated online through network technologies emerged across South African HEI's (Ravjee, 2007). E-learning is an ICT (Information and Communications Technology)-enhanced practice in universities ranging from e-mail provision, online journals, and networked libraries, to development of creative software solutions for information management tasks in teaching, research and administrative systems. Moll et al. (2007) defined e-learning as 'flexible learning using ICT resources, tools and applications, focusing on accessing information, interaction among teachers, learners, and the online environment'. Blended learning on the other hand, combines conventional learning methods with e-learning methods. King and Mc Sporrán (2005:4) define blended learning as the mixture of traditional delivery including lectures, group discussions, and experiential learning together with e-learning methods.

Using ICTs for education has been found to promote social transformation and improve skills necessary for a country to be competitive in the world wide job market (Jaffer et al., 2007). Universities can remain competitive by using innovative technologies in teaching and learning to improve the quality of their education provisioning and attract new learners (Mlitwa, 2006).

² E-learning and online learning will be used interchangeably.

Furthermore, the South African national plan for HE emphasizes that university activities should develop an information society, through technology use, for knowledge advancement to improve education and support the new education system (Mlitwa, 2006). Therefore, there has been a need for integration of ICTs in South African universities to compete globally, be innovative and address the learning styles and preferences of ‘digital natives’³ (Mlitwa, 2006).

The degree of support to students and availability of resource provisioning of the tertiary institution has been cited as playing a role in student outcomes of online learning (Xu and Jagers, 2013). Over the last decade, there has been a remarkable increase in the adoption of Learning Management Systems (LMS) in developing countries (Cavus et al., 2007). Most of the universities in developing countries especially in Africa view LMSs as the most appropriate e-learning tool in blended learning environments. As such, it is often regarded as the starting point of any web-based learning program (Akeroyd, 2005).

LMSs are web-based software application platforms that use web technologies and internet services to support online course creation, maintenance and delivery; student enrolment and management; education administration and student performance reporting (Dagger et al 2007; Hadjerrouit, 2010). LMSs also allow learners to use interactive features such as threaded discussions, chatrooms, and other methods of communication. In an attempt to understand the landscape of online education at tertiary institutions in South Africa, the next part of the paper will provide information on each HEIs LMS and online course availability and features.

At the University of Zululand (Zululand) each faculty has a different LMS and each LMS, tracks and reports student progress and interactions while providing a platform for course content, collaboration, facilitation, assessment and mentoring (Evans, 2010). With regards to online courses, Zululand currently does not have any of their own or partnership online or distance learning courses or degree programmes (Evans, 2010).

The University of Witwatersrand (Wits) LMS provides assessment and assignment tools, gradebook feasibility, and the ability to structure blended learning courses by giving lecturers the ability to set up classes, quizzes and tests (Wits ,2017). Wits has a whole section of their curriculum dedicated to online, part-time and distance studies. Wits offers their online learning courses in partnership with Digital Campus and GetSmarter (Wits, 2017). These two private partners allow Wits to reach a greater market whilst ensuring that the online degrees are

³ The new generation of learners who have grown up surrounded by technology and views them as ‘‘native speakers of technology, fluent in the digital language of computers, video games, and the internet.

structured in a way which allow students ease of access and usability. Furthermore, Wits also offers part-time studies, through blended learning including both degree and certificate courses.

The University of Johannesburg (UJ) has a student portal LMS (uLink), which enables the delivery of the content for each programme, while the web interface and mobile app allows students real-time access on any device (Ssekakubo et. al., 2011). Technical and academic support is available on the platform (Ssekakubo et. al., 2011). Towards the end of 2017, UJ launched four 100% online only master's degree programmes. Furthermore, UJ also offers many comprehensive online courses and even full online diplomas and certificates (University of Johannesburg, 2018). These courses range from the bachelor level all the way to a master's level.

The University of Cape Town (UCT) has an integrated online LMS, Vula, which is used to support UCT courses as well as other UCT-related groups and communities (CILT, 2018). Vula offers a broad spectrum of features, including tools for administration, assessment, communication, resource sharing and collaborative learning. UCT also offers lecturers the ability to record their lectures, for later viewing. With regards to online learning UCT offers the greatest variety of all four institutions (UCT, 2018). UCT has partnered with many external private parties such as GetSmarter, EdX and Coursera, as well as providing their own online courses (UCT, 2018).

Now that we have assessed the history and development of online education across universities in South Africa, it is important to determine how students will benefit from these online courses. The next section will outline the empirical evidence from the literature on the effects of online education and blended learning on student access and outcomes.

Tallent-Runnels et. al (2006), agrees with the notion that technology can be useful in higher education by giving students with disabilities or other obligations, access to the same education as those without these constraints. However, it is equally important to assess whether the increased access will be beneficial when compared to traditional learning.

Cobb (1997) argues that the effectiveness of a certain medium of technology in online education depends on how much it encourages a learner's cognitive performance. The literature suggests that communication through written forms of expression online can assist students in learning how to better articulate their ideas, debate with contrasting viewpoints, increase their

reflection time and develop their writing skills. Overall, this could even result in the development of their critical thinking skills (Garrison, Anderson & Archer, 2001; McKnight, 2001). However, if student's interactions remain on the surface, it is predicted that online education will not benefit students any more than traditional classes.

Rohleder et al. (2008) studied learners at UWC and US, and learners state that the creation of these "virtual communities" prepared them for the diverse society that South Africa is. The learners gave positive feedback and stated they would repeat the collaboration because of the learning and the personal growth opportunity. Discussion forums and chat rooms in the LMS promoted flexibility, creativity, collaboration, communication and interaction, enhancing the learning process. Learners enjoyed working collaboratively within diverse groups of race and socioeconomic backgrounds. However, Hadjerrouit (2010) found that students from advantaged institutions reported more ease of use in the LMS day-to-day than students from previously disadvantaged institutions. Furthermore, learners advocated for blended learning because they felt f2f sessions are important too (Rohleder et al., 2008). The LMS access challenges stated by learners, included computer shortages, inappropriate software versions, computer failures, viruses, no internet access and slow internet connections which led to download and website problems.

Developing the argument further, Kepell et. al's (2006) paper discusses the combination of peer learning, assessment and technology enhanced environments and its impact on the outcomes of tertiary students. The paper found that the use of an online virtual learning environment enabled students to reflect and revise on their work on the project. Furthermore, a major advantage of online learning is that it encourages students to take responsibility of their own learning by communicating with other students and providing and receiving feedback (Kepell et. al, 2006).

Other advantages of online education, include the fact that technology has been found to allow for the personalization of a learning experience. For example, instructors could use data and data systems that allow them to collect real-time feedback on student learning to quickly identify deficits of understanding, so they can tailor instruction to meet these needs (US Department of Education, 2017). Students can also receive faster feedback on their assignments, which will allow them to reflect while the idea is still fresh in their minds. Furthermore, the anonymity which comes with online learning has been cited as a main

advantage especially for introverted students in large lecture settings. The next section, discusses a case in point, describing the effects of blended learning on student outcomes.

The Statistics department at UCT, decided to shift their Statistics 1000 (STA1000S) course from traditional f2f teaching approach to a blended learning approach. Before 2014, this course was delivered in the traditional method of teaching to all first year Bachelor of Commerce (BCom) and Business Science (BBusSc) students in Commerce faculty. Starting in 2014, the course shifted to a blended learning format, where students would engage with the content online in the beginning of the week, through educational videos prepared by lecturers, quizzes and readings. This was done to prepare students for workshops at the end of the week, which was presented f2f. In these workshops students could then ask tutors and lecturers questions related to the content they covered online. Lectures were initially offered in parallel due to a concern that students from non-digital backgrounds may prefer conventional lectures (UCT Statistics Department, 2018). This proved to be unfounded based on the student evaluations and the fall off in attendance in the physical lectures which were offered in parallel in the pilot version (UCT Statistics Department, 2018).

According to the UCT Statistics Department, the STA1000S course shift to blended learning resulted in an improvement in student grades. Data from the Statistics Department showed that between the years 2010 to 2013 the average final mark for STA1000S was 55% with a pass rate of 64%. Between the years 2014-2017 when the blended learning format was implemented the average final mark was 63%, with a pass rate of 82% (Department of Statistics, 2016). The jump in the pass rate between 2013 and 2014, was more than 30%-point increase⁴. This case study shows that a change from f2f lectures to blended learning resulted in an improvement in student's grades. However it does not show that full online learning will have similar results. However, we may be able to infer that results will be close enough as most students opted not to attend lectures and workshops for the course even though they had the option to do so. This leads us to believe that students not only did better in the blended learning format but also may have preferred a fully online method of learning.

It is however, important to note that certain courses may be more feasible for an online setting compared to others. For example, STA1000S may be easier to deliver online than for example an engineering course. Additionally, some faculties are racially skewed due to entry

⁴ This is under the assumption that course content and "difficulty" remained relatively consistent between 2010-2017.

requirements. For example, the commerce faculty will most likely have lower entry requirements compared to the engineering faculty meaning that there will be more HD students in commerce than engineering. This could skew the results of this STA1000S case study as it is not representative of all faculties and its offered courses with respect to the ease of being offered online, as well as the demographics of students across different faculties.

On the other side of the argument various literature has cited that online education tends to negatively impact student outcomes generally, and especially for students in minority groups. Xu and Jagger (2013) assessed the effects of taking a course online rather than f2f, through two course outcomes: (1) course persistence, and (2) final course grade among those who persisted to the end of the course. Their results yielded robust estimates of negative impacts of online learning on both course persistence and course grade. Their analysis made use of academic subject fixed effects to control for student self-selection into different subject areas. They also included college, term, and course subject fixed effects.⁵

In this analysis it is important to note that some courses are more likely to be offered online compared to others. A direct comparison of online and f2f sections across these courses would then result in biased estimates. To address this problem, the study used an additional model that used college-by-course fixed effects with term fixed effects, thus effectively comparing online and f2f sections of the same course. The overall results of the study showed that for the typical student, taking a particular course in an online rather than f2f format would decrease the likelihood of course persistence by 7 percentage points, and if the student persisted to the end of the course, would lower their final grade by more than 0.3 points (Xu and Jagggers, 2013).

Most studies have looked at blended learning in the context of universities where students are naturally more academically prepared than those attending colleges. A review by Kozakowski (2019) focuses on whether blended learning can improve outcomes in community colleges. Using a difference-in-difference-in-differences identification strategy, the paper estimates the change in outcomes for cohorts of students within the same college and same level of math remediation before and after the adoption of a blended learning approach while differencing out the change for students in the same level of remediation in comparison colleges and the change for students in different levels of remediation within the same college.

⁵ Students may choose course subjects based on their preference for online or face-to-face course formats. And certain online courses may be more prevalent within particular colleges, terms, departments, or course subjects.

One concern in the paper was that it may not be random which courses made use of the blended learning model and that if these differences were time-varying, they could bias estimates of the effect of the blended learning⁶. To address this concern the author conducts event study analysis to test if the adopting courses have similar trends to the comparison courses in the preadoption period. And finds evidence that suggests the timing of the adoption of blended learning was likely exogenous. Another concern is that students might switch their course selection in response to the introduction of the blended learning model. To address this, the author tests for changes in enrolment in remedial courses and test for changes in the observable characteristics of students enrolled at each level of remediation and do not find evidence that these change systematically in response to the introduction of the blended learning model.

Overall the study finds that students who are taught using blended learning are kept from progressing to college-level courses that some of these students would have otherwise passed. Three years after enrolling, students are 5 percentage points less likely to have earned any degree. These results suggest caution in using blended learning approaches with students who are less academically prepared.

Xu and Jagers (2016) undertake another study this time assessing the differences in outcomes between students in traditional education settings compared to those in online education across differing types of students and subject areas.

The literature on online learning suggests that online courses require students to assume greater responsibility for their learning; thus, a successful online student may need high levels of self-regulation, and self-discipline. Dabbagh (2007) finds that the “successful online learner” has a strong self-concept and is competent in the use of online learning technologies, especially communication and collaborative technologies. The learner should have strong inter-personal and communication skills and should be self-directed. Studies of adolescents and young adults show that females, White students, and individuals with higher prior educational attainment tend to be more self-directed (Xu and Jagers, 2016).

The results suggest that students with a stronger academic background had a narrower online performance gap⁷, while students with weaker academic skills had a wider online performance gap. Thus differences between high-GPA and low-GPA students in f2f courses (0.96 vs. 0.94

⁶ For example, if colleges adopted the blended learning model in a particular course in response to falling pass rates, this could pose a problem.

⁷ Difference between mark under traditional teaching instruction compared to mark under online learning.

for course persistence; 0.223 vs. -0.331 for standardized course grade) were magnified in online courses. The interaction terms between subject area and course format reduced in size but remained significant for both course persistence ($F = 3.36, p < .01$) and standardized course grade ($F = 3.86, p < .01$), indicating that the difference across subject areas in terms of online course effectiveness persisted even after taking into account both the characteristics of students in each subject area, and how those characteristics might influence performance in online versus f2f courses.

After controlling for student characteristics in all feasible ways, including peer effects, the interaction terms between academic subject areas and course delivery format were still significant for both course persistence and standardized course grade, suggesting that subject areas varied in their online performance gaps for reasons that were not situated in the characteristics of their students.

Furthermore, a descriptive study using California community college student transcripts (Kaupp, 2012) found that the performance gap between White and Hispanic students in f2f courses (approximately one-quarter of a grade point) was exacerbated in online courses (increasing to over one-third of a grade point). Kaupp (2012) points out that in addition to individual differences in skills such as self-directed learning, some community college student populations may struggle in online courses due to inequities in computer and internet access (Gladieux & Swail, 1999). And although results showed that all students performed poorly in the online education setting, males, younger students, Black students, and students with lower prior GPAs had wider online performance gaps than their peers.

A study on whether massive open online courses (MOOCs), which are meant to cross divisions of race, class, age, gender, and geography, found that these courses tend to mostly be taken up by students from advantaged backgrounds and higher socio-economic status (Zillien and Hargittai, 2009). Barriers to accessing MOOCs, include lack of affordable, stable internet connections, proficiency in English, and digital experience and skills, all of which are characteristics of socioeconomic inequality. The paper concludes that in order to become truly accessible to all, MOOCs should be translated into languages other than English, include content that can be accessed on mobile devices and at low bandwidths, and be available in a disability-friendly format (Zillien and Hargittai, 2009).

The literature review has pointed out both the advantages and disadvantages of online education. It has also brought to attention that demographic factors usually at play in education, are exacerbated in online education. In South Africa, many students from disadvantaged backgrounds have no access to school or community libraries and computers (Bharuthram & Kies, 2012). These students from disadvantaged backgrounds then attend HDI's due to various socioeconomic factors and entry requirements; perpetuating existing inequalities (Bharuthram & Kies, 2012).

Policy makers may often suggest that institutions make use of technology due to the efficiencies that can arise in terms of access and costs. However, it is important to consider if students from rural backgrounds will even accept such technology into their education experience. A study by Halili and Sulaiman (2017) discusses how the use of ICT in education is accepted amongst rural students. They found that some of the problems faced by rural communities in the adoption of technology included factors such as lack of access to infrastructure, lack of knowledge, training and skills in ICT use (Halili & Sulaiman, 2017). Other challenges to the implementation of ICT in rural areas include: internet access and the cost, as well as infrastructure available in these rural areas (Halili & Sulaiman, 2017). The challenges are not only financial or technological, but are also social (Halili & Sulaiman, 2017). There are certain communities that feel as though technology may act as a negative influence. Individuals in these communities lack the skills or expertise to be able to realize how much ICT can benefit them and without any guidance in this regard, they continue to reject ICT use in their everyday lives (Halili & Sulaiman, 2017).

Jacob et. al (2016) showed that resources at home rather than resources at school was a significant determinant in whether a student did an online course. Their study finds that students with internet access and computers at home were more likely to take up virtual courses than those with no access (Jacob et. al, 2016). These case studies occurred in developed countries and we can only assume given the level of inequality in South Africa, that it will be direr here.

In addition, students confidence in using technology is influenced by their home and schooling environments (Greener and Wakefield , 2015). Sullivan (2002) finds that students are more positive towards online learning, the more experienced they are with technology. Students whose parents and home community have already adopted technology into their everyday lives tend to be comfortable with technology playing a role in their life from an early age and tend to be more comfortable adopting technology into their learning. Halili & Sulaiman (2017)

showed that students with more computer experience benefited more from the use of computers in their teaching instruction compared to students who did not feel confident using computers.

A UWC study by Jacob et. al, (2012) found that students with desktops at home were more at ease using technology than those who only make use of digital devices at university. This could indicate that wealthier students with these devices at home, will be more comfortable and confident using technology.

A study Bharuthram & Kies (2012) showed the noticeable division of students coming from advantaged and disadvantaged schooling and home environments. Some challenges students experienced were limited access to basic resources such as libraries and computers resulting in the lack of expertise in using the e-learning tool. Even though programmes were put in place to equip students with the necessary technical skills, some students still struggled to adapt to e-learning, especially those who did not have technical devices at home on which they could gain more comfortability.

The second concern in this experiment was that some students struggled to convey their ideas in English on the online platform (Bharuthram & Kies, 2012). Pretorius and Machet (2004) show that students from well-resourced schools tend to attain higher literacy levels than students from high poverty schools. This study showed that students coming from advantaged backgrounds and to a certain degree a language-enriched environment⁸ were found to show greater enjoyment and engagement in the task and requested more online lessons. The paper showed that student's literacy levels as well as prior exposure to ICT will have an impact on the ease or difficulty with which students are able to accomplish an online task which consequently impacts their confidence with online tasks.

Adding to this theory, the *Even it Up* report shows that wealthier parents can afford to send their children to well-resourced schools, enabling their entry into "elite" universities, which in turn facilitates higher paying jobs. This is reinforced by other advantages, such as the resources that children from wealthier families have access to, which further facilitate employment and education opportunities. In this way, the richest capture opportunities, which then become closed off from those who do not have the means to pay.

⁸ Environments which promote the development and acquisition of language skills.

From the literature review, we have established that there are potential positive and negative outcomes from online education and blended learning. However, students from advantaged backgrounds tend to do better in an online learning set up compared to students from disadvantaged backgrounds. Therefore, the increasing development and integration of online education and blended learning can in-fact increase existing inequalities in the education system as it could benefit advantaged students more than disadvantaged students⁹. Similar empirical studies have not yet been conducted in South Africa, but the insights are useful and can be applicable to this context. This thesis will therefore aim to understand how students perceive the use of online learning and its adoption in their tertiary education. And specifically how this perception is influenced by their access to resources.

The rest of the paper will focus on the data from Centre for Innovation Learning and Technology (CILT) which will look at the demographics of students and how it influences the probability of a student feeling prepared to use digital devices and given this, which students are more likely to take up an online course. Thus this paper aims to provide a more qualitative analysis to support the existing literature which has shown that some students benefit more from online education practices compared to others.

3. Data and Methodology

The data used for this part of the paper is obtained from a survey done by the Centre for Innovation Learning and Technology (CILT) at UCT in partnership with the University of Leeds, in the UK. The survey was conducted at four main universities in South Africa namely, UCT, UJ, Wits and Zululand.

The survey was conducted amongst students at each of these institutions over a period of four days. In total there are 200 student observations, with 50 students per institution. The survey covered a broad range of topics including: The views and experiences of the use of digital technologies in higher education by students and how students perceive technology to change their learning.

In this dataset, variables such as student demographics, reasons for taking an online course as well as resources students have access to, will be the focus. Other variables such as student's perceptions of whether they feel "prepared" to use digital technology in their learning, was also

⁹ Or in the instance where it has negative impacts, disadvantaged students are more negatively impacted by online education than advantaged students.

analysed. The data is based mostly on a student's perception of their abilities and as such should be interpreted with the necessary precaution.

This survey was done at one point in time, which means that it cannot be used to follow students over time. Secondly, the survey was not aimed at understanding the effects of online learning from one particular course. Rather it was aimed at understanding student perceptions related to the concept of online learning and their feelings towards undertaking online learning.

The paper will first analyse the relationships that already exist in the data by means of a descriptive statistics analysis. The paper will then look at the distribution of students across institutions by demographics, such as race and funding of studies. This will be followed by an analysis of students in the survey who have taken an online course.

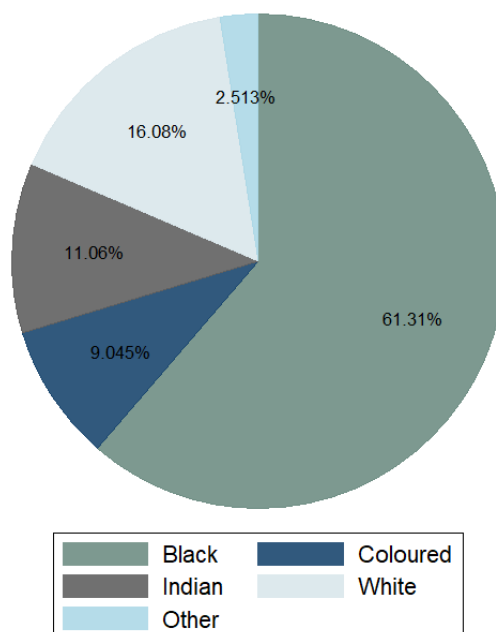
Lastly, the regressions will look at the relationship between whether a student feels prepared to use digital devices in their learning given their access to resources. And finally, the paper will try to estimate the effect of a student "feeling prepared" on the student actually doing an online course.

3.1. Descriptive Statistics

3.1.1. The General Sample

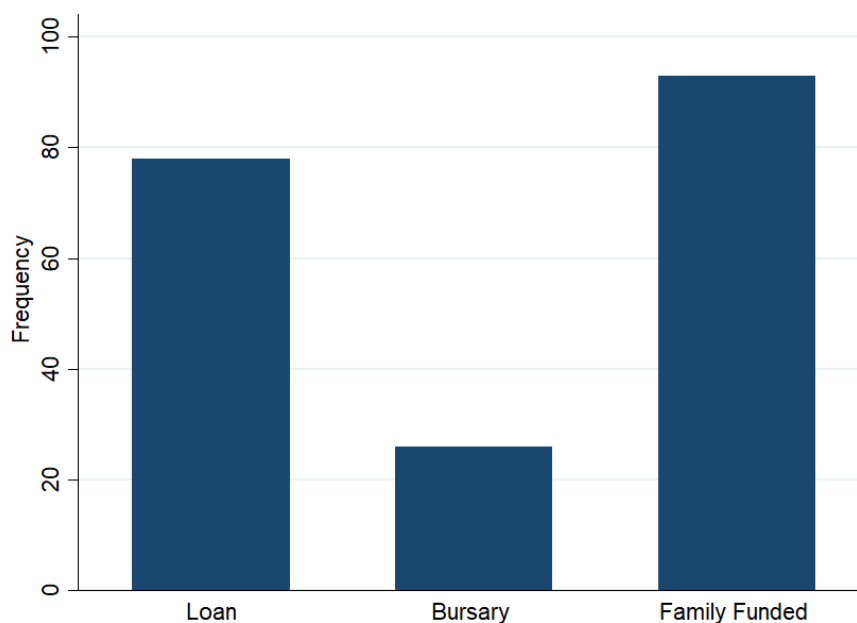
First, the paper will discuss the general sample characteristics, to understand what the sample looks like and whether it is nationally representative of the general student population. The data seems to be nationally representative of the university population with regards to gender, race and funding type. The sample is composed of 51.76% female and 47.74% male, with one individual who identified as other.

Figure 1: Pie chart of the distribution of race in the sample



With regards to race, the above pie chart shows that 61.31% of the sample identified as Black, 9.05% of the sample are Coloured, 11.06% are Indian and 16.08% identified as White. With regards to level of study, most of the sample are undergraduate students, with 9.55% of the sample made of postgraduate students.

Figure 2: Bar graph of the distribution of student's funding



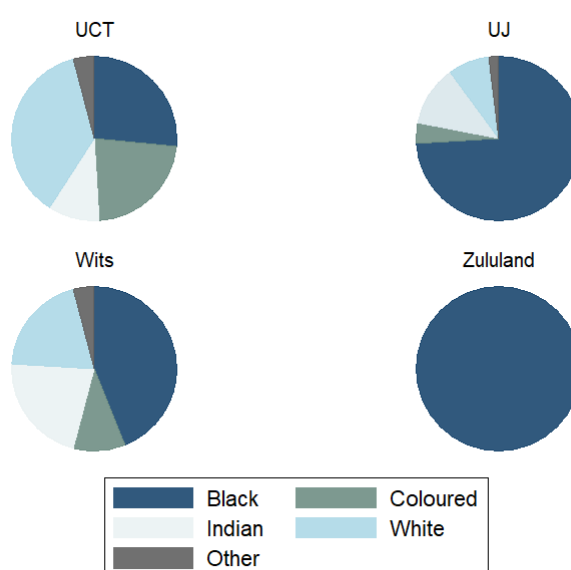
The category “Loan” includes: NSFAS and study loan students. The “Bursary” category includes: government and private bursaries as well as scholarships. And the “Family Funded”

category includes: students who are self-funded and funded by their family. The literature shows that wealthier students tend to be more inclined and prepared to do online learning than those students who are less well off. NSFAS is a national funding scheme for students who are financially eligible. It is expected that students funded by NSFAS/Study Loan are less likely to take up online learning, compared to students financed by their families, as per the literature. This could be due to a variety of confounding factors such as wealthier students having the necessary resources, or being “ahead” academically, and wanting to further their studies. Wealthier students could also have more time available to do an online course compared to students from financially constrained households, where these students may have more family responsibilities.

The paper will now look at specific demographic variables of interests and its influence on whether a student feels prepared to use digital technologies in their learning experience, to assess potential inequalities that exist in implementing technology in higher education.

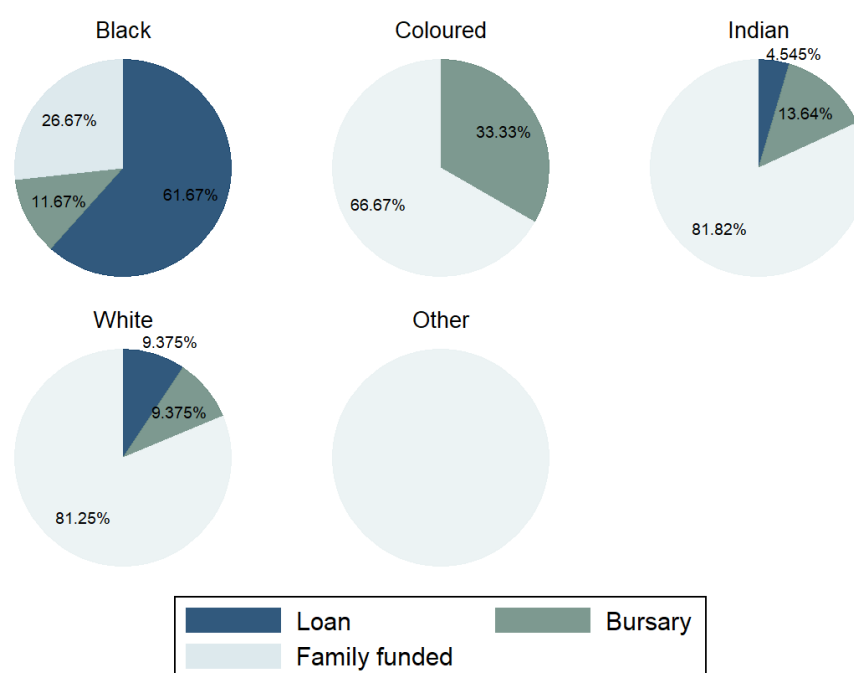
The literature showed how certain institutions have more funding and opportunities available to take advantage of the online learning market potential. The literature also acknowledges that certain institutions will be predominantly Black or White, which could result in inequalities arising if different institutions provide different resource access to their students who themselves come from advantaged or disadvantaged backgrounds.

Figure 3: Pie charts of the distribution of institution by race



When looking at institution by race, Zululand only has Black students in their sample, therefore it can be considered a predominantly Black university¹⁰. Furthermore, Zululand is considered a HDI, due to past apartheid policies. At UCT, White students make up the largest share of the student population, followed by Black students. This is useful to note as the paper assumes UCT to be a HAI, with the majority of the student population being previously advantaged by apartheid policies. Therefore, the figure shows a previously advantaged population group making up the majority at a HAI. Race is an important factor in South Africa, given the past apartheid inequalities, where disadvantaged population groups received poor education and job opportunities. This has led to great income, educational and socio-economic inequalities amongst the different racial groups which continue to exist today.

Figure 4: Pie charts of the distribution of funding by race



When looking at the distribution of funding by race we see that majority of Coloured, Indian and White students are funded by their family. Black individuals are mostly funded by Study Loans/NSFAS and then their family. To get NSFAS/Study Loan funding you need to be financially eligible. This indicates that most Black students in our sample are financially eligible, i.e. their parents cannot afford to pay their university fees. How a student funds their studies, could indicate how well off their family is. Wealth will also be correlated to

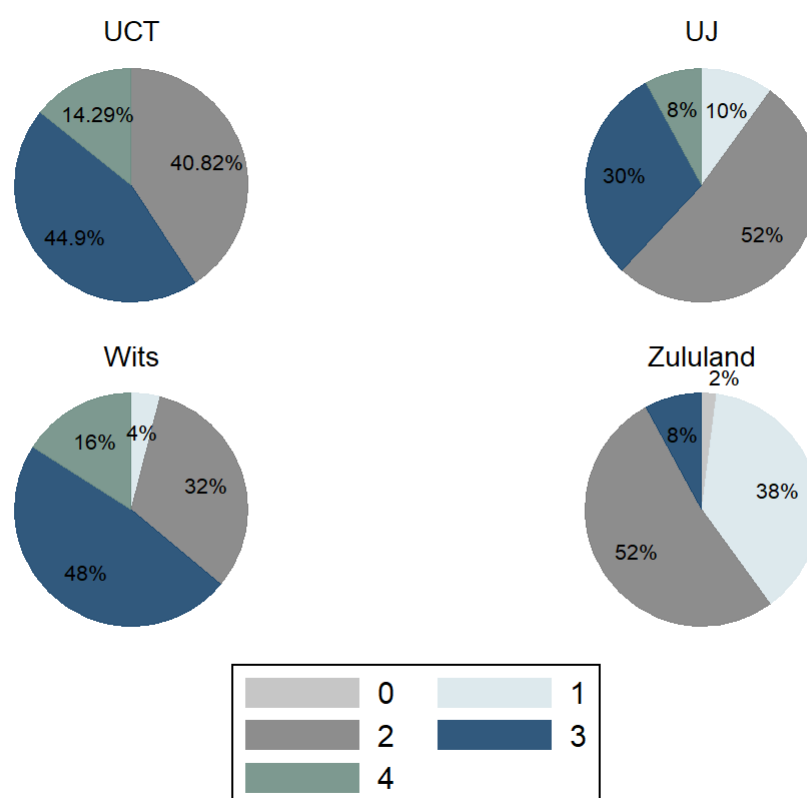
¹⁰ <http://www.unizulu.ac.za/wp-content/uploads/2019/11/UNIZULU-Facts-and-Figures-2019.pdf>

technological resources a student may have access to, as well as their home environment and parental factors. All of which could influence how a student benefits from e-learning.

3.2.1. Access to devices

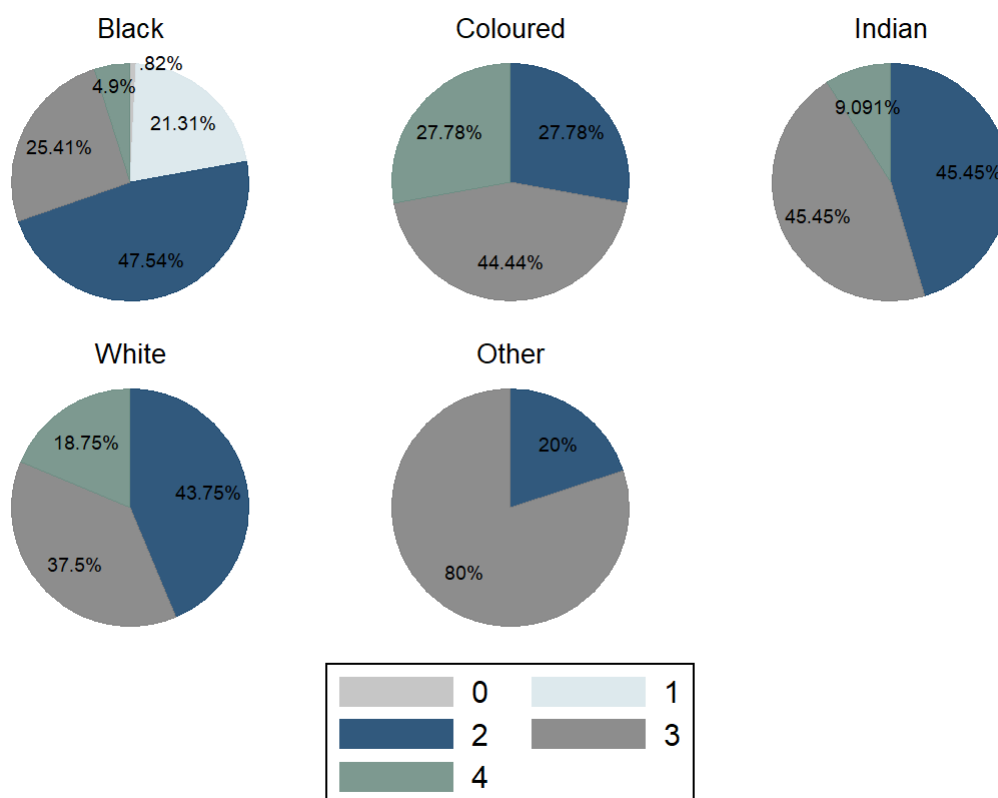
According to literature access to technological devices as well as a reliable internet connection are important determinants of students' acceptance of online learning. Having these devices means that students have the equipment to gain access to the technological resources enabling them to benefit from online education. Furthermore, having access to technological devices allows students to feel more prepared for online education as they gain comfortability using devices.

Figure 5: Number of devices per student by institution



Students from Zululand have the lowest access to technological devices compared to all the other institutions. This could be indicative that students from Zululand will feel less prepared to use digital devices or technology in their learning given their lack of access. However, the literature states that home access to resources was more important in promoting online learning than university access to resources.

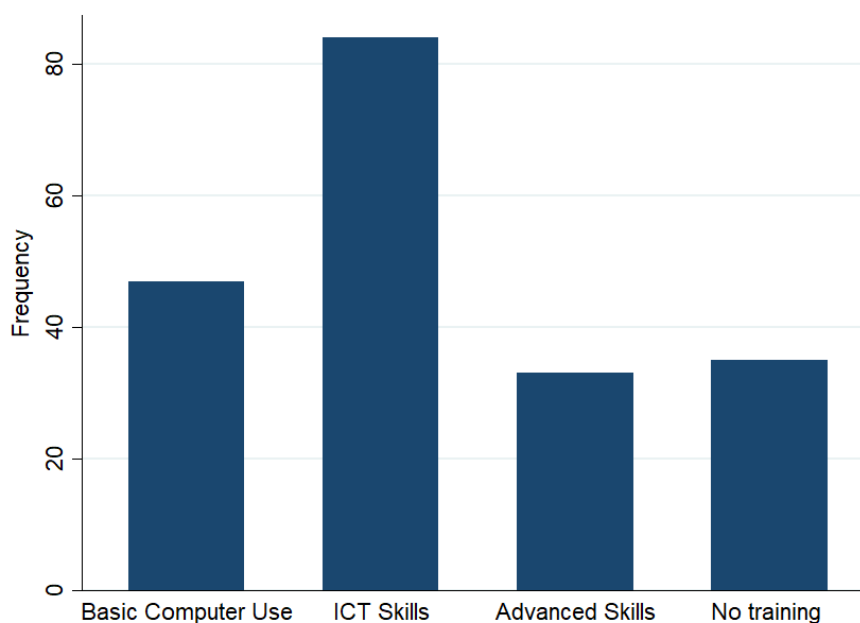
Figure 6: Number of devices by student race



When evaluating device access from the student's home, the data shows that Black students have less access when compared to all the other racial groups. This highlights an inequality constraint in the use of technology in education, as certain races could benefit more than others due to resource availability at home.

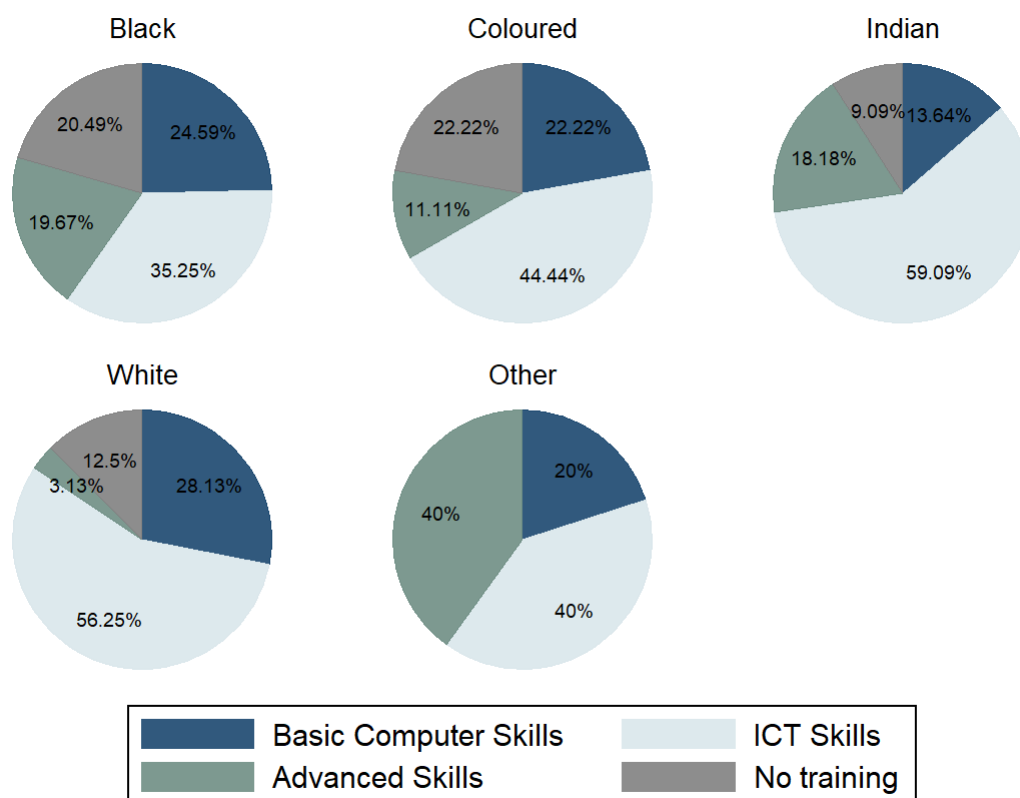
The descriptive statistics showed that student demographics play a role in student's access to digital devices in terms of both their home and tertiary institution access. The paper will now observe how factors such as how student training can influence how prepared students feel using digital devices in their education.

Figure 7: Bar graph of the technology training type



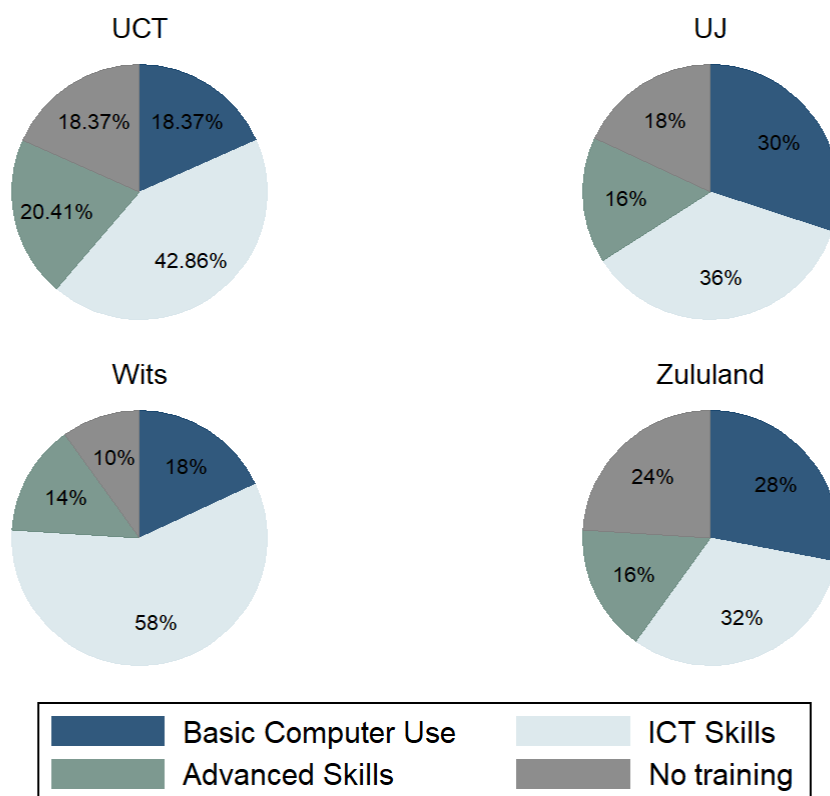
The bar chart above shows that majority of the sample received training in ICT Skills, which encompasses, university training for the use of the LMS, researching and searching tools as well as online communication, such as email and Skype. Very few students reported having received training in online digital creation and digital presence, which represents the advanced skills category. This is expected as it is quite unique and specialized training. Furthermore, there are quite a few students who have not received any training at all and this is cause for concern. According to the literature, students with no training will be the least likely to feel prepared to use digital devices in their learning and to do online courses.

Figure 8: Pie charts of the type of technology training by race



Looking at training by race, there are more Black students that have no training (20.49%) compared to White students (12.50%). This shows that racially, some population groups will be more prepared to use digital devices in their learning than others. Furthermore, the literature states that the institution a student finds themselves at, plays a role in the student's acceptance of technology in their learning process as some institutions have more online education practices, support and resources available.

Figure 9: Pie charts of the type of technology training by institution



Majority of the students at all the institutions stated that they received training in ICT skills, which makes sense as it encompasses the standard training students would receive at university. At UCT there is a small number of students who received basic computer use training. Instead there is a greater proportion of students receiving ICT skills. The student training type distribution at Zululand (a HDI) was quite different to UCT. There is a much greater proportion of students with no training when compared to UCT. Furthermore, there are more students receiving basic training when compared to UCT. This could be indicative that students at Zululand are lagging behind in terms of training in technology when compared to the distribution at UCT. This coupled with majority of Zululand students being Black and already being disadvantaged by previous apartheid policies, results in a double disadvantage for Black students at Zululand with respect to the integration of technology in their education.

The paper will now look at factors such as confidence in using technology in learning and whether the student feels prepared to use digital devices in their higher education. The literature shows that student ability and confidence in using digital devices plays an important role in whether a student will benefit from the implementation of technology in their learning.

3.3.1. Confidence

When students were asked whether they were confident¹¹ in using digital technologies in their learning experience, 90.8% of Black students said they were confident and 100% of Coloured and White students rated themselves as confident in using technology in their education. The lack of skills or confidence, which may be attributable to various factors could cause certain races to benefit more from the implementation of technology into education than other races. This may increase the already existing inequalities as more and more institutions start to adopt and implement technology into their curriculum.

In UCT, 100% of the students said they felt confident using technology in their learning, whereas this percentage was only 88% at Zululand. It therefore, seems that UCT students may have an advantage over the other students when technology is implemented into their learning, given their higher rating of confidence. How confident a student feels in using technology in their learning experience is highly dependent on how “prepared” they feel to use technology in education. And this may depend on factors such as training, home and institutional environments, resource provisioning, as well as personal factors (unobservable factors).

3.4.1. Prepared by Race

Table 1: Prepared by race

Do you feel prepared using digital devices in your learning	Black	Coloured	Indian	White	Other	Total
No	53	1	2	0	1	57
	43.44%	5.56%	9.09%	0.00%	20%	28.64%
Yes	69	17	20	32	4	142
	56.56%	94.44%	90.91%	100.00%	80%	71.36%
Total	122	18	22	32	5	199
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

When observing whether students feel prepared¹² to use digital technology in their learning by race, we see that 43.44% of Black individuals rated themselves as not prepared for using digital devices in their university experience. Whereas only 5.56% of Coloureds and no White

¹¹ Confident is related to how students felt at the time they were asked the survey questions and had been in university. Therefore, it could be used to infer how previous and university resources and training influenced their feelings towards using technology in their learning.

¹² Prepared refers to how the student felt at the beginning of their university career and therefore refers to what students learned prior to receiving training at university. Therefore, “prepared” could provide information on the the home and schooling environment a student is coming from.

individuals rated themselves as not prepared for using digital devices in their university learning process. Therefore, if technology were to be implemented in their learning experience, Black students feel as though they would derive less benefit from this implementation compared to other races who were asked the same question.

3.5.1. Prepared by Institution

Table 2: Prepared by institutions

Do you feel prepared using digital devices in your learning	UCT	UJ	Wits	Zululand	Total
No	1	13	11	32	57
	2.04%	26.00%	22.00%	64.00%	28.64%
Yes	48	37	39	18	142
	97.96%	74.00%	78.00%	36.00%	71.36%
Total	49	50	50	50	199
	100.00%	100.00%	100.00%	100.00%	100.00%

Students from the different institutions were asked whether they felt prepared to use technology in their learning process at university. Only 2.04% of students from UCT said they did not feel prepared to use technology in their learning whereas 64% of students from Zululand said they did not feel prepared. Looking at the other two tertiary institutions, 22% of students from Wits did not feel prepared to use digital devices and 26% of students from UJ said they were not prepared. This shows a stark difference in the “level of preparedness” among students from different tertiary institutions and could be indicative of students at UCT having higher levels of confidence from increased access and use of technological devices. One reason for this difference could be the institution itself, for example, one institution could provide more support and resources to online education compared to another. A lack of support and resources dedicated to e-learning has been found to reduce student outcomes in online education, and hence their level of “preparedness”.

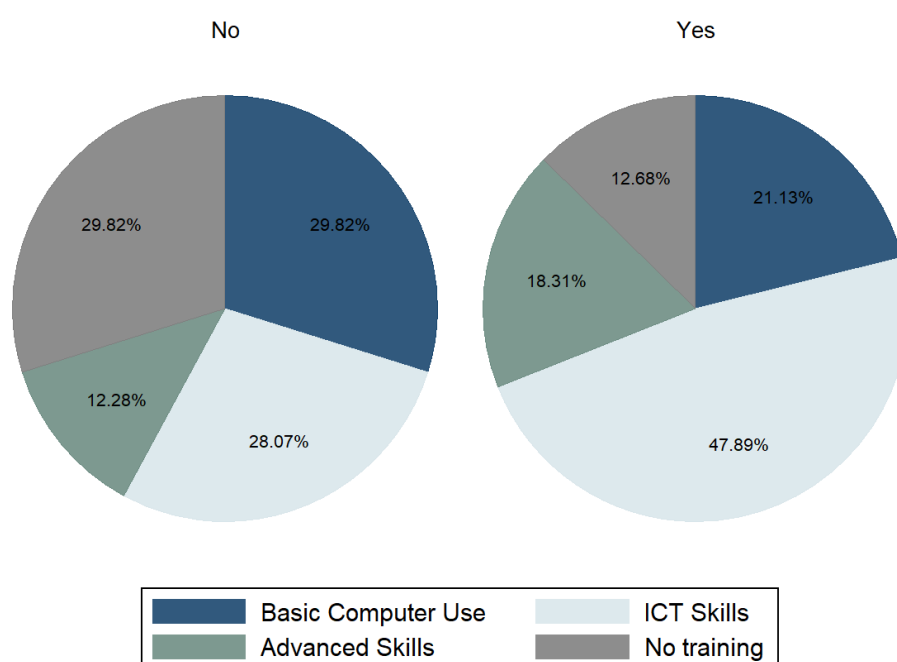
Table 3: "Being prepared" by number of devices owned

Prepared	Devices				Total
	0	1	2	3	
No	15	28	13	1	57
	60.00%	32.56%	18.84%	5.26%	28.64%
Yes	10	58	56	18	142
	40.00%	67.44%	81.16%	94.74%	71.36%
Total	25	86	69	19	199

	100.00%	100.00%	100.00%	100.00%	100.00%
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Looking at the above table, it is clear to see there is a positive relationship between number of technological devices a student has and how prepared the student feels to use technology in their learning experience. This is because the more access to technology a student has at home, allows them to become comfortable using this technology leading to more confidence and students feeling more prepared. Furthermore, having more devices could indicate that the student is wealthy and therefore has access to better resourced institutions and training.

Figure 10: Pie charts of “being prepared” by training type



When observing students rating of whether they feel prepared to use digital devices in their university learning by their training, there are also patterns which emerge. For example, the pie charts above show how students who received training in ICT skills and advanced skills rated themselves as prepared more often compared to students who had training in basic computer use and no training. This make sense as these types of training, require students to already have a basic understanding of computers and programmes. These types of training therefore not only allow students to become more equipped at the basic training, but also allow them to gain more comfortability and ease in using digital devices.

The paper has thus far considered various demographics and their interaction with how prepared students feel using technology in their learning. This was done to observe how advantages of both home environments and institutions can result in certain students benefiting more from online education and technology implementation in their education than other

students. The paper will now look at the online population, to gauge whether these inequalities have indeed influenced the type of students taking up online learning.

3.6.1. The Online Population

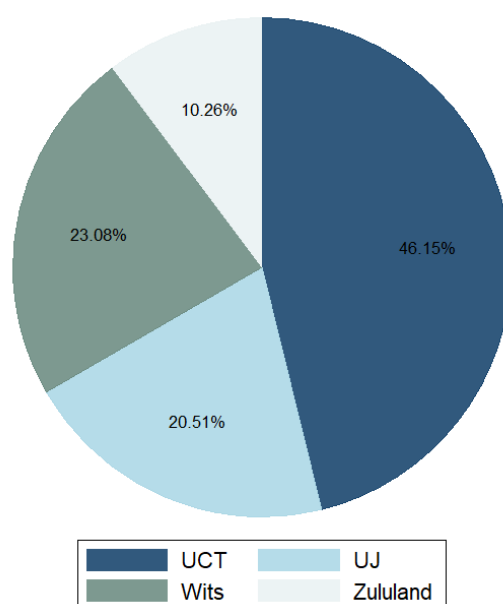
This section of the paper will observe the characteristics of students who have taken online courses or degrees, where these courses are provided by various institutions and not just the institution the individual is attending.

Table 4: Students who have taken an online course

Taken an online course	Frequency	Percent	Cumulative
No	160	80.40%	80.40%
Free online course	25	12.56%	92.96%
Paid online course	12	6.03%	98.99%
Full online degree	2	1.01%	100.00%
Total	199	100.00%	100.00%

Of the sample, 19.6% have taken online courses of which, 12.56% took a free online course, 6% took a paid online course and only 1% took a full online degree. When looking at students who have done an online course by race, the data shows that White students make up the majority followed by Indian students. This makes sense as cited in the literature, we expect a greater proportion of White students to have more technological resources and to take advantage of online resources or education more than other racial groups. Furthermore, White students rated themselves more prepared in using digital devices in learning and will therefore derive more benefit from the integration of technology in their learning experience. Black and Coloured students were the least likely to take an online course. This could indicate that they either believe they will not derive a large enough benefit from the course or that they do not have the resources or skills to make use of the online learning facilities. The literature has shown that people of colour tend to have lower outcomes when compared to their White counterparts. We can assume that such gaps as cited in the literature may be even larger in the context of the high levels of inequality which persist in South Africa.

Figure 11: Pie chart of students who have taken an online course by institution



Majority of the students who have taken an online course study at UCT, followed by Wits. With the least number of online students coming from Zululand. This could be indicative of a difference in preferences that exists amongst students at the different universities for online learning. When looking at online learning policies across these institutions, UCT is at the forefront of this trend. This could result in students being more aware of the possibilities of online learning and therefore experimenting more in this field. However, it could also be indicative of the resources available at the different institutions. If this is the case, it becomes questionable as to whether all institutions are providing students with equal opportunities to access online learning resources, and if not, should policy be put in place to evaluate or correct this. Furthermore, most students attending UCT are White students deemed to be advantaged in both the home and schooling environment. This may result in these students being more prepared to use digital technologies and take up an online course when compared to students at Zululand, a HDI with majority of students being Black.

Table 5: Students who have taken an online course by funding type

Online Course	Loan	Bursary	Family Funding	Total
No	71	20	69	160
	88.75%	76.92%	74.19%	80.40%
Yes	9	6	24	39
	11.25%	23.08%	25.81%	19.60%
Total	80	26	93	199
	100.00%	100.00%	100.00%	100.00%

The above table shows how students who are self-funded or funded by their family have taken more online courses compared to students in the other funding categories. Students who are able to pay their own fees will most likely come from an advantaged background and have access to more resources compared to those from disadvantaged backgrounds. Students with more advantaged backgrounds may also be more skilled in using technology in their learning and therefore may benefit more from online courses. These benefits may encourage and enable these students to pursue more online courses compared to other students.

This table agrees with the literature that students with loan type funding tend to be the least likely to take up online learning. This may be due to various factors which result in these students feeling less inclined to do online learning. Examples may include, that the students perhaps have less resources available in terms of devices and students may therefore feel less prepared using digital devices in their learning. Furthermore, these students may come from disadvantaged backgrounds in terms of previous schooling as well as household factors which also impedes their confidence in online learning. An example of this is that students from these disadvantaged backgrounds may have parents who themselves are less technologically inclined and therefore the household environment the student grows up in may not have been technologically friendly.

Additionally, funding may act as a determinant of the household environment a student finds themselves in, with respect to device access, internet access, as well as previous schooling and technology training received. All these factors could influence how prepared a student feels using digital devices as per the literature review.

Table 6: Students who have taken an online course by their perception of being prepared

	Not Prepared	Prepared	Total
Taken an online course	3	36	39
	5.26%	25.35%	19.60%

The table above shows that of the total of students who have taken an online course, 92% said they felt prepared to use technology in their learning. This shows that being prepared to use digital devices in your learning plays a significant role in whether a student will take up an online course.

The descriptive analysis has shown that the demographic factors of students influence both their home and institutional environments, which can influence how they feel about using digital devices in their learning. As a result certain students seem more open to online education than others as they experience more benefits from it than others. This could potentially result in increasing inequalities in higher education provisioning and outcomes, where HD students derive less benefits than students from more advantaged backgrounds.

It is however important to note that as this is a cross sectional study we cannot directly infer causation, and that these results only show correlation. In fact, some may argue, that by introducing technology into education, Black and Coloured students may benefit more as they will be acquiring technical skills they didn't previously have, making them potentially more employable in the ever growing digital workspace. Nonetheless, it provides a good understanding of the various factors policy makers will need to take into consideration when evaluating online and blended learning from an inequality perspective.

The paper will now attempt to uncover the direct effects of various demographic factors on whether a student feels prepared to use digital technologies in their learning. These results can be used to determine which type of students are more likely to take up an online course compared to other students.

3.2 Regression Model

A probit regression model will be used, since we are trying to determine the probability of a student feeling prepared to use digital devices in their learning. Followed by estimating the probability of a student doing an online course, given their rating of whether they feel "prepared" to use digital devices in their learning. The probability for both dependent variables, will lie between zero and one, and the paper will estimate the average partial effects (APEs) as these are the estimates that are most comparable to the results that would be obtained from a simple linear probability model (LPM). The paper estimates four different regressions per model, with "prepared" as the dependent dummy variable, equal to one if a student feels prepared using technology in their learning and zero otherwise. And in the second model, the dependent variable will be "Online course", which is equal to one if the student has taken an online course and zero otherwise.

Model 1:

$$\text{Prepared} = \beta_0 + \beta_1 \text{African} + \beta_2 \text{Training} + \beta_3 \text{Funding} + \beta_4 \text{Institution} + \varepsilon_t$$

The first model is a simple LPM with the independent variables being: African (binary variable equal to one if student is Black), institution of study, funding of studies, and technology training received. In the third regression, a probit model is used and estimates the APEs at the margin using the same dependent and independent variables as in the case of the LPM, excluding the African variable and including the desktop variable. The third probit regression has the same dependent variable as the second LPM regression with an additional independent variable being; “internet café”. The final regression includes all the independent variables from the third regression, but also includes the African variable.

Model 2:

$$\text{Online Course} = \beta_0 + \beta_1 \text{Race} + \beta_2 \text{Training} + \beta_3 \text{Funding} + \beta_4 \text{Institution} + \beta_5 \text{Gender} + \varepsilon_t$$

The second model, has the binary dependent variable, “Online Course”, which is equal to one, if an individual has taken an online course and zero otherwise. The second model, has the same independent variables as the first model, but excludes African, and includes gender and race variables. The first regression run will be a LPM, and include independent variables: African, training type and gender. The next set of regressions will be probit models, and the APEs at the margin will be estimated. The first probit model will use the same dependent and independent variables as in the LPM, including the funding type variable and the institution variable. The second probit regression will include two additional regressors, “Desktop” and “Internet Café”. And the last regression, will include all the independent variables of the third regression, with additional regressors being “prepared” as well as “year of study”.

The independent variables in the regression were found to be important determinants of whether a student felt prepared to use digital devices in their learning. The more advantaged the institution the more advantaged we expected a relative portion of students to be who attended that institution. Furthermore, the descriptive statistics showed that, Zululand which is considered a HDI only had Black students, who due to past apartheid inequalities will most likely have parents who were disadvantaged in the education they received, as well as their earnings. So, institutions, are related to race, which is related to funding, which all play a role in how “prepared” a student would feel to use digital technologies in their education. Due to the interaction between institution and race¹³, as well as race and the funding variable, the race variable was only included in the last regression, as the African variable. This was done because

¹³ The race variable includes students who are Black, Coloured, Indian and White.

the race variable, is not estimable in the first set of regressions, as all White individuals rated themselves as prepared¹⁴. Therefore, another variable “African” was created, which is a binary variable, equal to one, if the individual is Black and zero otherwise. This African variable will be included in the last regression. However, the normal race variable will be used in the second model set of regressions, where “online course” is the dependent variable.

3.3 Regression Results

3.3.1. Regression 1 Results

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Prepared	LPM	APE	APE2	APE3	APE4
African	-0.152**				-0.173**
	(0.0688)				(0.0771)
Base: UCT					
Wits	-0.110	-0.204***	-0.194***	-0.179***	-0.161**
	(0.0758)	(0.0648)	(0.0655)	(0.0662)	(0.0708)
UJ	-0.172***	-0.252***	-0.273***	-0.277***	-0.283***
	(0.0589)	(0.0675)	(0.0680)	(0.0696)	(0.0720)
Zululand	-0.365***	-0.438***	-0.407***	-0.392***	-0.333***
	(0.109)	(0.0998)	(0.0972)	(0.0965)	(0.0963)
Base: Study Loan					
Bursary	0.140	0.145	0.140	0.132	0.0918
	(0.102)	(0.111)	(0.110)	(0.111)	(0.102)
Family Funded	0.126	0.179**	0.166**	0.173**	0.0968

¹⁴ The dependent variable prepared predicted the independent variable race exactly. As 100% of White students rated themselves as prepared to use technology in their learning.

	(0.0832)	(0.0792)	(0.0789)	(0.0772)	(0.0742)
Base: Basic Computer Use					
ICT Skills	0.118*	0.132*	0.137**	0.114	0.0961
	(0.0708)	(0.0696)	(0.0690)	(0.0699)	(0.0683)
Advanced Skills	0.129	0.0867	0.101	0.0931	0.0817
	(0.0964)	(0.0905)	(0.0890)	(0.0874)	(0.0840)
No training	-0.100	-0.0951	-0.0911	-0.117	-0.116
	(0.0945)	(0.0918)	(0.0894)	(0.0872)	(0.0842)
Desktop			0.168***	0.209***	0.207***
			(0.0629)	(0.0540)	(0.0560)
Internet Café				-0.149*	-0.131
				(0.0874)	(0.0853)
Constant	0.843***				
	(0.0988)				
Observations	197	197	197	197	197
R-squared	0.314				

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

LPM, is a linear probability model, which represents a special case of a binomial regression model. The dependent variable for each observation takes values which are either 0 or 1 (i.e. only two outcomes).

APE is the average partial effect, which represents the effect of one variable on another at the margin. This shows how a small change in one variable can result in a given change in another variable.

3.3.2. Discussion of Results

For the probit models estimated the paper will interpret marginal effect of each variable at its mean. In the first regression, the LPM, the variable “African”, was included, as the dependent variable predicted race precisely and therefore the coefficients on the categorical race variable was not estimable. However, the race variable is highly correlated to the funding, institutions and even the internet cafe variable, and therefore racial effects may be captured in the regression without including the actual race variable. It is for this reason that the race variable is excluded from regression 2 - 4. However, the African variable is included in the final regression, in attempt to separate out the effects of race from the other variables it is correlated with.

The first variable of interest in the table is the “type of training” received by students. Basic computer use is used as the base case in this regression. In the first three probit regressions (2-4), students with ICT skills are significantly more likely to feel prepared using digital devices in their learning than students with basic computer use training, all else constant. This effect is however, not visible in the final probit regression, when “African” is included. It could be that Black individuals are clustered into a training category, and therefore when the African variable is included in the regression it captures the effect of the training, making the training variable appear insignificant and the African variable significant.

Furthermore, students with no training are less likely than students with basic computer use training to feel prepared in using digital devices in their learning and this is also expected, however, this result is not statistically significant. Students with Advanced ICT skills are the most likely, all else constant, to feel prepared using digital devices in their learning when compared to those with basic computer use training. However, this result is also not statistically significant.

The institution variable shows that students at UCT are on average more likely to feel prepared in using digital devices in their learning than students at any of the other tertiary institutions. And the results are statistically significant for all institutions and in all regressions, at the 1% level of significance. Students from Zululand, are the least likely to feel prepared in using digital devices in their learning when compared to UCT, all else constant. This could give rise to certain inequalities, as we know from the descriptive statistics that Zululand is a predominantly Black institution. Furthermore, Black individuals are seen to be the least likely to feel prepared in using digital devices in their learning already, regardless of the institution

they attend. This means that Black students at Zululand, are the most disadvantaged in terms of feeling prepared, not only due to the institution they attend, but also due to racial disadvantages.

Observing the funding variable in the second and third probit regressions (3-4), students who are family funded, are significantly more likely to feel prepared using digital devices in their learning than students who are funded through a loan. However, this result is not statistically significant in the final regression. In the final probit regression, the African variable is included, and the significance of the family funded variable falls away. This could be due to the relationship between race and funding type. In the descriptive statistics we saw that Black individuals were predominantly funded through NSFAS and this could result in the significance of family funded being captured by the African variable instead. The coefficient estimates on the bursary variable are also not statistically significant, but indicate that students who are funded through a bursary or scholarship are more likely to feel prepared using digital devices in their learning than students who are funded through a study loan.

Furthermore, the variable “Desktop”, which indicates whether a student has a desktop at home was found to be statistically significant in both regression 4 and 5. And shows that students with a desktop at home are significantly more likely to feel prepared in using digital devices in their learning than students without a desktop at home, all else constant. And this is at the 1% level of statistical significance.

Variables such as “Internet cafe” and “Year of Study”, were not found to be statistically significant in regressions. However, students, who made use of an internet cafe were found to be less likely to feel prepared using digital devices in their learning. Having to rely on an internet cafe, as a source of connection, could indicate that the student comes from a household where they are unable to afford their own devices or internet connection, and this could be indicative of a household with a low income, few technological devices, as well as a home environment which is not technologically inclined.

As students’ progress from one year of study to the next, we expect that students would start to feel more prepared using digital devices given the courses they do at university and the practice they acquire using digital devices while at university. The regression results agree with this notion and show that the longer the student is at university, the more prepared they feel to use digital devices in their learning.

The next regression model will try to estimate which factors contribute to a student doing an online course. Since model 1, tries to identify the factors that make a student feel prepared in using digital devices in their learning, the next step is to figure out, given the student's feeling of being "prepared", what other factors would encourage them to take up an online course or degree. A dummy variable for gender was also included in the regression as the literature indicates that females may benefit more from online learning than males.

3.3.3. Regression Results 2

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Taken Online Course	LPM1	APE1	APE2	APE3	APE4
Base: Black					
Coloured	0.124	-0.0391			
	(0.108)	(0.0953)			
Indian	-0.0225	-0.101			
	(0.0808)	(0.0812)			
White	0.210**	0.0278			
	(0.0965)	(0.0965)			
Base: Basic Computer Use					
ICT Skills	-0.0403	-0.0488	-0.0583	-0.0700	-0.0445
	(0.0744)	(0.0723)	(0.0723)	(0.0724)	(0.0696)
Advanced Skills	0.0810	0.0394	0.00371	-0.00272	0.0147
	(0.104)	(0.101)	(0.0941)	(0.0944)	(0.0876)
No training	-0.0440	-0.0501	-0.0547	-0.0661	-0.0208
	(0.0850)	(0.0870)	(0.0860)	(0.0856)	(0.0861)
Base: Study Loan					

Bursary		0.0279	0.0204	0.0223	-0.0424
		(0.0924)	(0.0908)	(0.0897)	(0.0909)
Family Funded		0.0727	0.0423	0.0462	-0.00736
		(0.0789)	(0.0695)	(0.0686)	(0.0727)
Base: UCT					
Wits		-0.192*	-0.186**	-0.169*	-0.0880
		(0.0985)	(0.0898)	(0.0937)	(0.0859)
UJ		-0.166*	-0.175**	-0.166*	-0.0988
		(0.0941)	(0.0884)	(0.0878)	(0.0799)
Zululand		-	-	-0.238**	-0.154
		0.263***	0.250***		
		(0.101)	(0.0931)	(0.0952)	(0.0970)
Male	0.0286	0.0338	0.0214	0.0251	0.0142
	(0.0570)	(0.0544)	(0.0521)	(0.0524)	(0.0521)
Has a desktop at home			0.0572	0.0671	0.0378
			(0.0712)	(0.0756)	(0.0716)
Uses internet café				-0.0690	-0.0345
				(0.0782)	(0.0870)
Prepared to use digital devices in learning					0.138**
					(0.0628)
Year of Study					0.0426**
					(0.0168)
Observations	194	192	197	197	197

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

LPM, is a linear probability model, which represents a special case of a binomial regression model. The dependent variable for each observation takes values which are either 0 or 1 (i.e. only two outcomes). APE is the average partial effect, which represents the effect of one variable on another at the margin. This shows how a small change in one variable can result in a given change in another variable.

3.3.4. Discussion of Regression Results 2

The first regression is an LPM, with independent variables, race, gender and training. This was done just to establish the effect of race on whether a student does an online course, as the institution variable is highly correlated to race and captures the effects of race, leaving the race variable inestimable in the other regressions. From the results we can see that White individuals are on average more likely than Black individuals to take an online course, all else constant. And this result is statistically significant at the 5% level of significance.

In the second regression, when the institution variable is included the significance of “White” falls away. All the institutions are significant determinants of whether a student does an online course, across all the regressions, except the final regression. In regression 2-5, students from Zululand are significantly less likely to do an online course when compared to students from UCT all else constant. And this is at the 1% and 5% level of significance. Students from Wits and UJ, are also less likely to do online courses compared to students from UCT, all else constant. However, the effect is smaller than students from Zululand.

The funding, training and desktop variables are all not significant determinants of whether a student does an online course. However, these variables are, all significant determinants of whether a student feels prepared to use digital devices in their learning. And in the final regression, where prepared is included as an independent variable, it is statistically significant in determining whether a student does an online course at the 5% level of significance. It could be that the prepared variable is capturing the impact of the funding, training and desktop variables, and how it influences whether a student does an online course.

Gender and whether a student uses an internet cafe were found to be insignificant determinants of whether a student does an online course or degree. Students who make use of the internet cafe were found to be less likely to participate in an online course or degree than those who

don't, all else constant. However, the internet café is predominantly used by Black students and the effect of internet café use could therefore be captured in the African variable.

Furthermore, year of study was also found to be a statistically significant determinant of whether a student does an online course and degree, even after controlling for the prepared variable. This could indicate that older students are more inclined to participate in online learning than younger students all else constant.

From the second regression we can see that the primary determinants of whether a student does an online degree, is how prepared they feel to use digital devices in their learning, their year of study as well as the institution they attend. From the first set of regressions, how prepared the student feels using digital devices in their learning is significantly influenced by their race, institution, funding and desktop access. The paper has also established that race and institution are highly correlated, so much so that the one can exactly determine the other. Furthermore, funding is also highly correlated to race. Therefore, these effects can be recognised as impeding on one another, and the actual path of causation is unknown.

One story the paper can tell is that a greater proportion of Black students are considered disadvantaged in many aspects compared to other racial groups. Their parents may have received poor education provisioning and job prospects resulting in majority of Black students receiving lower quality education and training, and therefore ending up at HDI's. Furthermore, their home environment may not be conducive to them being technologically inclined, which further impedes them from feeling "prepared" to use digital devices in their learning.

The final regression does however show, that even after controlling for how prepared the student feels in using digital devices, the institution the student attends still influences whether they will take up an online course. And this could be because of the relationship between the institution and race, or the institution and funding variable.

The results show that students at Zululand are the least likely to take up an online course or degree. Furthermore, students at Zululand are predominantly Black and would therefore be affected the most by past apartheid inequalities. These Black students also tend to end up at HDIs, further perpetuating their disadvantages.

In addition, Black students are more likely to fund their studies through a study loan, which indicates that their families are not well off. Therefore, these students may not have

technological devices or may have attended institutions where they received little or no technical training. Decreasing the chances of them feeling prepared to use digital devices in their learning. As these students don't feel prepared using digital devices and being prepared is one of the main determinants of doing an online course or degree, it follows that these students will be the least likely to do an online course or degree.

4. Conclusion and Recommendations

4.1. Conclusions

The literature cites that overall online education can have both positive and negative impacts and that these impacts are especially different for minority groups. Online education improves overall access to education, but more so for advantaged students rather than those who need it the most. Furthermore, students overall tend to do worse in online education compared to traditional education, however this is especially pronounced for students of colour. However, it is important to note that for some students online education could develop their critical thinking skills, enable them to take more responsibility of their work and result in many efficiencies in the education environment, so it should not be dismissed entirely.

Based on the results from the regression and the descriptive statistics, the following relationships prevailed. White individuals are on average more likely to undertake an online course when compared to all the other races. Furthermore, students from UCT are more likely to do an online course when compared to students from any other institution. Students from Zululand were the least likely to do an online course. This could be a result of student preferences, a lack of resources or a combination of the two. If students at Zululand are less technologically inclined, and perhaps come from a disadvantaged background we expect them to be less likely to do an online course than students with an advantaged background. It could also be the case that UCT being better resourced than the other institutions promotes online education to students more than the other institutions. As a result more students at UCT do online courses.

As expected students who are self-funded or funded by their family are the most likely to take an online course when compared to those who have NSFAS funding. However, it is important to note that Unisa is not included in this dataset, and they offer many distance learning options at affordable rates. Therefore, some students from low income households may have opted to undertake online education at Unisa and would not be included in this sample set.

Furthermore, we expect a greater proportion of students at HAIs will be coming from advantaged backgrounds and therefore have more resources than those coming from disadvantaged backgrounds. As these students have more resources due to both their socio-economic status and the institution they attend, they are more likely to have a positive experience with technology in their learning. While previously disadvantaged students who tend to have less resources due to their low wealth level and the institution they end up in are less likely to take up an online course.

As the literature has cited online education opens up opportunities of greater access to HEI in cheaper and more convenient ways, however students need certain resources and skills to benefit from online education. By having HAIs providing more online resources or courses than HDIs, already advantaged students are reaping more benefits from online education than disadvantaged students for whom it was intended to assist.

The policy implication of this is that, funding for technology implementation into learning could be more regressive than progressive and could potentially cause inequalities in education to increase. This can have detrimental effects on the education system, which aims to provide more assistance to students from previously disadvantaged backgrounds. By not providing online resources, HDIs are allowing students who are already disadvantaged to become more disadvantaged on a relative scale.

Students who rated themselves as prepared in using digital devices in their learning, were more likely to take an online course. This once again is to the advantage of the “advantaged” student, who most likely has more experience in using technology from within their living environment and their previous schooling. Therefore, students who feel prepared using digital devices in their learning are mostly students who are well-off. Data in the descriptive statistics showed that many Black students do not feel prepared and confident, whereas most White students do. Given the income distribution by race in South Africa, as well as the previous apartheid legacy, we expect a greater portion of Black individuals to be disadvantaged. Once again disadvantaged students are less able to take advantage of technology implementations potentially increasing education inequalities.

Tying this all together we see that a great proportion of students from previously advantaged backgrounds tend to end up at well-resourced institutions throughout their life. They have exposure to technology and resources from previous schooling and because of their wealth they

have a greater probability of ending up at well-resourced institutions. When these well-resourced institutions place more emphasis on technology in learning, students at these institutions are more likely to benefit from online learning compared to students from disadvantaged backgrounds; at the same advantaged institutions. Furthermore, students from disadvantaged backgrounds who attend less resourced HDIs will be the most disadvantaged of all the student groups.

If universities are receiving funding for the implementation of technology in education, then universities could be implementing a regressive policy. As those benefiting from the technology implementation are already advantaged. The funding is not being used to benefit previously disadvantaged students even though they need more assistance in their learning compared to advantaged students. These policies would then be widening an inequality gap in education.

There is however, the counter argument that online education could help students with disabilities or working students gain access to universities, which they previously would not have been able to. And arguments state, that even though existing inequalities could grow, it could be potentially offset by the benefits of providing university education to this market that previously would not have access to it.

4.2. Limitations and Recommendations of the data used in this thesis

4.2.1. Limitations

- 1) Limited sample size
- 2) Inability to accurately assess student outcomes-lack of measurement in terms of a treatment and control group
- 3) No accurate measure to assess students level of access to technological resources
- 4) Inability to assess the difference in outcomes when comparing online education to blended learning

Although the survey has very useful information and asks many relevant questions regarding technology in higher education, the analysis must be done with caution due to the small sample size. Furthermore, while the survey is useful in that it is based on student's perceptions of technology in higher education - these perceptions are subjective. As a result, the qualitative information should be treated with the necessary precautions.

In addition, it is difficult to measure student outcomes from the use of technology in their education experience as there is no defined treatment and control group in our sample. We are comparing different students at one point in time, and it would be useful to see results over time between online and f2f teaching.

There are very little appropriate measures in the survey looking at student's access to resources which facilitates online learning. Therefore, it is difficult to analyse the benefits of online learning or the integration of technology into education if we cannot accurately establish a variable to measure students' relative access to resources. The data only shows which devices students have, but not how the devices are used.

Finally, the paper speaks broadly about blended learning and online learning, with the one being a variation of the other. Therefore, it becomes difficult to understand the degree to which full online courses influence student outcomes, and which demographic of student will benefit from blended learning more than another. This is because the two forms of learning differ, and the degree to which they differ is unknown.

An overall limitation of this study is that it was a cross sectional study and although the results are interesting these results cannot be used to infer causation. Instead they should be understood to provide thought criteria for institutions and other academics in their adaption of traditional f2f teaching to online education or blended learning.

4.2.2. Recommendations

Create a bigger sample to increase the reliability of the estimates. The survey could be done over more days at different universities. Furthermore, Unisa would be a good institution to observe as they specialize in distance education.

In addition, the survey should follow the same students over time to develop an estimate that accurately measures student results -with a reasonably identified treatment and control group. By doing this, the impact of online learning when compared to traditional classes can be more reliably estimated, though not entirely. It is however, difficult to get such a measure, as ethically, the medium of delivery cannot be changed without good reasoning. In addition, there is the argument that student grades are not the only measure that is important in education quality. However, it is the measure which seems to matter the most. Other factors such as

student's engagement in the course, and their perceptions or feelings to the course could potentially be important indicators of the course's educational quality.

A more holistic measure of "technology access" should be obtained, where students can describe their access to digital devices. One possibility is for students to estimate the average time they have undisturbed access to a digital device.

Finally, an institution could randomly assign some students to do a course through blended learning and other students do the course online and then observe the difference in student grades and satisfaction between the two mediums. These results could be used to determine how much of a difference blended learning has on student grades when compared to fully online courses.

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